HAZARD ALERT

Worker Exposure to Silica during Countertop Manufacturing, Finishing and Installation

The Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) have identified exposure to silica as a health hazard to workers involved in manufacturing, finishing and installing natural and manufactured stone countertop products, both in fabrication shops and during in-home finishing/installation. This hazard can be mitigated with simple and effective dust controls in most countertop operations.

Introduction

Workers involved in manufacturing, finishing, and installing natural and manufactured stone countertops are at risk for significant crystalline silica exposure. Crystalline silica commonly occurs in nature as the mineral quartz, and 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.**

Silicosis results in permanent lung damage. Silica dust particles become trapped in lung tissue, causing inflammation and scarring and reducing the lungs' ability to take in oxygen. Symptoms of silicosis can include shortness of breath, cough and fatigue, and may or may not be obviously attributable to silica. Workers exposed to airborne crystalline silica also are at increased risk for lung cancer, chronic obstructive pulmonary disease (COPD), and kidney disease.

OSHA and NIOSH investigated U.S. worker exposure to respirable crystalline silica in the stone countertop industry following reports from other countries of stone countertop workers developing silicosis.[1, 2] In at least some cases from Spain and Israel, workers were exposed in shops operating without dust suppression, and without respiratory protection.[2, 3] While the stone industry in the United States has worked to implement dust controls to protect workers against the dangers of silica exposure,[4] studies and OSHA inspections indicate that exposure levels may not be adequately controlled in some stone countertop fabrication worksites in the U.S.[5]

Courtesy David L. Johnson & Margaret Phillips, University of Oklahoma Health Sciences Center

Cutting stone, as pictured, generates dangerous crystalline silica dust that can become trapped in lung tissue and cause silicosis.

This Hazard Alert focuses on countertop industry worker exposures to airborne silica dust, including from quartz in stone. It covers the health effects of breathing silica dust, recommends ways to protect workers, and describes how OSHA and NIOSH can help employers effectively reduce silica dust exposures. Employers must ensure that workers are properly protected from exposure to silica.

The Stone Countertop Industry

Stone industry workers in shops and on job sites throughout the United States saw, grind, polish, and drill slabs of natural (mostly granite) and manufactured (man-made, engineered, or cultured) stone as part of manufacturing, finishing, and installing countertops. Whether working with natural or manufactured stone, producing finished countertops involves similar tasks. Working with natural stone, however, involves different initial steps than working with manufactured stone. Granite and other natural stones are quarried and cut into large stone slabs where exposure to crystalline silica dust is likely. These slabs are further cut to countertop sizes at the quarries or at stone finishing shops. Manufactured stone countertop production—actually making the engineered or cultured slabs—involves mixing crystalline silica, resins, and pigments. Workers in the natural cut stone industry as well as those involved in finishing and installing both natural and manufactured stone are at risk of significant silica exposure. In both industries, production operators (such as sawyers), inspectors (including quality control technicians), and staff who perform maintenance and housekeeping activities in manufacturing facilities also may be exposed to hazardous levels of airborne silica-containing dust.

Why is silica a concern for workers in stone countertop manufacturing, finishing and installation?

Stone countertops contain high amounts of the natural mineral silica.

Finished natural and manufactured stone products, including finished countertops, do not present a health hazard themselves. However, cutting, grinding, chipping, sanding, drilling, and polishing natural and manufactured stone products can release hazardous levels of very small, crystalline silica dust particles into the air that workers breathe. Working with ground quartz in the countertop manufacturing industry can also expose workers to dangerous silica dust.

How much silica is in countertop material?

Depending on the type of stone in question, countertops may contain over 90% silica. The highest silica levels are associated with manufactured countertops, where pigments and adhesives comprise the remaining materials. Silica content is generally lower in natural stone products. Calcium-based stones, including limestone and certain varieties of marble (e.g., calcite, dolomite, and onyx), contain little or no silica. In contrast, granite can contain up to 45-50% silica. The table below describes typical silica/quartz content of common natural and engineered stones. Note that silica/quartz content will vary among stone varieties, and the exact content can be determined by petrographic and X-ray diffraction analysis on each rock.

Stone	Average % Silica
Engineered stone	≥93
Quartzite	95
Quartzitic sandstone	90
Sandstone	60
Granite	10 - 45
Slate	Varies
Soapstone	Varies

Sources: Silica Hazards from Engineered Stone Countertops, NIOSH Science Blog, March 2014; ASTM C616, *Standard Specification for Quartz-Based Dimension Stone;* American Geological Institute, *Dictionary of Geological Terms*

Certain work operations release crystalline silica dust into the air.

Workers operating powered hand tools, such as saws, grinders, and high-speed polishers, have some of the highest silica dust exposures in the countertop manufacturing, finishing and installation industries. These exposures come from dry cutting, grinding, edging, and contouring stone, and may occur in shop environments as well as on job sites where finishing work is completed.

In the manufactured stone industry, workers may also be exposed to silica dust when opening bags of ground quartz, moving or mixing bulk raw materials, cleaning and scraping mixers, or cleaning dust collector bag houses.

Workers performing other tasks in areas close to where silica dust-generating operations occur may also be exposed. Without proper engineering controls, such as water sprays or local exhaust ventilation (LEV), and personal protective equipment (PPE), where appropriate, workers can inhale silica-containing dust from these operations.

What can be done at stone countertop worksites to protect workers from exposure to silica?

Under the *Occupational Safety and Health (OSH) Act of 1970*, employers are responsible for providing safe and healthful working conditions for their workers. Employers must determine which jobs and activities expose workers to silica and take actions to control overexposures and protect workers. A combination of engineering controls, work practices, protective equipment, worker training, and other measures is needed to protect workers from overexposure to silica during stone countertop manufacturing, finishing and installation.

Monitor the air to determine worker exposures to silica

Collect respirable crystalline silica dust samples to determine which jobs expose workers to silica above exposure limits. Employers should consult with a trained occupational safety and health professional, such as a certified industrial hygienist, or contact OSHA's free On-site Consultation Program for small and medium-sized businesses: www.osha.gov/consultation.

If air samples show levels above OSHA's Permissible Exposure Limit (PEL), employers are required to take action to reduce worker exposures to below the PEL.

NIOSH Recommended Exposure Limit (REL)

NIOSH recommends that employers control exposure to respirable crystalline silica so that no worker is exposed to a time-weighted average concentration of silica greater than 50 µg/m^3 of air, as determined by a full-shift sample for up to a 10-hour workday of a 40-hour workweek.

OSHA Permissible Exposure Limit (PEL)

The OSHA general industry PEL for quartz, the most common form of crystalline silica, is an 8-hour time-weighted average exposure to respirable dust. For pure quartz silica, the PEL is approximately equal to 100 µg/m^3 of air.

However, both OSHA and NIOSH recommend that employers take the protective actions below to keep worker exposures below the NIOSH Recommended Exposure Limit (REL).

Control dust exposures by using engineering controls and safe work practices

Engineering controls and work practices provide the best protection for workers and must be implemented first, before respiratory protection is used. Working with industry partners, NIOSH and OSHA have identified the following control options for countertop manufacturing, finishing and installation operations:

Engineering controls and equipment changes for manufacturing and finishing

- Use water spraying systems and remote-controlled tools at the impact site where a saw or grinder generates dust.
- Large bridge or gantry-like saws usually use water sprays and can be remote-controlled for dust control and cooling.
- Hand-held angle grinders can be modified to deliver water to the point of contact with the stone.
- Wet-edge milling machines or stone routers can replace dry grinders in shops. They provide a clean edge profile with a diamond wheel.
- Use hand tools (e.g., drills, masonry saws, grinders) equipped with a shroud and a vacuum with a high efficiency particulate air (HEPA)-filter when wet methods are not practicable.
- Install LEV systems at fixed locations to capture dust at its point of origin.
- Use a combination of both water and ventilation controls, if necessary.

Work practices

- Use wet sweeping or HEPA-filtered vacuuming instead of dry sweeping or compressed air.
- Replace water and air filters as needed to control dust.
- Adjust water flow as necessary to control dust, following manufacturers' recommendations for water flow rates.
- Pre-wash stone slabs prior to cutting.
- Implement regular and thorough housekeeping procedures for water slurry and settled dust.

In high exposure areas, such as where cutting or polishing work generates silica dust, provide HEPA-filtered vacuums for cleaning worker clothes and water for hand, face, and hair cleaning.

Several OSHA standards and directives cover operations that may expose workers to silica, including:

- Air Contaminants (29 CFR 1910.1000)
- Hazard Communication (29 CFR 1910.1200)
- Respiratory Protection (29 CFR 1910.134)

OSHA's Directive CPL 03-00-007, titled *National Emphasis Program – Crystalline Silica,* has detailed information on silica hazards, guidelines for air sampling, guidance on calculating PELs for dust containing silica, and other compliance information.

Identify and isolate remaining dust-generating operations

- Through air monitoring, identify high exposure activities associated with countertop finishing operations. These likely involve angle grinding, other types of grinding and cutting with saws.
- Isolate the silica dust-producing operation(s) using enclosures or walls. Enclosures are more effective when used with LEV.
- Alternatively, enclose the person, if possible, by putting him or her in a control booth.
- In some severe cases it may be necessary to isolate some finishing tasks in separate areas.[6] This may be needed more frequently for manufactured stone because of its high silica content.

For installation operations in commercial and residential spaces

- Do as much work as possible under controlled shop conditions instead of on site, or perform work outdoors or in well-ventilated areas to reduce respirable crystalline silica dust exposure.
- Wet methods for dust control may not be practicable on or near finished cabinets, walls, and floors, so other suppression methods (e.g., LEV) should be used during these operations.
- Use grinding and drilling tools equipped with dust shrouds coupled with LEV and a HEPA filter. Controls can be either tool mounted (drills) or attached to a vacuum system.
- Use a HEPA-filtered vacuum to clean up dust as soon as practicable.

The Marble Institute of America (MIA) technical module, "Silicosis – An Industry Guide to Awareness and Prevention," offers tips on controlling silica exposures in stone cutting operations. It is available to workers and employers on the MIA web site: www.marble-institute.com/silica/Silicosis_Industry_Guide_Tech_Module_2008.pdf. Other resources from MIA can be found at: www.marble-institute.com/silica.

Provide respiratory protection when it is needed to protect workers

When engineering and work practice controls do not limit silica exposures to OSHA's PEL, employers must provide workers with respirators. Whenever respirators are required, the employer must have a respiratory protection program that meets the requirements of OSHA's Respiratory Protection standard (29 CFR 1910.134, www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716). This program must include proper respirator selection, fit testing, medical evaluations, and training.

The workers shown above are wearing a NIOSH-approved N95 filtering facepiece respirator (left), a full facepiece elastomeric respirator (center), and a loose-fitting powered air-purifying respirator (PAPR) (right).

If respirators are provided, use at least a NIOSH-approved N95 respirator. If the silica level is more than 10 times the PEL, a half-face respirator is not protective enough and a respirator that offers a greater level of protection, such as a full-facepiece respirator that will protect workers at silica levels up to 50 times the PEL, must be used. Powered air-purifying respirators (PAPR) also provide more protection than half-face air-purifying respirators. In general, workers find PAPRs to be more comfortable than pressure-demand respirators, including tight-fitting elastomeric varieties.

For more information, visit OSHA's Safety and Health Topics web page (www.osha.gov/SLTC/respiratoryprotection) and eTool (www.osha.gov/SLTC/etools/respiratory) on respiratory protection.

Provide training and information to workers about the hazards of silica and other chemicals

OSHA's Hazard Communication standard (www.osha.gov/hazcom) requires that employers provide their workers with training and information about hazardous chemicals used in the workplace. Employers must provide training and information to workers in a manner and language that the worker can understand. Employers must:

- Prepare and implement a written hazard communication program.
- Provide training and information on the hazards of silica and other chemicals used in the workplace.
- Provide workers access to Safety Data Sheets (SDSs) on silica and other hazardous chemicals they are exposed to during countertop manufacturing, finishing and installation.
- Ensure that each container of hazardous chemicals is labeled appropriately.

Consider medical monitoring for workers who are exposed to silica

As part of its National Emphasis Program on Silica (www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3790), OSHA recommends that employers provide medical exams to all workers who may be exposed to silica levels at or above one-half the PEL. Recommended medical tests include:

- A medical exam that focuses on the respiratory system and includes a work and medical history.
- A chest X-ray, evaluated by a qualified professional.

Employers should consult with a clinician, such as a Board-Certified Occupational Medicine physician familiar with the health effects of silica, when developing a medical monitoring program for their workers who are exposed to silica.

For additional information on medical monitoring, refer to OSHA Directive CPL 03-00-007, available at: www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3790.

Findings on Worker Exposures to Silica

Data from OSHA and NIOSH air monitoring and other published studies provide estimates of countertop industry worker exposure to airborne crystalline silica. In most countertop manufacturing, finishing, and installation operations, engineering controls and proper work practices are generally effective in reducing worker exposures to the OSHA PEL, and, in many instances, to levels at or below the NIOSH REL. Respiratory protection may still be necessary to protect workers in some cases, however.

In many shops, current practices still involve dry cutting, grinding, polishing, and other work that releases silica dust into the air. Phillips et al. (2012) found that approximately 74% of 47 countertop shops in three metropolitan areas of Oklahoma reported using predominantly dry methods in at least one step of their work, and only four shops (9%) reported using dust collection or suppression systems at all. The data summarized below provide information on worker exposures to airborne crystalline silica dust and illustrate how the implementation of proper controls can help protect workers from overexposures.

Countertop Finishers in Washington State

Simcox et al. (1999) reviewed data from six separate granite countertop shops in Washington State. Nineteen air samples were taken of fabrication and finishing workers using dry methods without engineering controls such as LEV. These samples showed exposures to silica concentrations between <40 and 770 µg/m^3. Shops using dry methods switched to wet methods, resulting in a dramatic reduction in worker exposure to silica dust. Eighteen samples from workers using wet methods showed silica concentrations between <20 to 100 µg/m^3. In one shop where the workers who were sampled used

bridge saws and angle grinders, the mean silica concentration dropped by 440 µg/m^3 after switching to new and retrofitted water-fed tools.

Cutting Stone Blocks and Slabs

OSHA reviewed results of exposure samples for sawyers from 10 OSHA Special Emphasis Program (SEP) Inspection reports and one NIOSH report. Among 22 instances in which sawyers used wet methods—often a water feed to the saw—to reduce dust, full-shift median exposure was 54 µg/m^3, with mean exposure of 61 µg/m^3 and a range of 15 µg/m^3 to 134 µg/m^3. Twelve results (55%) exceeded 50 µg/m^3, and four results (18%) exceeded 100 µg/m^3.

Where a water feed to a saw alone is not sufficient, spraying the stone before cutting it or between multiple cuts can further reduce exposures. In one operation where workers used wet sawing, they were still exposed to average silica concentrations of 70-110 µg/m^3. Using these added controls resulted in exposures below the 50 µg/m^3 NIOSH REL. The additon of LEV in the shop further reduced exposures to 15-32 µg/m^3.

Courtesy David L. Johnson & Margaret Phillips, University of Oklahoma Health Sciences Center

A worker uses an angle grinder with a polishing pad to finish a stone countertop. The water-fed tool helps reduce exposure to respirable crystalline silica dust generated during grinding and polishing operations.

Exposure Varies by Stone Type

Silica exposure can vary depending on the silica content of the stone used. OSHA collected air samples as part of inspections at several granite and marble shops. In the marble shop, two finishers dry grinding green marble with very low silica content (1.8% quartz) were exposed to airborne silica levels of 39 and 45 µg/m^3 (both below the NIOSH REL), even though no engineering controls, such as water sprays or LEV, were used. In the granite shop, which also did not use engineering controls, airborne crystalline silica dust exposures were considerably higher, ranging from 89 to 460 µg/m^3. It is reasonable to anticipate that performing similar operations using materials with higher silica content, such as some manufactured stone products, could result in even higher exposures.

How Can OSHA and NIOSH Help?

OSHA has compliance assistance specialists throughout the nation who can provide information to employers and workers about OSHA standards, short educational programs on specific hazards or OSHA rights and responsibilities, and information on additional compliance assistance resources. Contact your local OSHA office for more information by visiting: www.osha.gov/html/RAmap.html.

OSHA's On-site Consultation Program offers free and confidential advice for small and medium-sized businesses with fewer than 250 employees at a site (and no more than 500 employees nationwide) to help identify and correct hazards at worksites. On-site consultation services are separate from enforcement and do not result in penalties or citations. To locate the nearest OSHA Consultation office, visit: www.osha.gov/consultation or call 1-800-321-OSHA (6742).

NIOSH Health Hazard Evaluation Program: Employees, employee representatives, or employers can ask NIOSH to conduct Health Hazard Evaluations (HHEs) at their workplace. NIOSH may provide assistance and information by phone or in writing, or may visit the workplace to assess employee exposure and health. Based on their findings, NIOSH will recommend ways to reduce hazards and prevent work-related illness. The evaluation is done at no cost to the employees, employee representatives, or employers. For more information about the HHE program, visit the NIOSH HHE webpage at: www.cdc.gov/niosh/hhe/HHEprogram.html or contact the HHE program by phone at 513-841-4381. For general information or questions about any hazard or illness, call NIOSH Information Service: 1-800-CDC-INFO (1-800-232-4636).

NIOSH recommendations for preventing silicosis, including dust control, sampling and analysis methods, medical monitoring of workers, training, and respiratory protection, can be found at the Silica Topics webpage at www.cdc.gov/niosh/topics/silica.

Workers' Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For additional information on Workers' Rights, Employer Responsibilities, and other services OSHA offers, visit www.osha.gov.

Contact OSHA

For questions or to get information or advice, to report an emergency, to report a fatality or catastrophe, to order publications, to file a confidential complaint, or to request OSHA's free on-site consultation service, contact your nearest OSHA office, visit www.osha.gov, or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

Many states operate their own occupational safety and health programs approved by OSHA. States enforce similar standards that may have different or additional requirements. A list of state plans is available at www.osha.gov/dcsp/osp.

Contact NIOSH

To receive documents or more information about occupational safety and health topics, please contact NIOSH at 1-800-CDC-INFO (1-800-232-4636), TTY 1-888-232-6348, email cdcinfo@cdc.gov, or visit the NIOSH website at www.cdc.gov/niosh.

Industry Information

The Marble Institute of America—a trade association of natural stone producers, exporters/importers, distributors/wholesalers, fabricators, finishers, installers, and industry suppliers—has developed several training videos, guidebooks, and other training resources to assist employers in the stone countertop industry in protecting their workers from exposure to respirable crystalline silica. Visit www.marble-institute.com/silica to learn more.

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Disclaimer

This Hazard Alert is not a standard or regulation, and it creates no new legal obligations. It contains recommendations as well as descriptions of mandatory safety and health standards [and other regulatory requirements]. The recommendations are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace. The Occupational Safety and Health Act *requires employers to comply with safety and health standards and regulations promulgated by OSHA or by a state with an OSHA-approved state plan. In addition, the Act's General Duty Clause, Section 5(a)(1), requires employers to provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. The mention of any non-governmental organization or link to its website in this Hazard Alert does not constitute an endorsement by OSHA or NIOSH of that organization or its products, services, or website.*

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