Silica

POCKET GUIDE

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Silica

Introduction

Crystalline silica refers to several mineral forms of silicon oxide, including quartz, cristobalite, and tridymite that are widely distributed in nature and have characteristic structural habits. Minerals that contain crystalline silica tend to be hard. Processing these minerals often involves grinding and abrasion, which frequently produces significant amounts of airborne fine dust.

What Is Silica?

Crystalline silica is an important material found abundantly in the earth's crust. Quartz, the most common form of silica, is a component of sand, stone, rock, concrete, brick, block, and mortar. Materials containing quartz are found in a wide variety of workplaces.

Silica dust is hazardous when very small (respirable) particles are inhaled. These respirable dust particles can penetrate deep into the lungs and cause disabling and sometimes fatal lung diseases, including silicosis and lung cancer, as well as kidney disease.

Crystalline Silica is OSHA Regulated

- Three forms – Alpha Quartz, Cristobalite, Tridymite
- Most common is Quartz, e.g. concrete or masonry dust
- All Silica forms have distinctive X-ray diffraction patterns

Respirable crystalline silica is created during work operations involving stone, rock, concrete, brick, block, mortar, and industrial sand. Exposures to respirable crystalline silica can occur when cutting, sawing, grinding, drilling, and crushing these materials. These exposures are common in:

- Abrasive blasting/crushing
- Drilling rock and concrete
- Masonry and concrete work
- Mining/tunneling
- Cement and asphalt pavement manufacturing
- Jack-hammering
- Brick and concrete block cutting
- Fiber-cement siding work
- Fracking Operations

History of Silica

The U.S. Department of Labor first highlighted the hazards of respirable crystalline silica in the 1930s, after a wave of worker deaths. The department set standards to limit worker exposure in 1971, when OSHA was created. However, the standards are outdated and do not adequately protect workers from silica-related diseases. Furthermore, workers are being exposed to silica in new industries such as stone or artificial stone countertop fabrication and hydraulic fracturing.

A full review of scientific evidence, industry consensus standards, and extensive stakeholder input provide the basis for the final rule, which was proposed in September 2013. The rule-making process allowed OSHA to solicit input in various forms for nearly a full year. The agency held 14 days of public hearings, during which more than 200 stakeholders presented testimony, and accepted over 2,000 comments, amounting to about 34,000 pages of material. In response to this extensive public engagement, OSHA made substantial changes, including enhanced employer flexibility in choosing how to reduce levels of respirable crystalline silica, while maintaining or improving worker protection.

Health Effects of Silica

Occupational exposure to crystalline silica often occurs as part of or working alongside common workplace operations involving cutting, sawing, drilling, and crushing of concrete, brick, block, rock, and stone products. Operations using sand products can also result in worker inhalation of small (respirable) crystalline silica particles in the air. Health effects from silica exposures include:

- Silicosis, a disabling, non-reversible and sometimes fatal lung disease;
- Other non-malignant respiratory diseases, such as chronic bronchitis;
- Lung cancer; and
- Kidney disease, including nephritis and end-stage renal disease.

To a lesser extent, there is cause for concern that silica exposures may be associated with auto-immune disorders and cardiovascular disease.

Why Respirable Crystalline Silica?

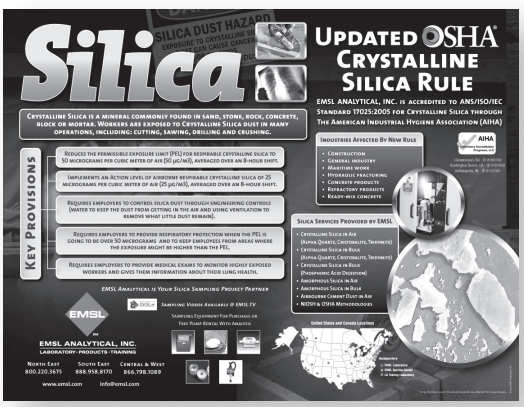
The dust resulting from these processes contains varying amounts of microscopic crystalline silica particles, many of which are of a size range (approximately 0.1 to 10 microns, with a 50% cut point of 4 microns) that deposit in the gas-exchange region of the lung, i.e., the alveoli and bronchioles. These particles are referred to as the respirable fraction. Particles in this size range are not eliminated efficiently from this region, which can lead to damage to lung tissue and / or absorption with damage elsewhere in the body.

Inhalation of these dusts in the course of employment has long been associated with a specific type of lung disease, called silicosis. More recently, chronic exposures to respirable crystalline silica have been associated with lung cancer, as well as diseases of the kidney. For many years, air sampling for these dusts has been a key component in the control of exposure to silica for the prevention of disease.

The Occupational Safety and Health Administration (OSHA) has issued a final rule to help protect workers from exposure to respirable crystalline silica, which was phased into effect on September 23, 2017. The rule revised permissible exposure limits (PELs) for crystalline silica that are from one-half to one-fourth of the previous limits.

Crystalline silica is a mineral commonly found in sand, stone, rock, concrete, brick, block or mortar. Workers are exposed to crystalline silica dust in many daily operations like cutting, sawing, drilling or crushing components that contain crystalline silica. Industries affected by this new rule include construction, general industry, maritime and hydraulic fracturing.

EMSL Analytical, Inc. is accredited to ANS/ISO/IEC Standard 17025:2005 with respect to crystalline silica through the American Industrial Hygiene Association (AIHA). EMSL provides testing services for crystalline silica including alpha-quartz, cristobalite, tridymite and amorphous silica. Let EMSL help you meet OSHA's silica standards.



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OSHA Regulation

On September 23, 2017, the Occupational Safety and Health Organization (OSHA) issued a new rule to curb lung cancer, silicosis, chronic obstructive pulmonary disease and kidney disease in America's workers by limiting their exposure to respirable crystalline silica. The rule is comprised of two standards, one for Construction and one for General Industry and Maritime.

OSHA estimates that the rule will save over 600 lives and prevent more than 900 new cases of silicosis each year, once its effects are fully realized. The rule is projected to provide net benefits of about $7.7 billion, annually.

About 2.3 million workers are exposed to respirable crystalline silica in their workplaces, including 2 million construction workers who drill, cut, crush, or grind silica-containing materials such as concrete and stone, and 300,000 workers in general industry operations such as brick manufacturing, foundries, and hydraulic fracturing, also known as fracking. Responsible employers have been protecting workers from harmful exposure to respirable crystalline silica for years, using widely-available equipment that controls dust with water or a vacuum system.

Establishes a permissible exposure limit (PEL) for respirable crystalline silica of 50 micrograms per cubic meter of air (50 µg/m3), averaged over an 8 hour shift.

Establishes an action level of of airborne respirable crystalline silica of 25 micrograms per cubic meter of air (25 µg/m3), averaged over an 8 hour shift.

OSHA Regulation (Con't)

Requires employers to control silica dust through engineering controls (water to keep the dust from getting in the air and using ventilation to remove what little dust remains).

Requires employers to provide respiratory protection when the PEL is going to exceed 50 ug/m3, and to keep employees from areas where the exposure might be higher than the PEL.

Requires employers to provide medical exams to monitor highly exposed workers and gives them information about their lung health.

MSHA Regulation

On June 17, 2024, the Mine Safety and Health Administration (MSHA) put into effect a new rule with the goal of better protecting miners against occupational exposure to respirable crystalline silica. The rule includes more stringent approaches to airborne exposure monitoring, respiratory protections, corrective actions, and medical surveillance.

At the heart of the new rule is an update to their PEL (Permissible Exposure Limit) and AL (Action Level) for respirable crystalline silica. For full-shift exposures calculated as 8 hour TWA's, the PEL has been lowered to 50 micrograms per cubic meter of air (ug/m3), and the AL to 25 micrograms per cubic meter of air (ug/m3).

Initial exposure monitoring is required for any worker that is exposed, or may be reasonably exposed, to silica. In the event that the initial sampling results fall at or above the AL, but at or below the PEL (25 ug/m3 < 50 ug/m3), re-sampling must occur until the results are below the AL for 2 consecutive sampling events. If any result is above the PEL of 50 ug/m3, corrective actions must be implemented immediately, and be in place until the results fall below the PEL.

MSHA has established formal compliance dates of April 14, 2025 for coal mine operations, and April 8, 2026 for MNM (Metal Non-Metal) mine operations.

An overview of Crystalline Silica Analysis

EMSL Analytical, Inc. uses x-ray diffraction (XRD) to determine the species and mass of silica present on samples taken. These samples are often taken to test the air in the employee's breathing space or area samples around the work site. X-ray diffraction is considered the industry standard and the most accurate method for determining silica content.

EMSL Analytical, Inc. can analyze bulk materials and air samples for silica content.

EMSL Analytical, Inc. is accredited by the American Industrial Hygiene Association (AIHA-LAP) and successful participants in the AIHA PAT Programs silica PT program. The new OSHA Silica standard requires analytical labs to be accreditated against ISO 17025:2005 quality standards as well as to maintain successful participation in a silica proficiency testing (PT) program.

Amorphous Silica

EMSL Analytical, Inc. can also determine the presence of amorphous silica using x-ray diffraction. Amorphous silica is used in high strength concrete, microelectronics and as a filler in rubber, toothpaste, paints and printer ink. It may have the same negative health consequences as crystalline silica.

EMSL Silica Sample Types

- Air Sampling OSHA REGULATED
- Bulk Materials
- Settled Dust
- Surface Wipes

How to Sample for Respirable Crystalline Silica in *Air*

According to the OSHA rule, air samples for respirable silica may be collected on a PVC filter using a size-selective sampler meeting the ISO/CEN criteria for the respirable fraction, including cyclones (aluminum, Dorr-Oliver, GS-1, Higgins Dewell), and the Parallel-Particle Impactor (PPI). A preweighed 37mm 5µm PVC cassette (if respirable dust fraction data are desired) or a standard 37mm 5µm PVC cassette is used with any cyclone for collection. The Parallel Particle impactor also uses 37mm 5um PVC filters, weighed for gravimetric measurement of respirable dust, or unweighed for respirable silica only. Samples can now also be collected on disposable PPI impactors.

The flowrate will vary depending on the sampler used (GS-1 , Dorr-Oliver: 1.7 L/min; Higgins-Dewell: 2.2 L/min; aluminum cyclone: 2.5 L/min, PPI: 2,4, or 8 L/min, or via 2, 4 or 8 L/min disposable PPI).

Minimum collected air volume required to "see" the Permissible Exposure Limit of 50 ug/m3 is 500L. The minimum collected air volume to reach the Action Level (25 ug/m3) is 1000L. Care must be used when sampling near the maximum volume to prevent overloading. Analysis of the samples is by NIOSH 7500 method, analysis of crystalline silica by X-Ray Diffraction (XRD).

Equipment Needed

To collect Silica Air samples, a Disposable PPI Sampler can be utilized, or the traditional Cassette and Cyclone:

Disposable PPI Sampler

- Choose the sampler from your desired flow rate: 2 LPM, 4 LPM or 8 LPM
- Low Flow Sampling Pump (1-4 LPM)
- Field Rotameter
- Tubing
- Primary Calibrator (optional)
- Low Flow Sampling Pump (1-4 LPM)
- Field Rotameter
- Tubing
- Primary Calibrator (optional)

Cassette & Cyclone Method

- Preweighed 5um 37mm PVC Cassette
- Cyclone (SKC, Higgins-Dewell, Dorr-Oliver)
- Cyclone Calibrator-Adapter or Calibration-Jar (Higgins-Dewell, Dorr-Oliver)
- Low Flow Sampling Pump (1-4 LPM)
- Field Rotameter
- Tubing
- Primary Calibrator (optional)

EMSL provides pump and cyclone rental at NO charge.
Nominal fee for preweighed cassette.

Step-By-Step Sampling Guide – Disposable PPI Sampler

Step 1 – Setting Up the Calibration Train

- Apply the calibration adaptor to the top of the PPI inlet plate.
- Remove the protective cap from the PPI exhaust port.
- Connect the PPI exhaust port to the pump inlet using flexible tubing.
- Connect the PPI calibration adaptor inlet to the calibrator port using another section of flexible tubing.

Step 2 – Calibrate the PPI

- Turn on pump and allow it to run for approximately 5 minutes to allow it to equilibrate.
- Calibrate the sampler to the designated flow rate for the PPI in use (ie, 2, 4, or 8 LPM) by adjusting the pump's flow until the calibrator displays the desired flow rate.
- Once the flow rate has been calibrated, dismantle the calibration train by removing the pump, PPI with calibration adaptor, and calibrator from one another.

Step 3 – Sampling

- Connect PPI to the pump using tubing between the PPI exhaust port and the pump inlet.
- Clip the PPI to the worker's collar using the attached clip, and the pump to the worker's belt.
- Turn on the pump and sample for the desired time. Make note of the start time.

Step-By-Step Sampling Guide – Disposable PPI Sampler

- Once sampling is complete, turn off the pump. Make note of the end time.
- Disconnect the PPI from the pump.
- Repeat Step 2 for post-calibration, if desired.

Step 4 – Submit Samples to the Lab

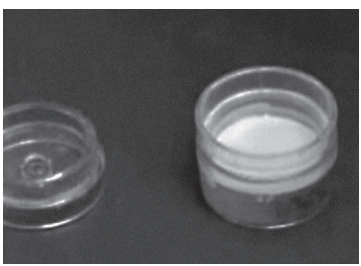
- Fill out a Chain of Custody form with the related sample information.
- Ensure that the physical samples are clearly marked to where they correlate to the appropriate sample descriptions on the COC.
- Pack samples securely and ship to EMSL along with a copy of the Chain of Custody.

Step-by-Step Sampling Guide – Cassette & Cyclone

Step 1.

- Locate the inlet of the Cassette (blue top).
- Cut the plastic band between the inlet section and the middle section of the cassette.

- Remove the top portion of the cassette, and set aside.
- What remains is the middle and bottom part of the cassette and the filter inside.



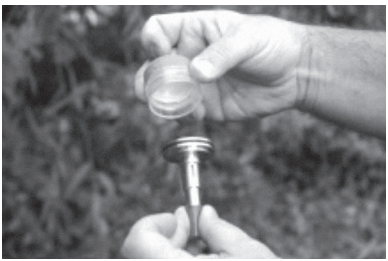
Also, please view the EMSL.TV Silica Sampling Video:

https://www.emsl.tv/silicarespirabledustsampling

Step-by-Step Sampling Guide – Cassette & Cyclone

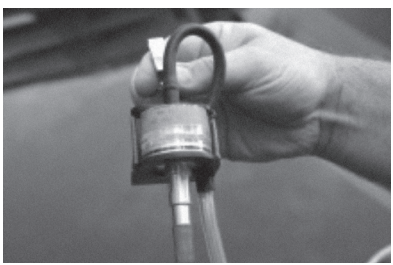
Step 2.

Insert the cyclone into the open section of the cassette:



STEP 3.

Insert the cyclone and cassette into the cassette holder, and attach the hose to the outlet:



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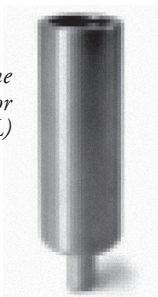
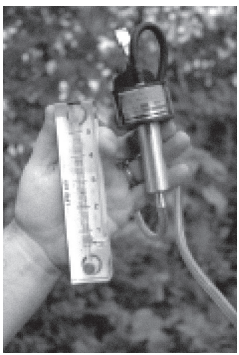
Step-by-Step Sampling Guide – Cassette & Cyclone

Step 4.

- To calibrate, attach the calibrator adaptor to the cyclone.
- Run tubing from calibration adaptor to secondary calibrator, then to pump.
- Turn on the pump.
- Adjust the flow rate of the pump to 2.5LPM.

SKC Cyclone Calibration Adaptor (Provided by EMSL)





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Step-by-Step Sampling Guide – Cassette & Cyclone

Step 5.

- Remove secondary calibrator to begin sampling.
- Place the pump in the sampling area.

STEP 6.

- Perform a post calibration.
- Disassemble the sampling train.
- Close Cassette.
- Complete Chain of Custody form.
- Return cassette to EMSL with Chain of Custody form and return pump rental if utilizing EMSL.

Also, please view the EMSL.TV Silica Sampling Video:

https://www.emsl.tv/silicarespirabledustsampling

Additional Sampling Methods

Bulk Samples

A minimum of 2 to 5 grams in weight is required, with a target sample size of 10 grams collected in a small container or sealable bag. A bulk sample can also be used to categorize site materials for potential silica hazards.

Dust Samples

For any air samples collected, the method calls for a settled dust sample to be taken in order to categorize the silica types present. A minimum of 2 to 5 grams in weight is required, with a target sample size of 10 grams collected in small container, silica sampling cassette or sealable bag.

Wipe & Microvac Samples

Wipe samples can be collected on ghost wipes or an equivalent media, and placed into a sampling tube or sealable bag. Surface dust can also be microvacuumed into a silica, tem, or pcm cassette for sample collection. These samples can help identify surfaces contaminated with silica dust. Typically a surface area of 1 square foot is sampled to obtain a representative dust sample.

EMSL Silica Sampling Supplies

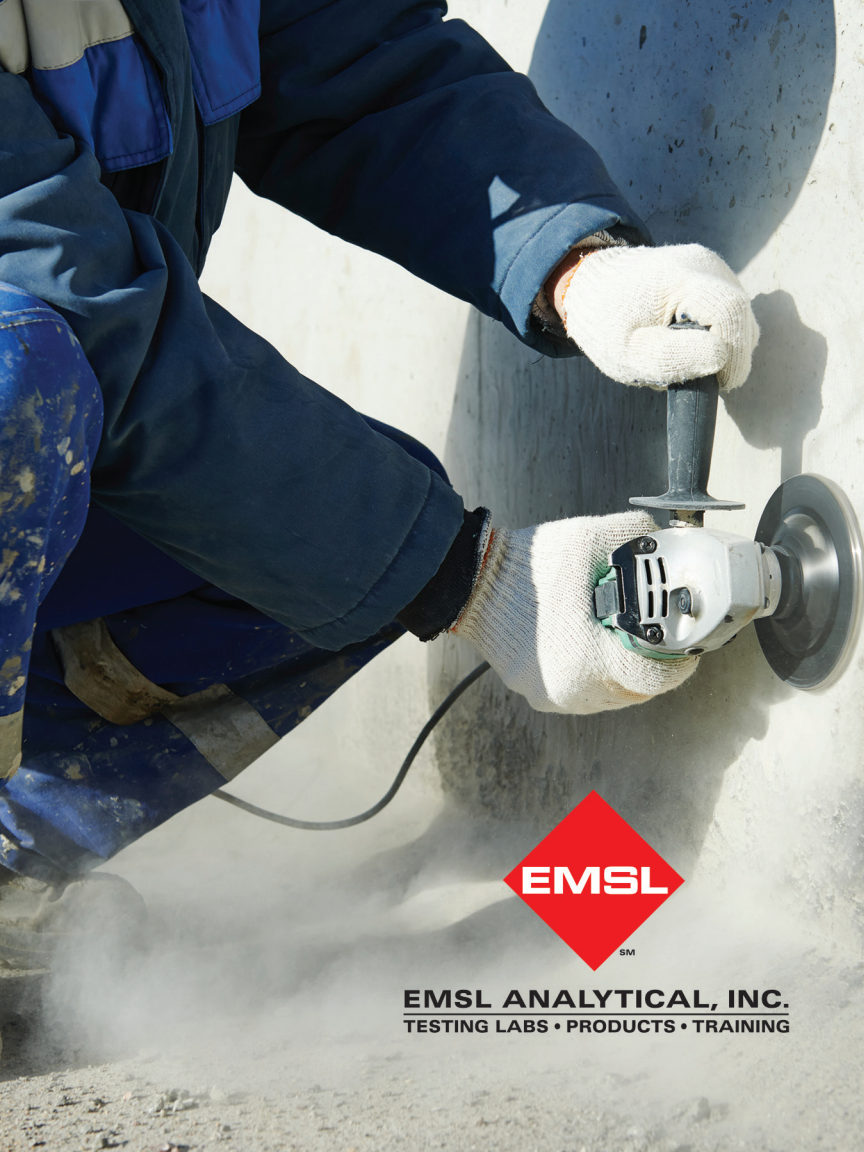
EMSL Product Number	Type	Description
8715500	Cassette	37mm 5um PW PVC Cassette
8715500B	Cassette	37mm 5um PW PVC Cassette (Box)
87IH203	PPI Impactor, 2LPM	Parallel Particle Impactor, 2LPM w/Pre-weighed Filter
87IH205	PPI Impactor, 4LPM	Parallel Particle Impactor, 4LPM w/Pre-weighed Filter
87IH209	PPI Impactor, 8LPM	Parallel Particle Impactor, 8LPM w/Pre-weighed Filter
8706200	Low Volume Pump	Buck Libra L4
8706207	Low Volume Pump	Sensidyne GilAir-3
8715802	Cyclone	Zefon Aluminum Cyclone
8715804	Calibration Adapter	Zefon Calibration Adapter
8706925	Cyclone	Nylon Dorr-Oliver Cyclone
8715800	Calibration Jar	Zefon 1 Liter Calibration Jar
8703915	Primary Calibrator	TSI 4146 Primary Calibrator
8704203	Secondary Calibrator	EMSL Rotameter, 0.4-4 LPM

EMSL Silica Sampling Supplies

EMSL Product Number	Type	Description
87RD050	2LPM PPI Pump Kit	Buck L4 or L5 pump calibrated to 2LPM, medium flow rotameter, 2ft section tubing and calibration adaptor
87RD049	4LPM PPI Pump Kit	Buck L4 or L5 pump calibrated to 4LPM, medium flow rotameter, 2ft section tubing and calibration adaptor
87RD051	8LPM PPI Pump Kit	Buck LP20 pump calibrated to 8LPM, high flow rotameter, 2ft section tubing and calibration adaptor

EMSL provides FREE PUMP RENTAL* with the analysis of your Silica Air samples. Contact us today to learn more!

* Excludes 8LPM PPI pumps



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