

SILICA DUST

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Exposure to dust containing silica can cause silicosis, a progressive, irreversible, and sometimes fatal lung disease. Every year more than one million American workers are exposed to silica dust at their jobs. Deaths from silicosis may number a few hundred cases per year. Hundreds more are being permanently disabled by this disease. Every one of these cases is an unnecessary tragedy. Silicosis is preventable.

- If you work or are an employer in one of the many occupations where dust containing silica is present, you need to know how to prevent this disease and save your life or other workers' lives.
- Employers, safety supervisors, and foremen should work together to develop a silica exposure control program to protect their workers.
 - Explain what silica is
 - Identify occupations that can be exposed
 - Describe silicosis and other health effects of silica
 - List permissible exposure levels of silica
 - Discuss recommended control procedures
 - List guidelines for developing a silica exposure control program

What is Silica?

Crystalline silica, also called alpha silica or free silica, is silicon dioxide (SiO₂). In pure, natural form, SiO₂ crystals are tiny, very hard, translucent, and colorless. Silica is the second most common mineral in the earth's crust and is a major component of sand, quartz, granite, and mineral ores.

- The three most common types of crystalline silica encountered in industry are quartz, tridymite, and cristobalite. Silicates, composed of SiO₂, are also a source of silica (usually less than 1%).
- Silicates include mica, soapstone, talc, tremolite, and Portland cement.
- Quartz content can vary greatly among different rock types. Granite can contain anywhere from 10 to 40% quartz; shales have been found to average 22%, and sandstone averages almost 70 % quartz.

What occupations are at risk to silica exposure?

Any occupation where workers are handling rock, brick, sand, or drilling, quarrying, or tunneling through the earth's crust may expose workers to silica. Silica is present in almost every process where natural minerals are handled.

Occupations exposed to silica dust in various levels:

- Construction: sandblasting, rock drilling, masonry work, jack hammering, tunneling
- Mining: cutting or drilling through sandstone and granite
- Foundry work: grinding, moldings, shakeout, core room
- Ceramics, clay, and pottery
- Stone cutting: sawing, abrasive blasting, chipping, grinding
- Glass manufacturing
- Agriculture
- Railroads: setting and laying track
- Manufacturing and use of abrasives
- Manufacturing of soaps and detergents
- Shipyards: abrasive blasting
- Rock crushing and transport: sand and gravel operations
- Demolition of concrete and masonry structures
- Dry sweeping or pressurized air blowing of concrete or sand dust
- Cement and asphalt pavement manufacturing: concrete mixing, tunneling, and cutting
- Paper and pulp mills: repair or replacement of linings of rotary kilns
- Food processing operations: preparing crops for market, sorting, grading, and washing

Workers encounter high-risk silica exposures through sandblasting, rock drilling, and mining. Workers who remove paint and rust from buildings, bridges, tanks, and other surfaces; clean founding castings; work with stone or clay; etch or frost glass; and work in construction are at risk of overexposure to crystalline silica.

Health effects

Silicosis: Silicosis has taken a serious toll in the United States, attacking workers in many settings.

- ❑ Silicosis is lung damage caused by breathing dust containing fine particles of crystalline silica. If silica particles are inhaled, they become embedded in the lungs, the lung tissues react by developing fibrotic nodules and scarring around the trapped particles. The scar tissue makes the lungs hard and stiff. The scarring can greatly reduce the function of the lungs making it difficult and sometimes painful to breathe.
- ❑ Not only does silica tear up the lungs but it also reduces the body's ability to fight off infections making workers more susceptible for developing other lung illnesses and infections. If workers smoke, silica exposure may greatly increase the risk of developing lung cancer.
- ❑ The incidence of tuberculosis is high among silicosis victims.

Symptoms of silicosis: Early stages of the disease may go unnoticed.

Early symptoms can include:

- Shortness of breath during physical exertion
- Fever
- Occasionally bluish skin at the ear lobes or lips

Progression of silicosis can lead to:

- ❑ Fatigue
- ❑ Labored breathing
- ❑ Loss of appetite
- ❑ Pain in the chest
- ❑ Respiratory failure, which may cause death
- ❑ In severe cases, fibrous tissue can hinder the flow of blood in vessels of the lung and the heart can enlarge in an effort to pump more blood.
- ❑ Death can result from cardiopulmonary effects of chronic silicosis.
- ❑ Chronic silicosis: The most common form of the disease; may go undetected for years in the early stages. Chest x-rays may not reveal an abnormality until after 15 or 20 years of exposure. If you believe you are overexposed to silica dust, visit a doctor who knows about lung diseases. The progress of silicosis can only be stopped; but cannot be cured.
- ❑ Accelerated silicosis: A form of silicosis that shows symptoms within five to 10 years.
- ❑ Acute silicosis: A form of silicosis that develops in workers exposed to very high levels of crystalline silica. Symptoms may appear within only a few weeks of an initial exposure.
- ❑ Silica dust can also irritate worker's eyes. Goggles or safety glasses should be worn if eye irritation is a problem.

Permissible Exposure Levels

The current permissible exposure limit (PEL) for crystalline silica respirable dust is 10 milligrams silica per cubic meter of air (mg/m³) divided by the percent silica in the dust +2. For total dust the PEL is 30mg/m³ divided by the percent silica in the dust +2. **Formula:**

Mineral Dusts		
Substance	mppcf ^a	mg/m ³
Silica:		
Crystalline		
Quartz (Respirable)	250 ^b %SiO ₂ +5	10 mg/m ³ ^e %SiO ₂ +2
Quartz (Total Dust)		30 mg/m ³ %SiO ₂ +2
Cristobalite: Use 1/2 the value calculated from the count or mass formulae for quartz		
Tridymite: Use 1/2 the value calculated from the formulae for quartz		
Amorphous, including natural diatomaceous earth	20	80 mg/m ³ %SiO ₂
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (not containing asbestos)	20	
Talc (containing asbestos) Use asbestos limit		
Tremolite, asbestiform		
Portland cement	50	
Graphite (Natural)	15	
Coal Dust:		
Respirable fraction less than 5% SiO ₂		24 mg/m ³ ^e
Respirable fraction greater than 5% SiO ₂		10 mg/m ³ ^e %SiO ₂ +2
Inert or Nuisance Dust: d		
Respirable fraction	15	5 mg/m ³
Total dust	50	15 mg/m ³

Conversion factors - mppcf X 35.3 = million particles per cubic meter = particles per c.c.

(a) Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

(b) The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

(c) Containing less than 1% quartz; if 1% quartz or more, use quartz limit.

(d) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by this limit, which is the same as the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1.

(e) Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
.5	50
5.0	25
10	0

☐ The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m³ in the table for coal dust is 4.5 mg/m^{3K}.

PEL (mg/m³), respirable dust = $\frac{10 \text{ mg/m}^3}{(\% \text{SiO}_2 + 2)}$

To calculate the PEL for a sample of respirable dust containing 5.0 % SiO₂, substitute 5.0 % in the formula.

PEL = $\frac{10 \text{ mg/m}^3}{(5.0 + 2)} = 1.4 \text{ mg/m}^3$

NIOSH has recommended a PEL of 0.05mg/m³ for a 10-hour shift, 40 hours per week. The American Conference of Governmental Industrial Hygienists (**ACGIH**) recommends the following levels for respirable fraction of the dust.

- 0.05mg/m³ for cristobalite
- 0.1mg/m³ for quartz
- 0.05mg/m³ for tridymite
- 0.1mg/m³ of contained tripoli respirable quartz

Control of Silica Dust Exposures

The key to preventing silicosis is preventing silica dust from being in the air. Employers are required to provide and assure the use of appropriate controls for dusts containing crystalline silica.

Engineering Controls

To achieve compliance with the established PEL, the employer must first implement engineering controls or administrative controls whenever feasible.

Wet work: Airborne silica dust can be minimized or reduced by applying water to the process or clean up. When sawing or drilling concrete or masonry use saws/drills that provide water to the blade.

Isolation: Use containment methods such as blast-cleaning cabinets when sandblasting. Cabs of vehicles or machinery cutting or drilling through rock that might contain silica should be enclosed and sealed.

Ventilation: Use local exhaust systems to remove silica dust from industrial processes. Dilution ventilation may be used to reduce the silica dust concentration to below the PELs in large areas.

- ☐ Adequate measures should be taken to ensure that any discharge would not produce health hazards to the outside environment. A dust collector should be set up so that accumulated dust can be removed without contaminating work areas.
- ☐ Routinely maintain ventilation systems to keep them in good working condition.

Dust Control: A vacuum with a high-efficiency particle air (HEPA) filter can be used to remove dust from work areas.

Substitute with less hazardous materials: Do not use silica sand or other substances containing more than 1% crystalline silica as abrasive blasting materials.

Administrative Controls

Air Monitoring: Air monitoring must be performed to determine exposures, evaluate engineering controls, selecting respiratory protection, evaluate work practices, and determine the need for medical surveillance.

- Exposure measurements should be made in the employee's actual breathing zone.
- Any appropriate combination of long-term or short-term respirable samples is acceptable.
- Total sampling time must be at least 7 hours.
- Monitoring should be repeated at least quarterly.

Workers should be trained in the following:

- The health effects of silica dust exposure
- Operations and material that produce silica dust hazards
- Engineering controls and work practice controls that reduce dust
- The importance of maintenance and good housekeeping
- The proper use of respirators and personal protective equipment
- Personal hygiene practices to reduce exposure
- Details of the employer's hazard communication and crystalline silica program

Housekeeping: Remove dust on overhead ledges, on floors, and equipment before it becomes airborne due to traffic, vibration, and random air current.

- Never dry sweep or use compressed air for cleanup of dust that may contain silica.
- Use wet methods or vacuums with a HEPA filter for clean up.
- Gentle wash down of surfaces is preferable if practical.

Personal Hygiene: Practice good personal hygiene to avoid unnecessary exposure.

- Hand-washing facilities should be conveniently located throughout a worksite in order to minimize worker contact.
- Lockers should be provided for employees to store uncontaminated clothing.
- Workers should shower (if possible) and change out of work clothes contaminated with silica dust before they leave the jobsite. Wearing work clothes home covered in silica dust can expose the workers family to the hazard.
- Work clothes should not be cleaned by blowing or shaking. They should be vacuumed with a HEPA filter vacuum before removal.
- Locate eating/lunch areas away from exposed areas.
- Workers should park their cars where they will not be contaminated with silica.

Restricted areas

- Post warning signs in areas where silica exposure already exists or is possible.
- Unauthorized employees should not be allowed in restricted areas.
- Warning signs should contain the following information:

- SIGN: **WARNING SILICA DUST HAZARD : RESPIRATOR REQUIRED**
- SIGN: **SILICA DUST CAN CAUSE SILICOSIS : RESPIRATOR REQUIRED**

Provide medical examinations: Employers should provide medical examinations for employees who may be exposed to respirable crystalline silica.

- Medical exams should include chest X-rays, pulmonary function tests, and tuberculosis test.
- Chest X-rays should be read by a specialist in dust diseases.
- Develop a plan for reducing exposures of employees whose X-rays show changes consistent with silicosis. Ordinarily, this is accomplished by removal from jobs or tasks involving crystalline silica exposure, but in some cases it may be accomplished by the effective use of supplied air respirators.

Report cases: All cases of silicosis should be reported to state health departments and recorded on OSHA logs, as required.

Personal Protective Equipment: Personal Protective Equipment (PPE) should only be used when engineering and administrative controls do not provide adequate worker protection and reduce the PELs below recommended limits.

- PPE is the last line of defense for fighting silicosis.

Respiratory Protection: Only when all engineering or administrative controls have been implemented, and the level of respirable silica still exceeds permissible exposure limits, may an employer rely on a respirator program to protect workers.

- ❑ The respirator program must comply with the standards for respiratory protection set forth in the respiratory section of your manual.
- ❑ The employer must select and provide an appropriate respirator that will effectively protect their employees.
- ❑ When abrasive blasting is done, the type C supplied-air, positive pressure, demand type abrasive blasting respirator shall be worn.
- ❑ Respirators must be approved by NIOSH for protection against the specific type of dust encountered.
- ❑ An abrasive-blasting respirator must cover the wearer’s head, neck, and shoulders to protect from rebounding abrasives.
- ❑ The respirator program outlined in your manual must be strictly followed to protect workers and comply with OSHA standards.

Respiratory Selection Chart for Crystalline Silica Dust	
Particulate Concentration	Minimum Respiratory Protection* Required Above X** mg/m ³
5X** mg/m ³ or less	Dust respirator
10X**mg/m ³ or less	Dust respirator, except single-use or quarter-mask respirator Fume respirator or HEPA filter respirator Self-contained breathing apparatus (SCBA)
50X**mg/m ³ or less	HEPA filter respirator with a full facepiece Supplied-air respirator with a full facepiece, helmet, or hood SCBA with full facepiece
500X**mg/m ³ or less	Powered air-purifying respirator with a HEPA filter. Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500X**mg/g ³ or entry and escape from unknown concentrations	SCBA with a full facepiece operated in pressure demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary SCBA operated in pressure-demand or other positive pressure mode.
*Only NIOSH-approved or MSHA-approved equipment should be used	
**X indicates the permissible exposure as defined above	

Crystalline Silica Protection Program

A silica protection program is an effective tool that can be used by employers committed to protecting their workers from silicosis.

Elements which need to be included in an effective crystalline silica protection program:

- ❑ Ongoing personal air monitoring program
- ❑ Ongoing medical surveillance program
- ❑ Training and informing workers on hazards of silica dust.
- ❑ Availability of air and medical surveillance data to workers.
- ❑ Engineering controls and a scheduled maintenance program.
- ❑ Work practice controls
- ❑ An effective respiratory protection program
- ❑ Hygiene facilities and clothing change areas
- ❑ Appropriate recordkeeping
- ❑ Housekeeping program
- ❑ Regulated areas.

Silica Dust Exposure Control Program

Employers must develop their own program specific to their industry or worksite.

Our Company recognizes that exposure to silica dust can cause silicosis (a deadly lung disease) and may cause lung cancer.

Our Company takes responsibility for protecting the safety and health of its employees.

The Occupational Silica Dust Control Program includes the following parts:

- Hazard Identification
- Worksite Air Monitoring
- Employee Monitoring
- Housekeeping Procedures
- Engineering Controls
- Personal Hygiene
- Personal Protective Equipment
- Medical Examinations and Evaluation
- Recordkeeping
- Emergency First Aid Procedures for Silica Dust
- Spill and Disposal Procedures

Hazard Identification

Our Company recognizes that the following jobs/task can produce silica dust hazards at our workplace (sandblasting, concrete cutting, determine hazards for each site)

When any of these jobs/tasks are performed by a worker employed by Our Company they will be protected by the Occupational Silica Dust Exposure Control Program.

_____ is responsible for identifying silica dust exposure hazards.

Worksite Monitoring

When a job/task is identified as a silica dust hazard, the process and the worker's breathing zone will be monitored for silica dust concentrations. Employee exposure measurements must represent actual breathing zone exposure conditions for each employee.

Each job/task identified in part one will be monitored every four months and whenever a change is made to the process. Engineering controls will be monitored immediately after implementation and quarterly thereafter.

Employees will be able to view all air monitoring records; copies of the records can be found at _____

_____ is responsible for the worksite monitoring program.

Employee Training

All employees working in the jobs/tasks identified in part one are required to complete a training course prior to working in the exposure area. Workers will be trained when first assigned to the job/task and annually thereafter.

Training for Occupational Silica Dust Exposure will include the following topics:

- Health hazards of silica dust exposure (including signs and symptoms of silicosis).
- Operations and materials that can produce silica dust exposures.
- Engineering and work practice controls used to protect them from exposures.
- The importance of proper equipment and control maintenance.
- Housekeeping procedures.
- Proper use of respirators and the respirator standard.
- Personal hygiene procedures to reduce exposures.

- How smoking increases the risk of developing silicosis and other lung damage.
- The details of the Occupational Silica Dust Exposure Program.

Training will be performed by _____
 Records of attendance, dates of training, and training material will be documented and located at _____

- Additional training or reference material on silica dust exposure will be made available upon request to employees.

Housekeeping Procedures

- Dry sweeping and the use of compressed air are prohibited for removing dust in jobs/task identified in part one. Work areas and equipment covered by dust will be cleaned at the end of every shift by using a HEPA filter vacuum.

Vacuums are stored at _____

- Wet clean up may also be used to remove dust.

Waste material will be stored at _____
 and will be removed at least weekly.

- Supervisors are responsible for ensuring that work areas are free from dust at the end of each shift.

Engineering Controls

- Our Company will use engineering controls whenever possible to control silica dust exposures.

Ventilation systems will be inspected and maintained by _____

- Ventilation systems will be checked at least weekly to determine if they are functioning properly.
- Our Company will not use abrasives that contain more than 1% crystalline silica during blasting operations.

_____ is responsible for inspecting and maintaining engineering controls at all jobs/tasks identified in part one.

Personal Hygiene

Employees working at the jobs/tasks identified in part one will change out of contaminated clothing and work boots before leaving the jobsite. Contaminated clothing will be vacuumed with a HEPA filter vacuum to remove silica dust.

Vacuums will be located at _____

- Lockers or containers will be provided to store clean clothes at the jobsite. Employees are required to wash their hands and shower (when feasible) before leaving the worksite.

Showers are located at _____

Hand washing facilities are located at _____

- When worksites are located in the field away from normal operation Our Company will provide water in portable containers to hand washing.
- Employees will not eat, smoke, or use smokeless tobacco in areas identified in part one.

Personal Protective Equipment

- When respirators are required to protect employees for silica dust exposure Our Company's Respirator Program will be strictly followed.

Copies of the Respirator Program are located at _____

Medical Surveillance

- All workers working in jobs/tasks identified in part one will be given medical examinations to prevent the development of silicosis. Medical examination will be conducted once a year for employees working in jobs/tasks that expose them to silica dust.

Medical examination must include:

- Chest X-rays
- Pulmonary function tests
- Tuberculosis evaluation

Medical examinations will be performed by _____

- Employees whose chest X-rays show changes consistent with the development of silicosis are customarily removed from jobs/tasks that expose them to silica dust. Input from the attending physician will be considered in making this decision.

Medical records will be made available at _____

Recordkeeping

Training, medical records, air monitoring, engineering control maintenance records, and injury records will be kept and located at _____

_____ is responsible for the recordkeeping program.

Emergency First Aid Procedures for Silica Dust

Eye Exposure

- If crystalline silica dust gets into the eyes, wash immediately with large amounts of water, lifting the lower and upper lids occasionally.
- If irritation is present after washing, get medical attention.
- Portable eyewashes will be kept at jobsites in the field away from the company locations.

Breathing

- If a person breathes in large amounts of crystalline silica dust, move the exposed person to fresh air immediately.
- If breathing has stopped, perform chest compressions (if trained).
- Keep the affected person warm and at rest.
- Get medical attention as soon as possible.

Spill and Disposal Precautions

If crystalline silica is spilled or released in hazardous concentrations, the following steps will be taken:

- Ventilate the area of the spill or release.
- Persons doing the clean-up are required to wear appropriate respirators.
- Collect spilled material in the most convenient and safe manner for reclamation or disposal in a secured sanitary landfill.

I have read and understand the requirements of this program and will participate in all training and safety precautions.

Employee Signature _____

Employee Signature _____

Employee Signature _____

Employee Signature _____

Date: _____ Time: _____

