

CHAPTER 2 – HEALTH HAZARDS OF ABRASIVE BLASTING

DID YOU KNOW THAT THAT RESPIRABLE CRYSTALLINE SILICA CAN CAUSE?

- Silicosis
- Chronic Obstructive Pulmonary Disease (COPD)/Emphysema
- Lung cancer
- Chronic Kidney Failure
- Connective tissue disease – rheumatoid arthritis, scleroderma
- Tuberculosis (TB) activation

IF YOU PERFORM ABRASIVE BLASTING, BE AWARE OF THESE HAZARDS:

- Noise
- Metals
- Other Safety and Health hazards

WHAT IS CRYSTALLINE SILICA (QUARTZ)?

Crystalline silica is a natural constituent of the earth's crust and is basic component of sand, quartz, granite and most other types of rock. Quartz is the most common form of crystalline silica. Cristobalite and tridymite are two other forms of crystalline silica. All three forms may become respirable size particles when workers chip, cut, drill, or grind objects that contain crystalline silica.

TWO TYPES OF SILICA

1. Harmful (Silica, crystalline (as respirable dust))

Trade Names for Crystalline Silica

- Quartz
- Cristobalite
- Tripoli
- Tridymite

2. Less-harmful* (Silica, amorphous)

Trade Names for Amorphous Silica

- Diatomaceous earth
- Diatomaceous silica
- Diatomite
- Silica gel
- Silicon Dioxide (amorphous)

* When diatomaceous earth is heated to 450°C (calcined), the amorphous form begins to convert to the crystalline form, cristobalite. As such, it would be defined as toxic.

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WHAT IS SILICOSIS?

Silicosis is a progressive, debilitating lung disease caused by breathing dust containing microscopic crystalline silica particles. Cigarette smoking adds to the lung damage caused by silica.

HOW DOES SILICA HARM MY HEALTH?

The silica dust you inhale damages the region of your lungs where oxygen in the air is exchanged for the carbon dioxide in your blood. This area of your lungs is called alveoli or air sacs. The hairs in your nose and small hair called cilia in your upper lungs will remove a lot of the dust and silica particles before they get into these air sacs. Unfortunately, these hairs can only remove larger particle sizes; the very fine particles of silica dust will escape these defense mechanisms and get into the air sacs. The particles that enter your air sacs are around 3-5 microns (μ) in diameter. To put this into perspective, the diameter of a human hair ranges from 40 μ - 150 μ .

Once in the air sacs, the silica dust stimulates a defense reaction. White blood cells called macrophages in the alveoli ingest the silica and die. The resulting inflammation attracts other macrophages to the region. Scar tissue (fibrous nodules) form to seal off the reactive area. As the condition worsens, the nodules become progressively larger. The scar tissue affects your breathing by limiting how much your lungs can stretch during inhalation. This limits the amount of air you can breathe in. The scarring also produces less surface area available in your air sacs to exchange carbon dioxide for oxygen.

The rate at which silicosis progresses is related to the length of time you are exposed and the amount of respirable silica in the air. The disease may progress even after exposure has stopped.

WHAT ARE THE FORMS OF SILICOSIS?

Silicosis is classified into three forms: acute, accelerated and chronic.

⇒ **Acute**: The acute form of silicosis may develop after only a short period (weeks or months) following extremely high exposure such as occurs with abrasive blasting. The lungs become inflamed and fill with fluid, which causes severe shortness of breath and low blood oxygen levels. Acute silicosis may occur when abrasive blasters blast without respiratory protection. Symptoms include:

- * fever
- * extreme shortness of breath
- * loss of appetite

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- * pain in the chest
- * respiratory failure

⇒ **Accelerated:** Accelerated silicosis occurs after 3-10 years of exposure when exposure conditions are high. Symptoms include severe shortness of breath, weakness, and weight loss. The onset of symptoms takes longer than in acute silicosis. **This form has been described most often in sandblasters.**

⇒ **Chronic:** Chronic silicosis occurs in two forms: simple and complicated. Chronic silicosis occurs after 15–20 years of moderate to low exposures to respirable crystalline silica.

- **Simple Silicosis** (Limited scarring of the lung)

Chest X-rays show small, rounded masses (nodules) about 1 cm in size. Symptoms might include:

- * shortness of breath upon exercising
- * fatigue
- * loss of appetite

- **Complicated Silicosis** (More advanced scarring of the lungs.)

Another name for complicated silicosis is *progressive massive fibrosis (PMF)*. The nodules increase in size and grow together to form larger masses. In fact, the nodules encompass blood vessels and airways. Chest X-rays show both small, rounded masses and large masses (golf ball size and larger). Progression of the disease leads to:

- * fatigue
- * extreme shortness of breath
- * loss of appetite
- * respiratory failure

There is **NO CURE** for silicosis.
PREVENTION IS THE ONLY ANSWER.

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WHAT ARE OTHER DISEASES CAUSED BY SILICA EXPOSURE?

⇒ **Chronic Obstructive Pulmonary Disease (COPD)**

In addition to silicosis, inhalation of respirable crystalline silica particles increases the risk of other lung diseases, primarily COPD. COPD includes chronic bronchitis, emphysema, bronchiectasis, and chronic airway obstruction. Symptoms include:

- * Chronic cough
- * Shortness of breath while doing everyday activities (dyspnea)
- * Frequent respiratory infections
- * Blueness of the lips or fingernail beds (cyanosis)
- * Fatigue
- * Producing a lot of mucus (also called phlegm or sputum)
- * Wheezing

Smoking cigarettes causes COPD and the combination of smoking cigarettes and silica exposure markedly increases your chance of getting COPD more so than just smoking or just being exposed to silica. Stopping smoking, no matter how long you have smoked, reduces your chance of getting COPD or if you have COPD of it getting worse.

⇒ **Tuberculosis (TB)**

Silica exposure is a risk factor for developing TB. Silica particularly affects the cells that control TB infection and makes people more likely to get sick from TB bacteria if they are exposed. Symptoms include:

- * Coughing that lasts three or more weeks
- * Coughing up blood
- * Chest pain, or pain with breathing or coughing
- * Unintentional weight loss
- * Fatigue
- * Fever
- * Night sweats
- * Chills
- * Loss of appetite
- * Shortness of breath.

⇒ **Lung Cancer**

The International Agency for Research on Cancer (IARC), a recognized authority on the health effects of chemicals and mineral dusts, has classified silica as a known cancer-

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causing agent. Lung cancer symptoms may include:

- * Persistent cough lasting three or more weeks
- * Coughing up blood
- * Chest pain, or pain with breathing or coughing
- * Fatigue
- * Shortness of breath.
- * Weight Loss

Smoking cigarettes causes lung cancer and the combination of smoking cigarettes and silica exposure markedly increases your chance of getting lung cancer more so than just smoking or just being exposed to silica. Stopping smoking, no matter how long you have smoked, reduces your chance of getting lung cancer.

⇒ **Autoimmune Disease and Chronic Renal Diseases**

Workers occupationally exposed to crystalline silica may develop autoimmune diseases such as scleroderma, systemic lupus erythematosus (lupus), and rheumatoid arthritis. Kidney failure has been observed among workers with high silica exposure, such as in abrasive blasters.

WHAT MIOSHA AND OSHA REGULATIONS APPLY?

The MIOSHA and OSHA general industry standard and construction standard establishes a permissible exposure limit (PEL) for respirable crystalline silica of 50 micrograms of respirable crystalline silica per cubic meter of air ($50 \mu\text{g}/\text{m}^3$) calculated as an 8-hour time-weighted average (TWA), and an action level of $25 \mu\text{g}/\text{m}^3$ calculated as an 8-hour TWA. In addition to the exposure limits, the standard includes provisions to protect employees such as requirements for exposure assessment, methods for controlling exposure, respiratory protection, medical surveillance, hazard communication, and recordkeeping.

⇒ **General Industry** employers performing abrasive blasting are subject to the requirements outlined in MIOSHA Occupational Health Standard, Part 590 - Silica in General Industry.

⇒ **Construction employers** performing abrasive blasting are subject to the requirements as outlined in MIOSHA Occupational Health Standard, Part 690 - Silica in Construction.

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Please Refer to Appendix III:
**MIOSHA Part 590: Silica in General Industry
and
MIOSHA Part 690 – Silica in Construction**

Other relevant MIOSHA and OSHA regulations pertaining to the use of silica include: abrasive blasting, air contaminants, respiratory protection, posting of warning signs, record keeping, reporting of occupational illnesses, occupational noise exposure, personal protective equipment, and training. There are also rules on hazard communication, safety and health programs, and access to employee exposure and medical records.

A reminder to both workers and employers:

The American Lung Association recommends quitting smoking for better lung health.

Call 1-800-LUNG-USA for more information on how to quit.

WHERE CAN YOU GET MORE INFORMATION ON PREVENTING SILICOSIS?

- ⇒ **Michigan State University:** Our website contains information on silicosis, this training manual, and other health and safety information. Internet Address: www.oem.msu.edu/.
- ⇒ **MIOSHA Silica Resource Page:** MIOSHA developed a Silica resource page containing links to Part 590 and Part 690, MIOSHA resources and federal OSHA resources. The MIOSHA Silica Resource page can be found [here](https://www.michigan.gov/lara/0,4601,7-154-11407_15317-413123--,00.html) (https://www.michigan.gov/lara/0,4601,7-154-11407_15317-413123--,00.html).
- ⇒ **OSHA Safety and Health Topic: Silica, Crystalline:** OSHA's Safety and Health Topics pages provide regulatory and enforcement information, hazard identification and controls as well as best practices and other resources to assist employers, workers and safety and health professionals ensure safer workplaces. Internet Address: <https://www.osha.gov/dsg/topics/silicacrystalline/>

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- ⇒ **CDC-NIOSH Silica Topic Page:** The Centers for Disease Control (CDC), National Institute for Occupational Safety and Health (NIOSH) has a searchable bibliographic database of occupational safety and health publications, documents, grant reports, and journal articles supported in whole or in part by NIOSH as well as other information on silica and silicosis. Internet Address: <https://www.cdc.gov/niosh/topics/silica/default.html>

- ⇒ **Center for Construction Research and Training (CPWR): Working Safely with Silica.** This site includes the tools and information needed to identify silica hazards, understand the health risk, and find equipment and methods to control the dust. Users will also find information on regulatory and voluntary efforts to minimize silica exposures as well as a central place to share successes and challenges. Internet Address: <https://www.silica-safe.org/>

- ⇒ **NIOSH Workplace Safety and Health Topics:**
 - **Silica.** Internet Address: <https://www.cdc.gov/niosh/topics/silica/default.html>
 - **Abrasive Blasting.** Internet Address: <https://www.cdc.gov/niosh/topics/blasting/>

- ⇒ **NIOSH Alert “Preventing Silicosis and Deaths from Sandblasting”** Publication No. 92-102. Internet Address: <https://www.cdc.gov/niosh/docs/92-102/>

- ⇒ **NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Silica,** April 2002. DHHS (NIOSH) Publication No. 2002-129. Internet Address: www.cdc.gov/niosh/02-129pd.html

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Other Health Hazards

NOISE

Repeated exposure to noise levels where it is difficult to hear someone speaking and/or loud impact noises can lead to permanent deterioration of your hearing system. An evaluation of noise levels and their duration during the day should be conducted. Noise levels associated with abrasive blasting operations (e.g. loud machinery as well as sound reverberating from the surface of impacted materials) can pose serious risks to hearing and often exceed the MIOSHA PEL (90 dBA); 90 dBA is the PEL for both general industry and construction.

TABLE 1
PERMISSIBLE NOISE EXPOSURES¹

Duration per day, hours	Sound level dBA, slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

¹ When the daily noise exposure is composed of 2 or more periods of noise exposure of different levels, their combined effect shall be considered, rather than the individual effect of each. If the sum of $C(1)/T(1) + C(2)/T(2) + \dots + C(n)/T(n)$ exceeds unity, then the mixed exposure shall be considered to exceed the limit value. C(n) indicates the total time of exposure at a specified noise level, and T(n) indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Part 380: Noise Exposure in General Industry, Table 1

TABLE D-2
PERMISSIBLE NOISE EXPOSURES

Duration per day, hours:	Sound Level dBA Slow Response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Part 680: Noise Exposure in Construction, Table 2

For both **General Industry** and **Construction** employers, if employees are subjected to **sound exceeding the levels listed in the relevant table, feasible administrative or engineering controls are required**. Engineering controls are defined as any modification or replacement of equipment or related physical change at the noise source or along the transmission path that reduces the noise level. If the controls fail to reduce sound levels within the levels listed in the relevant table, hearing protective equipment such as muffs or plugs are required to be provided and used to reduce employee noise exposure below the levels listed in the table.

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- ⇒ **General Industry** employers: when noise levels equal or exceed 85 dBA (the action level (AL)), the employer must develop a hearing conservation program. Abrasive blasting operations are loud and often exceed the AL. Part 380 requires the hearing conservation program to include:
- Noise exposure monitoring
 - Noise control process
 - Hearing protection
 - Education and notification
 - Audiometric evaluation
 - Record keeping
- ⇒ **Construction Industry** employers: An employer is required to provide a continuous and effective hearing conservation program if sound levels exceed the values shown in Table D-2. Part 680 does not describe what elements are necessary to comply with the language “a continuous and effective hearing conservation program”. It is highly recommended that construction employers adopt and implement the requirements described in the General Industry Standard Part 380.

METALS

Before you blast, find out what you are blasting with and on, and protect yourself from the hazards. Metals cause adverse health effects in nearly every organ of your body.

You should be aware of the hazards associated with exposure to metals including inorganic arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, titanium, tin and vanadium. MIOSHA has air contaminant rules for both general industry and construction for these materials.

The OSHA [Lead in Construction Advisor](https://webapps.dol.gov/elaws/oshalead.htm) (<https://webapps.dol.gov/elaws/oshalead.htm>) is one of a series of Employment Laws Assistance for Workers and Small Businesses Advisors (e-laws) developed by the U.S. Department of Labor (DOL) to help employers and employees understand their rights and responsibilities under Federal employment laws.

Read the Safety Data Sheet (SDS) of the abrasive material you are using. Silica substitutes may also contain potential health contaminants. If you don't have the SDS, request it from the supplier before you blast. If you cannot obtain it, assume the worst-case scenario and protect yourself accordingly.

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GENERAL SAFETY AND HEALTH HAZARDS

⇒ **OTHER HAZARDS** associated with abrasive blasting are the hazards of:

- media ricochet
- a jammed hose
- slips, trips, and falls from accumulated dust particles (especially when a particularly slippery abrasive material is used, such as steel shot or glass)
- falls when working from heights
- fatigue
- carbon monoxide exposure
- danger of one blaster inadvertently shooting another

REFERENCES:

Appendix III – MIOSHA Occupational Health Standards

Appendix III-A: PART 590 - Silica in General Industry

Appendix III-B: PART 690 - Silica in Construction

Appendix IV - MIOSHA Occupational Health Standards:

Appendix IV-A: PART 523 - Abrasive Blasting

Appendix IV-B: PART 601 - Air Contaminants in Construction

Appendix IV-C: PART 301 - Air Contaminants in General Industry

Appendix IV-D: PART 680 - Noise Exposure in Construction

Appendix IV-E: PART 380 - Noise Exposure in General Industry

Appendix V contains:

Occupational Safety and Health Administration. Occupational exposure to respirable crystalline silica-review of health effects literature and preliminary quantitative risk assessment. 2010; Docket OSHA-2010-0034. Internet address: https://www.osha.gov/silica/Combined_Background.pdf.

NIOSH Alert “Preventing Silicosis and Deaths from Sandblasting” Publication No. 92-102. Internet Address: <https://www.cdc.gov/niosh/docs/92-102/>

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Notes