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SILICA EXPOSURE

- October 2021



DUST EXPOSURE

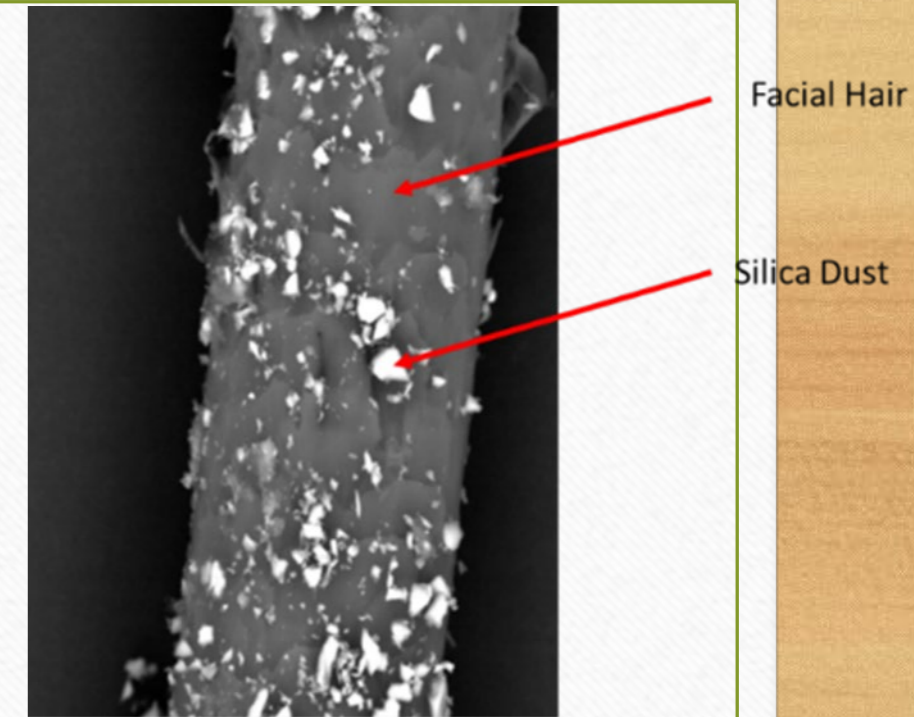
When mining and processing minerals, the mined ore undergoes a number of crushing, grinding, cleaning, drying, and product sizing operations as it is processed into a marketable commodity. These mechanized operations can generate large amounts of dust, potentially exposing workers to elevated levels of airborne dust. Therefore, federal regulations are in place to help to protect workers by limiting their respirable dust exposure, and mining operations implement engineering controls in an effort to reduce dust generation and limit worker exposure.

DUST

Dust can be broadly defined as small solid particles created as a consequence of the breaking up of larger particles. Depending on their size, these particles can become hazardous to worker health, particularly when suspended in air. The largest size particle that can be suspended in air for long periods of time from wind velocity acting upon it is about the thickness of a human hair.

Smaller airborne particles of dust, which can remain suspended in air for hours, pose a greater risk to the respiratory system when inhaled. In general, the smaller the aerodynamic diameter of the inhaled dust particle, the more likely it will be deposited more deeply in the respiratory tract.

Respirable—particles that are small enough to remain suspended in the air, enter the respiratory tract through the nose or mouth, pass through the trachea, reach the respiratory bronchioles, and be deposited in the inner regions of the lungs where gas exchange occurs (alveolar regions). These particles are generally considered to be 10 μm in diameter and smaller [ACGIH 2007].



Current MSHA Dust Standards for the Metal/Nonmetal Mining Industry

Currently, the U.S. metal/nonmetal mining industry airborne dust standard is regulated and defined by the Federal Mine Safety and Health Act of 1977. Federal regulations set PELs for airborne contaminants for surface and underground metal and nonmetal mines incorporating by reference the 1973 edition of the American Conference of Governmental Industrial Hygienists threshold limit values.³

That publication lists a 10 mg/m³ “nuisance particulate” exposure limit for dust containing no asbestos and less than 1 percent respirable crystalline silica. If the sampling history at a mine indicates that the dust contains no asbestos and less than 1 percent respirable crystalline silica, total dust sampling should be considered [MSHA 2018].

Regulation #####

10-mm Dorr-Oliver cyclone and 37-mm filter cassette assembly



Self-adjusting sampling pump

Photos by NIOSH

Two workers wearing personal gravimetric sampling assemblies. The pump connects to the cyclone/filter unit via Tygon tubing. In these examples, note that the cyclone unit for the worker on the right should be raised to ensure that it is closer to his breathing zone, as it is for the worker on the left.



- Personal gravimetric dust sampling is conducted to quantify a worker's average exposure to respirable dust exposure over his or her working shift. A dust sampling inlet is placed within the breathing zone of the worker to obtain a representative measure of the worker's exposure.
- Results from this sampling show that the worker's exposure is either above or below acceptable levels or that action needs to be taken to lower respirable dust levels in the worker's breathing environment. If elevated dust levels are encountered, personal protective equipment (PPE) is required while engineering or administrative controls, or both, are being implemented to reduce respirable dust levels below the PEL.

When workers inhale respirable dust, the particles can penetrate the body's defense mechanisms and reach the gas exchange region of the lungs. Respirable crystalline silica particles that deposit in the lungs stimulate an inflammatory and toxic process that can ultimately develop into clinically recognizable silicosis. Depending on the concentration of respirable crystalline silica and duration of exposure, workers may develop any of three forms of silicosis (Figure 1.2)

[NIOSH 2002]:

- *Chronic*—resulting from long-term excessive exposures, first clinically apparent 10–30 years after first exposure.
- *Accelerated*—resulting from exposure to higher concentrations of respirable crystalline silica, first clinically apparent 5–10 years after the initial exposure.
- *Acute*—resulting from exposure to unusually high concentrations of respirable crystalline silica, clinically apparent within weeks to 5 years after the initial exposure.

Chronic silicosis, the most common form of the disease, typically results in characteristic nodular scarring in the lungs. Over time, the initial small nodules can eventually coalesce into large fibrotic masses—a condition called progressive massive fibrosis.

Accelerated silicosis, much less common than chronic silicosis but progressing more rapidly, results from inhaling very high concentrations of respirable crystalline silica over a shorter period of time.

Acute silicosis, a rarely occurring form of the disease, is the most serious and most rapidly fatal form, and it results from inhaling extremely high concentrations of respirable crystalline silica over a very short time period.

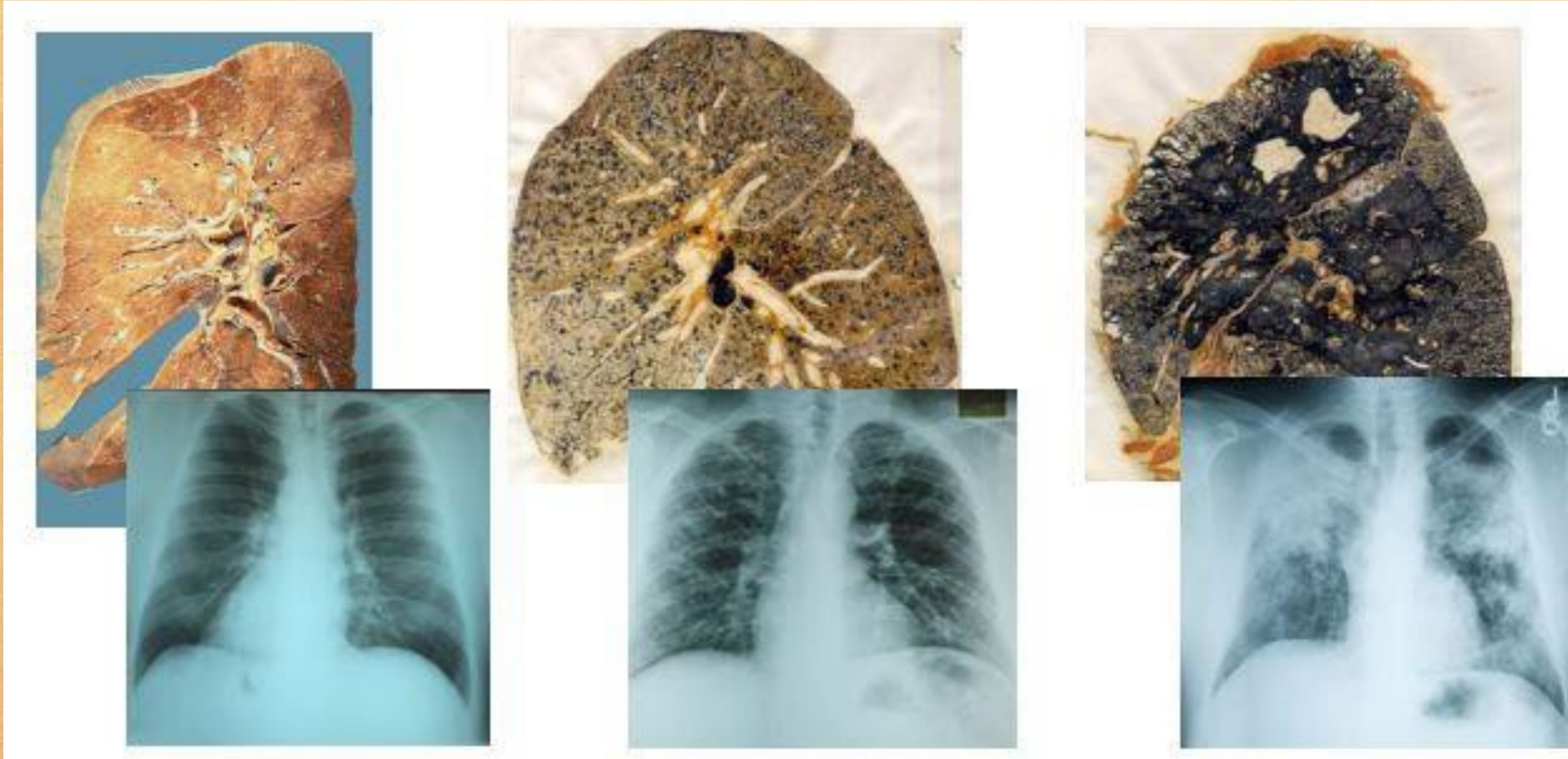
Silicosis can result in various symptoms, including chest irritation with uncontrollable coughing and shortness of breath, and can be debilitating and warrant therapeutic intervention.

Additionally, those with silicosis are at substantial risk for developing tuberculosis or other mycobacterial diseases [NIOSH 2002; Davis 2002].²

Silicosis is the most common among the pneumoconiosis diseases associated with respirable crystalline silica overexposure in mining. Silicosis is an incurable and often fatal lung disease caused by the inhalation of respirable crystalline



Photos by NIOSH



Photos by NIOSH

Figure 1.2. Photos and radiographs of lungs. The left photo shows a normal lung, the center photo shows a lung with simple silicosis, and the right photo shows a lung with complicated silicosis.