Respirable silica in mining

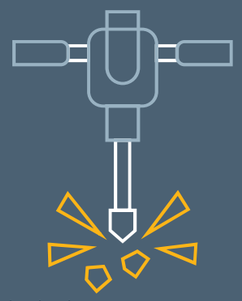
Respirable silica in mining

Silica is one of the most abundant natural minerals and is the major component of most rocks and soils. Crystalline silica is the form of silicon dioxide that is abundant in most soils and rocks. Other forms of silica are less harmful than crystalline silica and include amorphous and fumed silica.[1]

TYPE	AMOUNT
Granite	25-40%
Shale	22%
Natural sandstone	67%
Composite (engineered) stone	>90%

When mechanical energy is applied to silica-containing ore and other rocks, such as crushing and grinding, then small, respirable particles of crystalline silica (RCS) particles can be generated. These respirable particles are generally too fine to see unless specific lighting conditions exist.

RCS generating activities in mining



Dust that contains RCS is generated during mining activities such as:

- drilling and blasting
- extraction
- hauling
- crushing and screening
- stockpiling aggregates, construction materials and sands

Maintenance activities can also generate significant dust and are sometimes overlooked.

Health hazards associated with RCS dust

Workers exposed to elevated levels of RCS have an increased risk of developing lung diseases such as[2]:

- chronic obstructive pulmonary disease (COPD)
- chronic bronchitis and emphysema
- acute silicosis
- accelerated silicosis
- chronic silicosis
- progressive massive fibrosis (PMF)
- lung cancer

Exposure pathways

RCS dust is created when crystalline silica is broken down and released into the air, which then has the potential to be inhaled. This respirable fraction (<10µm) can enter deep into the lungs and can penetrate the gas exchange area of the lungs (the alveolar region).

Respirable crystalline silica is an aggressive, lung-damaging dust because it is able to penetrate deep into the lung. The type and extent of the diseases are influenced by the particle size, composition, concentration and duration of exposure.

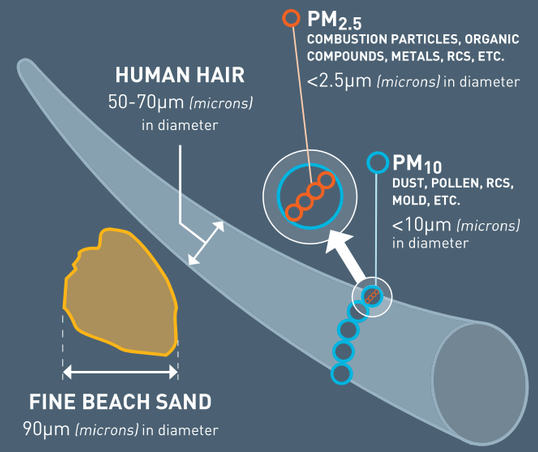


Diagram: United States Environmental Protection Agency https://en.wikipedia.org/wiki/File:PM_and_a_human_hair.jpg

Regulatory requirements

Regulation 49 of the *Work Health and Safety (Mines) Regulations 2022* outlines that mine operators must ensure that no person at the mine is exposed to a substance or mixture in an airborne concentration that exceeds the exposure standard for the substance or mixture. In addition, r635A states that an operator of a mine must ensure that the concentration of any airborne contaminant at the mine is as low as is reasonably practicable.

The current workplace exposure standard for RCS is 0.05 mg/m^3 as an 8-hour time weighted average.

Risk assessment

Once a health hazard has been identified, an operator must use appropriate health risk assessment methods to investigate and evaluate the hazard (r675EA). The health risk assessment must be conducted by a person or group that is competent to conduct the assessment (r617). The risk assessment must include all operational activities, areas or phases of operations and address all aspects of the hazard (e.g. likelihood, consequence, different ways the hazard may arise, or different impacts it may have in different circumstances). The outcomes of the health risk assessment should be further documented in the site Health Management Plan (HMP) (r675EA).

RISK MATRIX EXAMPLE

			POTENTIAL CONSEQUENCES				
			L5	L4	L3	L2	L1
			Minor injuries or discomfort. No medical treatment or measureable physical effects.	Injuries or illness requirimg medical treatment. Temporary impairment.	Injuries or illness requiring hospital admission.	Injury or illness resulting in permanent impairment.	Fatality.
			Not significant	Minor	Moderate	Major	Severe
LIKELIHOOD	Expected to occur regularly under normal circumstances	Almost certain	Medium	High	High	High	High
	Expected to occur at some time	Likely	Medium	High	High	High	High
	May occur at some time	Possible	Low	Medium	High	High	High
	Not likely to occur in normal circumstances	Unlikely	Low	Low	Medium	Medium	High
	Could happen, but probably never will	Rare	Low	Low	Low	Low	Medium

The need for dust monitoring

Monitoring worker exposure to respirable dust and RCS is often an important component of assessing the risk. Regulation 50 of the Work Health and Safety (Mines) Regulations 2022 outlines that exposure monitoring must be undertaken if you are unsure if the dust at your site exceeds the workplace exposure standard for RCS, or if you are uncertain if RCS is a risk to worker health at your site.

Hazard determination

Results of monitoring conducted to identify a RCS exposure concentration or risk to worker health under r50 of the WHS (Mines) Regulation 2022, should be reviewed by a qualified occupational hygienist. The characterisation of worker exposure to RCS can be undertaken by evaluating the monitoring data. Statistical metrics including the geometric mean of results, the estimated average (MVUE) of measurements, 95% upper confidence limit of the MVUE, or the 95th percentile probability distribution can be used to establish compliance with exposure standards. A report outlining the review of the monitoring results and comparison with the workplace exposure standard should be provided by the occupational hygienist.

Health monitoring

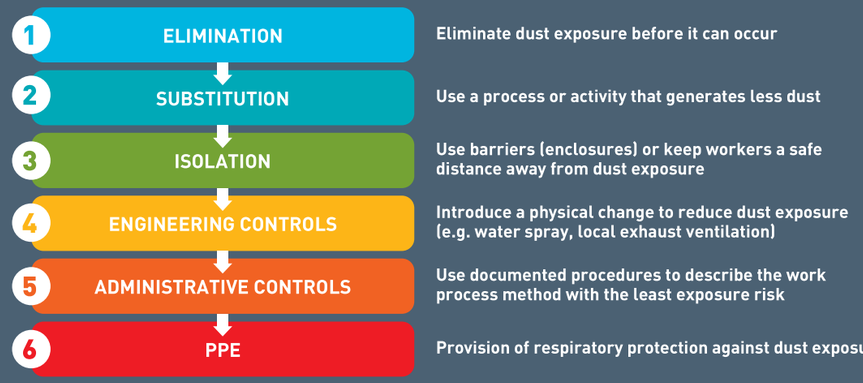
Health monitoring is required to be provided by the employer, at no cost, to workers who are at risk of adverse health effects from exposure to a hazardous substance in the workplace.[3] Health monitoring usually involves taking a work and medical history, a physical examination including a breathing assessment such as spirometry. The examination may include a low dose high resolution computed tomography (HRCT) scan. The requirement or otherwise for HRCT scans should be made via consultation between the approved medical practitioner and an appropriately qualified occupational hygienist.

Control measures

Controls for silica containing dust, in the mining industry, must be implemented based on the hierarchy of controls.[4]

- **Elimination** of activities or processes that generate dust.
- The **substitution** of plant or processes to those that generate less dust.
- **Isolating operators** from dust exposure by use of an enclosed cab and filtration system, remote operation, or by conducting tasks upwind of dust-generating activities.
- **Engineering controls**, for example local exhaust ventilation or using water sprays or mists to suppress dust where it is generated, e.g. hoppers, conveyors, vibrating components, and discharge points.
- **Administrative controls**, including operational and maintenance procedures, must be developed with consideration given to reducing worker dust exposures.
- The selection of **PPE** must be considered the last line of defence and only used when the above controls are not adequate or impractical, or in conjunction with other controls. RPE (Respiratory Protective Equipment) fit testing and training are essential if RPE is relied on as a control (AS 1715).[5]

HIERARCHY OF DUST CONTROL



Examples of controls

Practical and pragmatic guidance on dust control for mining applications are outlined in the NIOSH publication "Dust Control Handbook for Industrial Minerals and Processing."[6] This document provides information on effective control technologies that lower workers' dust exposure during:

- drilling
- load and haul
- crushing
- screening
- conveyance
- bagging
- loadout
- transport

Implementation of the engineering controls outlined can assist operators, health specialists, and workers in reaching the ultimate goal of eliminating the risk posed by respirable crystalline silica and other occupational diseases caused by dust exposure in the mining industry.

Resources and further information

1 DMIRS Mines Safety Bulletin No 163, Reducing expoxsure to respirable crystalline silica (quartz)
2 SafeWork Australia, Health monitoring guide for crystalline silica
3 DMIRS, Health Surveillance – Silica (respirable crystalline) A Guide for Medical Practitioners
4 AIOH position paper, Respirable Crystalline Silica and Occupational Health Issues
5 Australian Standard AS/NZS 1715:2009 – Selection, use, and maintenance of respiratory protective equipment
6 NIOSH Dust Control Handbook for Industrial Minerals Mining and processing