

CHEMICAL HAZARDS

Risks related to crystalline silica

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This is a translation of the original French version available at: [Programmes de santé au travail pour les établissements / Commission des normes de l'équité de la santé et de la sécurité du travail - CNESST](#). In the event of any discrepancy or inconsistency between the French and English versions, the French version shall prevail.

1. INTRODUCTION

1.1. Background

Workers can be exposed to crystalline silica dust in the workplace. The health effects of inhaling these dusts can be serious, even fatal, and disabling when they lead to the development of lung diseases such as silicosis and cancer. These diseases generally only appear after many years of exposure, and they continue to develop even after exposure has ceased. The risk posed by crystalline silica therefore needs to be managed.

Crystalline silica is the most abundant mineral in the earth's crust. It is also the main component of sand, rock and numerous minerals.

Crystalline silica is used in the manufacture of many products, including kitchen countertops, glass, ceramics, paint, abrasives and cosmetics. It is also used in the manufacture of cement and concrete, refractory products and polymers. The main workplaces concerned are listed in the section [High-risk sectors of activity, trades or tasks](#).

1.2. Legal obligations

This occupational health program is developed in accordance with section 107 of the *Act respecting occupational health and safety* (AOHS). The employer is required to take it into account in its prevention program (AOHS, s. 59) or in its action plan (AOHS, s. 61.2). It contains recommendations for the prevention of health problems linked to crystalline silica exposure and, in particular, sets out the preventive measures to be implemented to protect the health of exposed workers. Thus, the employer must determine which actions of the occupational health program to consider and include in its prevention program or action plan to deal with situations of exposure to crystalline silica in its workplace.

Section 61 of the AOHS provides that the Commission may order an employer to submit a prevention program. It may also order the employer to amend the content of the program, in particular to bring it into line with the elements of the occupational health programs it develops. Section 127(1) of the AOHS provides that the public health director may assess the components of a health program, prevention program or action plan and make recommendations to the employer, the Commission and, where applicable, the health and safety committee.

The information presented in this health program provides general guidelines. It is strongly recommended to consult the tools presented in the section [For more information](#) for the preventive actions to be implemented in workplaces.

2. RISK PROFILE

2.1. Overview of crystalline silica

Crystalline silica exists in several forms:

- Quartz is a major component of many rocks. It is the most common form of crystalline silica in its natural state. Tripoli is a microcrystalline form of quartz.
- Cristobalite, relatively rare in nature, can be found in volcanic rocks. In certain industrial processes, quartz is transformed into cristobalite at high temperatures.

2.2. Routes of exposure and health effects

Crystalline silica dust enters the body via the respiratory tract (through inhalation). Chronic exposure to crystalline silica can cause a lung disease known as silicosis. This disease occurs when the finest silica dust is embedded in the lower parts of the lung (the alveoli). The accumulation of fine dust causes inflammation, which is the lung's defence mechanism. Scarring forms and disrupts the passage of oxygen through the bloodstream, leading to irreversible respiratory failure. Generally, the signs of silicosis can be seen on chest X-rays before the onset of symptoms such as cough and shortness of breath.

There are three forms of silicosis:

- **Chronic silicosis:** Develops progressively and appears on X-ray after at least 10 years of exposure. The risk of developing chronic silicosis increases with the duration and extent of exposure.
- **Accelerated silicosis:** Develops and appears within 5 to 10 years of exposure to higher concentrations of crystalline silica.
- **Acute silicosis:** Develops and appears after a short period of exposure to very high concentrations of crystalline silica.

Other health effects

According to international bodies (e.g. International Agency for Research on Cancer, National Toxicology Program), exposure to crystalline silica dust causes **lung cancer**.

Lung infections, such as tuberculosis, can complicate silicosis.

Exposure to crystalline silica is associated with other **non-malignant lung diseases**, such as chronic obstructive pulmonary disease (COPD). It can also play a role in certain **autoimmune diseases**, such as rheumatoid arthritis, scleroderma and systemic lupus erythematosus.

2.3. Legislation and best practices

2.3.1. Permissible exposure values (Quebec regulatory standards)

For crystalline silica (quartz/tripoli or cristobalite), the permissible exposure value (PEV)¹ is 0.05 mg/m³ expressed as inhalable particulates (IP), for an 8-hour workday and a 40-hour workweek.

This is known as the “time-weighted average exposure value” (TWAEV).²

Other PEVs for shorter exposure periods (excursion limits) and unusual work schedules (AAVAs) can be found in the *Regulation respecting occupational health and safety* (ROHS). In addition, the sum of the fractions of the mixture (Rm) must be considered when workers are simultaneously exposed to more than one form of crystalline silica.

Under regulations, crystalline silica is recognized as a substance having a suspected carcinogenic effect in humans (C2). This is why workers’ exposure must be reduced to a minimum (EM rating), even when regulatory values are respected.

2.3.2. Threshold Limit Value

The threshold limit value (TLV) represents an exposure threshold beyond which preventive measures should be implemented to avoid harmful effects on health. It is based on the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH)[®]. For example, for crystalline silica, it is recommended that prevention measures be implemented as soon as exposure reaches 0.025 mg/m³ over 8 hours. Applying preventive measures even when regulatory values are respected is prudent.

2.3.3. Zero tolerance

Silica is one of CNESST’s zero-tolerance targets. [A zero-tolerance sheet](#) (in French only) on exposure to crystalline silica is available. It sets out the preventive measures that employers must apply.

¹ Maximum concentration, as defined in Schedule I of the *Regulation respecting occupational health and safety* (ROHS) for an air contaminant or group of air contaminants, which must not be exceeded in the air in a worker’s respiratory zone for a period,

² Average concentration, weighted for a period of 8 hours per day, based on a 40-hour week, of a chemical substance (in the form of gas, dust, fumes, vapours or mists) present in the air in a worker’s respiratory zone

3. HIGH-RISK SECTORS OF ACTIVITY, TRADES OR TASKS

Exposure to silica occurs in many sectors of the economy and affects a large number of professions/trades.

These work situations are presented in the non-exhaustive lists below. Other situations can also be a source of exposure to crystalline silica.

High-risk sectors of activity

- Motor vehicle dealerships
- Construction
- Mining, quarrying and oil and gas extraction
- Manufacturing (non-metals, metals, machinery, computer and electronic products, vehicle bodies, motor vehicles and parts)
- Other miscellaneous merchant wholesalers
- Repair and maintenance of motor vehicles
- Sawmills

High-risk professions or trades

- Logging truck driver
- Auto body repairer
- Concrete finisher, bricklayer, tilesetter
- Labourers in metal and mineral processing, well drilling and servicing, and processing services
- Mechanic (industrial, construction and heavy equipment), motor vehicle mechanic
- Miner, driller, blaster
- Forging machine and metalworking machine operator, glass forming and cutting machine operator, stone processing machine operator
- Landscaper
- Welder, machinist and machining and tooling inspector
- Foundry worker, moulder

Examples of high-risk tasks or processes

- Mining activities, including crushing, grinding and mineral screening
- Abrasive sandblasting
- Cutting, etching, grinding, dry buffing, sawing, carving and finishing of stone, rock, concrete, brick, mortar and other products that may contain silica.
- Manufacture of bricks, concrete blocks, stone countertops, ceramic products
- Coremaking, fettling, grit removal from sand moulds
- Sanding or sandblasting concrete walls or vehicle bodies

4. PREVENTION APPROACH

4.1. Identify and analyze risks

4.1.1. Identify risks

Identifying high-risk situations involves identifying processes or tasks in the workplace that generate crystalline silica dust. It enables the workplace to analyze and prioritize risks. This step can be accompanied by environmental monitoring, i.e. measuring the contaminant in the work environment.

There is a risk of exposure to silica whenever a task or process causes dust from the following materials or products to be airborne:

- slate, asphalt, concrete, brick, ceramic, cement, gypsum joint compounds, fibre cement, granite, aggregate, sandstone, silicate refractories, mortar, quartz countertops (synthetic stone or composite materials), interlocking paving stones, sand, etc.
- product for which crystalline silica quartz, tripoli or cristobalite is listed in section 3 of the safety data sheet
- product subjected to temperatures above 450°C for which amorphous silica is listed in section 3 of the safety data sheet

Caution: harmful dust is not visible to the naked eye. It is possible for workers to be exposed to crystalline silica even when there is no dust cloud.

4.1.2. Analyze risks

When one or more high-risk situations are identified, they need to be analyzed and actions must be prioritized. For silica, the actions to be taken are adapted based on the three levels of risk described below.

High risk

Any situation corresponding to one of the following statements:

- Visible dust cloud **AND/OR** absence of source control measures.
- Permissible exposure value (PEV) exceeded (e.g. exposure levels above 0.05 mg/m³ over 8 hours)

Actions needed:

- Apply the hierarchy of controls ([see the “Correct” section](#)).
- While waiting for corrective measures, wear [respiratory protective equipment](#) (RPE) in accordance with a respiratory protection program (RPP).
- Assess workers’ exposure before and after corrective measures that have an impact on airborne silica concentrations.*

Contact the Réseau de santé publique en santé au travail (RSPSAT) occupational health physician to assess the relevance of adding silicosis screening in the prevention program or action plan

Moderate risk

Any situation corresponding to the following statement:

- Source control measure(s) in place and effective **AND** exposure levels unknown or between 0.025 mg/m³ and 0.05 mg/m³ over 8 hours; no visible dust cloud.

Necessary action:

- Apply the hierarchy of controls.
- Assess the workers’ exposure levels if they are not known.*
- Contact the [RSPSAT](#) occupational health physician to assess the relevance of including screening for silicosis in the prevention program or action plan.

Recommended action:

Wear [respiratory protective equipment](#) (RPE) in accordance with a respiratory protection program (RPP).

Low risk

Any situation corresponding to the following statement:

- Source control measure(s) in place and effective **AND** exposure levels less than 0.025 mg/m³ over 8 hours.

Necessary actions:

- Continue to apply the hierarchy of controls.

Reassess workers' exposure when changing tasks or processes.*

*To measure workers' exposure levels, samples must be taken in the respiratory zone by a person competent in occupational hygiene. Silica dust should be sampled and analyzed following the methods described in the [Sampling guide for air contaminants in the workplace](#) from the IRSST. The physician in charge must report to the CNESST, the employer and the health and safety committee any deficiency likely to require preventive measures.

4.2. Correct risks

Once the high-risk work situations have been identified and the actions to be taken prioritized, corrective measures must be implemented to eliminate or reduce worker exposure. These corrective measures should be chosen in accordance with the hierarchy of controls. It is often necessary to combine several preventive measures to prevent harmful effects on workers' health. It is up to the workplace to determine which of the following preventive measures are applicable to their situation.

Elimination at the source or substitution

Elimination at the source ensures the highest level of safety, since the risk is removed from the workplace (e.g. modifying a process to avoid the use of crystalline silica).

Wherever possible, a product that contains **crystalline silica should be replaced by a less toxic one that does not**, such as **using synthetic olivine** in the abrasive blasting process.

4.2.2. Engineering control

Engineering controls make it possible to reduce workers' exposure to silica dust. Here are a few examples:

- automate the process to eliminate the presence of the worker for a high-risk task, or change parameters to reduce the generation of silica dust
- isolate the process by enclosing the source generating silica dust (e.g. cutting operation)

- isolate the worker by equipping a closed cabin with high-efficiency particulate air (HEPA) filters (e.g. quarry vehicle)
- reduce the quantity of dust emitted at the source by using tools equipped with HEPA-filtered dust collectors or tools equipped with a water supply
- reduce the quantity of dust emitted at the source by wetting materials before operations involving cutting, drilling, grinding, etc.
- reduce the amount of silica in water by filtering or decanting dust captured by water scrubbing when water is recirculated in the system (e.g. during granite cutting)
- dilute the dust in the air by using a general ventilation system or by airing the room through natural ventilation

4.2.3. Awareness-raising

In addition to engineering controls, measures that improve workers' ability to identify risk must be put in place.

Here are a few examples:

- delineate the area where high-risk tasks are carried out
- post signs to identify jobs or tasks where personal protective equipment (PPE) must be worn.

4.2.4. Administrative controls

Administrative controls help to improve workers' ability to carry out their tasks while minimizing their exposure. They make it possible to introduce safe work methods. Here are a few examples:

- provide workers with safe work procedures and instructions on organizing work, tasks and responsibilities
- prohibit the use of air jets or sweeping for housekeeping activities, and remove dust through HEPA-filtered vacuuming or the wet method
- prohibit eating, drinking or smoking in work areas
- use HEPA-filtered capture systems or tools with an integrated water supply
- implement shift rotations to avoid exposure of the same workers to high-risk situations throughout the shift
- ensure preventive maintenance of tools, machines and equipment, and replace HEPA filters according to manufacturers' recommendations

It is important to train workers adequately. Training must include the following topics at a minimum:

- identification of high-risk tasks
- exposure levels
- principles of exposure reduction
- health effects
- hygiene measures to follow, such as no eating, drinking or smoking
- work procedures

- proper use of preventive measures to reduce or control the risk, such as source capture, wetting of materials and the use of personal protective equipment (PPE)
- respiratory protection program (RPP)

Training must be tailored to all workers, including those with occasional exposure such as summer students and temporary or agency workers.

4.2.5. Personal or collective protective equipment

Personal protective equipment (PPE) must be used if the preventive measures in place are not sufficient to ensure the protection of workers' health, or until such measures are implemented.

The use of [respiratory protective equipment \(RPE\)](#) is recommended as soon as worker exposure levels are likely to exceed 0.025 mg/m³ over 8 hours. However, it becomes mandatory when levels exceed regulatory values such as the time-weighted average exposure value (TWAEV) of 0.05 mg/m³.

RPE must be worn in accordance with [a respiratory protection program \(RPP\)](#), in particular to ensure that workers are wearing their RPE properly and are able to clean, inspect and store it correctly. In this context, before supplying tight-fitting RPE, a fit test must be carried out. For workers with beards, RPE is available, such as a loose-fitting hood, helmet or flexible mask with face shield.

Adequate hydration is important during hot spells. Workers wearing RPE must also take frequent breaks, outside of work areas. In extreme cases, postponing the activity should be considered.

Other personal protective equipment, such as gloves, goggles or safety boots, may need to be worn depending on the task. Wearing protective apparel to prevent contamination outside the work area is recommended.

4.3. Control risks

Once corrective measures have been implemented, the employer, in collaboration with the workers, must ensure that they remain in place permanently.

The following control measures must therefore be implemented:

- plan preventive maintenance on machines, equipment and tools
- regularly reassess the possibility of implementing corrective measures to further reduce workers' exposure
- identify new work situations where exposure to silica presents a high or moderate risk
- introduce a purchasing policy giving preference to equipment that generates less dust
- specify the frequency of surface cleaning and changeovers replacement

- assess and update the respiratory protection program (RPP) annually
- regularly remind workers of procedures and best work practices
- include training for new employees to help them recognize high-risk tasks and properly apply preventive measures
- carry out inspections to validate that workers are making proper use of preventive measures

5. MEDICAL SURVEILLANCE

5.1. All sectors

According to the criteria established by the Communauté médicale de pratique en santé au travail du Québec (CMPSATQ), only screening for accelerated and chronic silicosis is recommended. Screening consists of a work history questionnaire and a chest X-ray.

Silicosis screening in the context of medical surveillance of workers exposed to silica must be carried out in conjunction with the necessary preventive measures and never to the detriment of the latter.

Screening should be done whenever a worker is exposed to more than 0.025 mg/m³ on an annual basis (weighted average over the duration of their shift, i.e. 8 hours) or its equivalent. All silicosis screening activities must be performed according to the [Guide to the medical supervision of workers exposed to silica](#) (in French only). Workplaces with a moderate or high risk of crystalline silica exposure should contact their occupational health team or an occupational health physician. They will determine whether screening is required, taking into account the worker's exposure and work history. In addition, the [Practice guide concerning the worker's free and informed decision in the context of occupational health screening or medical surveillance \(2019\)](#) (in French only) should be applied during medical surveillance.

5.2. Mining and quarrying

Companies in these sectors are subject to the [Regulation respecting pulmonary health examinations for mine workers \(S-2.1, r.7\)](#), which sets out the medical monitoring protocol to be implemented.

6. SERVICES OFFERED BY RSPSAT TEAMS

The Réseau de santé publique en santé au travail (RSPSAT), together with its partners and in accordance with its legal mandates under the *Act respecting occupational health and safety* (AOHS), the *Public Health Act* (PHA) and the *Act respecting health services and social services* (AHSSS), works to prevent and protect workers' health by supporting workplaces in meeting their obligations to prevent occupational illness. The RSPSAT has multidisciplinary teams (medical, nursing, occupational hygiene, ergonomics, psychosocial risks, etc.) with expertise in occupational health that are entirely funded by the Fonds de la santé et de la sécurité du travail. It has been offering its services free of charge throughout Quebec since the adoption of the AOHS in 1979.

Specifically, with regard to the risk posed by exposure to crystalline silica, the RSPSAT may:

- identify situations at risk of overexposure
- assess and measure worker exposure
- support the workplace in prioritizing the preventive measures to be implemented, taking into account other hazards present in the workplace
- support the workplace and advise on the choice of preventive measures to be implemented
- assess the effectiveness of preventive measures implemented
- provide information sessions on health effects, preventive measures to be used and the respiratory protection program to raise awareness among workers and employers
- support the workplace in developing its respiratory protection program and selecting respirators
- carry out medical surveillance in accordance with the *Guide to the medical surveillance of exposed workers* (in French only)

For more information on the service offering, visit www.santeautravail.qc.ca.

7. SERVICES OFFERED BY OTHER PARTNERS

The CNESST's other [partners](#) help support workplaces in their OHS management efforts in many ways. The [joint sector-based associations](#) (JSAs) provide their members with services:

- advice and personalized assistance
- training and information
- research and development on the prevention of occupational accidents and illnesses

If you're linked to a JSA, you can find out about the specific services it offers its members.

The CNESST and the MSSS would like to thank the following partners for their participation in the development of occupational health programs:



For general information, [contact the CNESST](#).

8. FOR MORE INFORMATION

8.1. Additional information for workplaces

CNESST web pages

- [Toxicological directory](#) (in French only)
- [Preventing worker exposure to silica](#) (in French only)
- [Zero-tolerance sheet](#) (in French only)

Laws and regulations

- [Act respecting occupational health and safety \(AOHS\)](#)
- [Regulation respecting occupational health and safety \(ROHS\)](#)

[Réseau de santé publique en santé au travail \(RSPSAT\)](#)

- CIUSSS de la Mauricie et du Centre-du-Québec, *Silica dust* (in French only), 2017

8.2. Additional information for specialists

[Réseau de santé publique en santé au travail \(RSPSAT\)](#)

- LÉVESQUE, Christian, Claude HUNEAULT et al. *Guide to the medical supervision of workers exposed to silica and recommended exposure limits (REL)* (in French only), 2014.
- Groupe de travail sur le consentement éclairé en santé au travail. *Practice guide concerning the worker's free and informed decision in the context of occupational health screening or medical supervision* (in French only), 2019.

[Institut de recherche Robert-Sauvé en santé et en sécurité du travail \(IRSST\)](#)

- OUELLET, Capucine and Charles Labrecque. *Respiratory protection guide* (in French only), 2022. RG-1123-fr. [Respiratory protection guide \(irsst.qc.ca\)](#) (in French only)
- DROLET, Daniel and Guylaine Beauchamp. *Sampling guide for air contaminants in the workplace*, 8th edition, 2012. T-06. [Sampling guide for air contaminants in the workplace \(8th edition, version 8.1, updated\) \(irsst.qc.ca\)](#)

Instrument loan, calibration, repair and analysis services are also available.