AWARENESS MODULE:

SILICA HAZARDS

SAFETYGUYS
workplace safety trainers

Scope

Employers have a duty to protect their workers from silica exposure on construction projects. This Guideline has been prepared to raise the awareness of employers and workers in the construction industry of the hazards posed by silica in construction and the measures and procedures that should be taken to control those hazards

For the purposes of this guideline, silica refers to crystalline silica in a respirable [1] form.

Silica in Construction

Silica (SiO_2) is a compound resulting from the combination of one atom of silicon with two atoms of oxygen. It is the second most common mineral in the earth's crust and is a major component of sand, rock and mineral ores. Silica exists in several forms, of which crystalline silica is of most concern. The best-known and most abundant type of crystalline silica is quartz. Other forms of crystalline silica include cristobalite, tridymite, and tripoli.

In construction, worker exposure to silica is of particular concern because silica is the primary component of many construction materials. Some commonly used construction materials containing silica include:

- abrasives used for blasting
- brick, refractory brick
- concrete, concrete block, cement, mortar
- granite, sandstone, quartzite, slate
- gunite
- mineral deposits
- rock and stone
- sand, fill dirt, top soil
- asphalt containing rock or stone.

Many construction activities can generate airborne silica-containing dust. In construction, abrasive blasting generates the most dust. Exposure to silica from abrasive blasting can result if the abrasive contains silica and/or if the material being blasted contains silica. Other activities that generate airborne dust include:

- chipping, hammering, and drilling of rock
- crushing, loading, hauling, and dumping of rock
- sawing, hammering, drilling, grinding, and chipping of concrete or masonry structures
- demolition of concrete and masonry structures
- dry sweeping or pressurized air blowing of concrete, rock, or sand dust
- road construction
- sweeping, cleaning, and dismantling equipment
- tunnelling, excavation, and earth moving of soils with high silica content.
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[1] "Respirable" means that size fraction of the airborne particulate deposited in the gas-exchange region of the respiratory tract and collected during air sampling with a particle size-selective device that,

a) meets the American Conference of Governmental Industrial Hygienists (ACGIH) particle size-selective criteria, and

b) has the cut point of 4 microns at 50 per cent collective efficiency.

Legal Requirements

Occupational Health and Safety Act

The Occupational Health and Safety Act (OHSA) sets out, in very general terms, the duties of employers and others to protect workers from health and safety hazards on the job. These duties include, but are not limited to:

- taking all reasonable precautions to protect the health and safety of workers [clause 25(2)(h)],
- ensuring that equipment, materials and protective equipment are maintained in good condition providing information, instruction and supervision to protect worker health and safety [clause 25(2)(a)], and
- acquainting a worker or a person in authority over a worker with any hazard in the work and in the handling, storage, use, disposal and transport of any article, device, equipment or a biological, chemical or physical agent [clause 25(2)(d)].

In addition, section 30 of the OHSA deals with the presence of designated substances on construction projects. Since silica is a designated substance (O. Reg. 490/09), compliance with the OHSA and its regulations requires action to be taken where there is a silica hazard on a construction project.

Section 30 of the OHSA requires the owner of a project to determine if silica is present on a project and, if it is, to so inform all potential contractors as part of the bidding process. In a similar way, contractors who receive this information are to pass it onto other contractors and subcontractors who are bidding for work on the project. If the owner or any contractor fails to comply with this requirement, they will be liable for any loss or damages that result from a contractor subsequently discovering that silica is present.

WHMIS 2015

Workplace Hazardous Materials Information System (WHMIS) Regulation (R.R.O. 1990, Reg. 860)

The WHMIS Regulation applies to all workplaces covered by the OHSA. Any employer or constructor who uses WHMIS controlled products is required to comply with the WHMIS Regulation regarding the requirements for labels, material safety data sheets, and worker education and training.

The Ministry of Labour is responsible for the administration and enforcement of both federal and provincial WHMIS legislation.

Regulation for Construction Projects (O. Reg. 213/91)

The Regulation for Construction Projects, O. Reg. 213/91, applies to all construction projects. Although silica is not mentioned specifically, the following sections of the regulation would apply to situations where there is the potential for workers to be exposed to silica:

Section 14

(5) A competent person shall perform tests and observations necessary for the detection of hazardous conditions on a project.

Section 21

(1) A worker shall wear such protective clothing and use such personal protective equipment or devices as are necessary to protect the worker against the hazards to which the worker may be exposed.

(2) A worker's employer shall require the worker to comply with subsection (1).

(3) A worker required to wear personal protective clothing or use personal protective equipment or devices shall be adequately instructed and trained in the care and use of the clothing, equipment or device before wearing or using it.

Section 30

Workers who handle or use.substances likely to endanger their health shall be provided with washing facilities with clean water, soap and individual towels.

Section 46

(1) A project shall be adequately ventilated by natural or mechanical means,

(a) if a worker may be injured by inhaling a noxious.dust or fume;

(2) If it is not practicable to provide natural or mechanical ventilation in the circumstances described in clause (1)(a), respiratory protective equipment suitable for the hazard shall be provided and be used by the workers.

Section 59

If the dissemination of dust is a hazard to a worker, the dust shall be adequately controlled or each worker who may be exposed to the hazard shall be provided with adequate personal protective equipment.

Regulation for Designated Substances (O. Reg. 490/09)

The Ministry's Designated Substances Regulation (O. Reg. 490/09) specifies occupational exposure limits (OELs) for silica and requires an assessment and a control program to ensure compliance with these OELs. The OEL for respirable crystalline silica is 0.05 milligrams per cubic meter (mg/m^3) of air by volume as an 8-hour daily or 40 hour weekly time-weighted average limit for cristobalite. In the case of quartz and tripoli, the OEL is 0.10 milligrams per cubic meter (mg/m^3) of air by volume.

Although O. Reg. 490/09 and the OEL for silica do not apply to an employer on a construction project or to their workers at the project, employers still have a responsibility to protect the health of their workers and to comply with the OHSA and other applicable regulations. Section 25(2)(h)of the OHSA requires that employers take "every precaution reasonable in the circumstances for the protection of a worker."

Health Effects:

The prolonged inhalation of respirable dust containing crystalline silica may result in silicosis, a disease characterized by progressive fibrosis of the lungs. A pneumoconiosis (lung disease caused by the inhalation of dust), silicosis is marked by shortness of breath and impaired lung function which may give rise to complications that can result in death. The development and the severity of silicosis depends on the airborne concentration of silica dust to which a worker is exposed and the duration of exposure.

The International Agency for Research on Cancer (IARC) has concluded that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans and has classified these forms of silica as Group 1 carcinogens. In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) has classified quartz as a suspected human carcinogen with an A2 classification.

Crystalline silica may be harmful following high exposure levels received over a period, ranging from a few weeks to years or after long-term exposures to lower levels. There are three major types of silicosis: chronic, accelerated, and acute.

Chronic Silicosis

Chronic silicosis is most common. Symptoms may not appear for a long time, usually more than 10 years, and may progress and worsen over a period of many years. Chronic silicosis may be either a simple or a complicated type. The effects of silicosis can continue to develop even after the exposure ceases and they are irreversible. In addition, the progression of lung fibrosis can also lead to the development of lung cancer

Simple Chronic Silicosis

Simple silicosis is almost entirely without symptoms. In the early stages of the disease the lung nodules are small (usually 1 to 3 mm) and discrete in the upper lung fields. As the disease progresses the nodules increase in number and size and also occupy the lower field. Although simple silicosis may never grow more serious, long-term exposure to silica dust may lead to complicated silicosis.

Complicated Chronic Silicosis

Complicated chronic silicosis is also called progressive massive fibrosis (PMF). The first symptoms may be shortness of breath with exercise, wheezing or sputum that causes coughing. However, some people with the disease have no symptoms. Complicated silicosis can become worse when in combination with other lung diseases. Severe complicated silicosis can result in heart disease in addition to lung disease.

Accelerated Silicosis

Accelerated silicosis is almost the same as chronic silicosis. However, it develops more quickly and the lung scars show up sooner. Accelerated silicosis can develop when exposure to large amounts of silica dust occurs over a short time period. Nodules may appear on a chest x-ray five years after the first exposure to silica dust and the disease can quickly worsen.

Acute Silicosis

Acute silicosis is a lung disease that develops rapidly. As few as 8 to 18 months may elapse from the time of first exposure to the onset of symptoms, which include progressive shortness of breath, fever, cough and weight loss. There is a rapid progression of respiratory failure usually resulting in death within one or two years.

How does silica enter the body?

Occupational exposure to silica occurs through inhalation of small airborne particles of silica dust, mainly in the range of 5.0 mm to 0.5 mm, which are not expelled from the lung when inhaled. Instead, they remain in the lung and are deposited in lymph nodes, where over time, calcium can deposit in those nodes and settle along the rim of the lymph node. This condition is known as "egg-shell" calcification. In some cases, silica particles are carried into the lungs where a scar may form around the particles. Over time, the hardened scars gradually start to show up on the chest x-ray as fibrosis of the lung.

Controlling the Silica Hazard

In order for silica to be a hazard, silica-containing dust particles that are small enough to be inhaled (i.e., respirable) must get into the air. The strategy for controlling the silica hazard can therefore be broken down into three basic approaches:

- prevent silica dust from getting into the workplace air
- remove silica dust present in the air
- if present, prevent workers from inhaling the dust.

To avoid the inhalation of silica, it is essential to have the following control methods in place:

- engineering controls
- work practices and hygiene practices
- respirators and personal protective equipment
- training.

However, even with appropriate measures to control silica, some workers may still be affected. For this reason, periodic medical examinations are important for determining if the control measures in place are effective and if workers are suffering from any of the effects of silica exposure. This is known as medical surveillance (see Appendix 1), and can be considered to be a method of early detection and prevention of silicosis.

Engineering Controls

Engineering controls are methods of designing or modifying equipment, ventilation systems, and processes to minimize the amount of a substance that gets into the workplace air. They include:

- substitution
- process control
- enclosure and/or isolation of the emission source
- ventilation.

Substitution can eliminate silica from certain processes by replacing it with a less toxic material. **Some examples are:**

- silica sand used in abrasive blasting may be replaced by metal shot and grit, alumina, garnet, cereal husks, sawdust, high pressure water, steel sand, silicon carbide or corundum (Note: When choosing non-silica containing abrasives, avoid choosing abrasives that may introduce new health hazards to the workplace. For example, abrasives containing walnut shells may cause allergic reactions in some workers.);
- the replacement of sandstone grinding wheels with ones using an abrasive like aluminum oxide; and
- the use of magnesite or aluminum oxide bricks in place of silica bricks in furnaces.

When it is not possible to use a silica substitute, changing how a process is performed can lower silica exposures. For instance, wet methods reduce dust and should be used whenever practical, particularly in cutting, grinding, and drilling operations. Another example is the modification of an abrasive operation to produce a coarser dust that is less hazardous because it settles more readily and is less likely to be trapped in the lungs if inhaled.

If a process cannot be modified to reduce exposure, it may have to be isolated or enclosed. Dusty operations can be isolated by carrying them out in areas that are physically separated from non-dusty areas and keeping workers not involved in the operation out of the area. Where isolation is not effective, the process can be completely sealed off from the rest of the workplace with an enclosure.

Ventilation refers to engineering controls that rely on the removal of contaminated air from the workplace and the replacement of exhausted air with filtered air. The most effective use of ventilation to control a silica hazard is the removal of dust at its source (local exhaust ventilation). Often dust-generating tools are equipped with dust collection systems to prevent dust from spreading or becoming airborne. An essential component of these systems are the cleaning devices, such as filters, which will effectively remove the dust.

Work Practices and Hygiene Practices

Work practices and hygiene practices are on-the-job activities that reduce the exposure potential from contaminated surfaces and work areas. Silica can also accumulate on the hands, clothing and hair. From there it can be disturbed, re-suspended in air and inhaled. Workers should therefore be able to wash and shower at the end of each shift.

There should be no smoking, eating, drinking or chewing in contaminated areas and lunches should be stored in an uncontaminated area. It is therefore important to follow good work and hygiene practices whenever silica is present.

Good housekeeping is important wherever silica dust is generated. Containers of silica-containing waste should be kept tightly covered to prevent dust from becoming airborne. Surfaces should be kept clean by washing down with water or vacuuming with a vacuum equipped with a high-efficiency particulate air (HEPA) filter. Cleaning with compressed air or dry sweeping should be avoided.

Personal Protective Equipment

Personal protective equipment includes protective clothing and respirators. The purpose of protective clothing is to prevent the contamination of regular clothing and the transportation of silica-containing materials from the workplace. Clothing that is contaminated with silica dust should not therefore be worn home without cleaning.

Sometimes engineering controls and work practices cannot lower the concentration of silica to non-hazardous levels and workers must wear respirators for protection. If respirators must be used, a respirator program should be implemented. It should include written procedures for the selection, use, care and maintenance of personal respiratory protection equipment. Workers should be instructed and trained on the care and use of personal protective equipment before using it. Some workers may have a medical condition that causes them to have difficulty breathing when wearing a respirator. Such workers should not be assigned to do work that requires a respirator if they have written medical proof of their condition.

Respirator Selection

Where respirators are provided, they should be appropriate in the circumstances for the type and the concentration of airborne silica. Respirators should be selected in accordance with the U.S. National Institute for Occupational Safety and Health (NIOSH) assigned protection factors (APF).

Use, Care, and Maintenance of Respirators

The following general use, care, and maintenance procedures should be followed whenever respirators are required:

- respirators should be used and maintained in accordance with the manufacturer's specifications
- proper seal of respirators should be checked prior to each use
- storage of respirators should be in a convenient, clean and sanitary location and stored in a manner that does not subject them to damage or distortion
- respirators assigned for the exclusive use of one worker, should be cleaned, disinfected and inspected after each shift
- respirators used by more than one worker, should be cleaned, disinfected and inspected after each use
- any respirator parts that are damaged or that have deteriorated should be replaced before the respirator is used.

For additional information on the use, care, and maintenance of respirators, please refer to CSA standard Z94.4-02.

Ideally respirators should be assigned for the exclusive use of one worker. But before a decision is made for a respirator to be shared by more than one worker, the following factors should be considered:

- the fit of the equipment
- the health and safety risk to the worker that would be caused by non-exclusive use of the equipment
- any undue economic hardship to the employer that would be caused by exclusive use of the equipment.

Respirators with a tight-fitting facepiece must be fitted to the worker in such a way that there is an effective seal between the equipment and the worker's face. Each worker must be fit-tested for each type of respirator to be worn.

Medical Surveillance

Medical surveillance can be used as a preventive and remedial measure. By providing regular medical examinations and clinical tests on workers exposed to silica, subsequent adverse health effects can be detected. The examining physician can then alert the worker, the employer and the joint health and safety committee to exposure problems in the workplace that might otherwise go unrecognized. This should ensure that remedial steps will be taken.

Workers working with silica on a regular basis should have pre-placement medical examinations that include chest X-rays and pulmonary function tests, followed by periodic medical examinations. The frequency of the periodic examination will depend on the intensity and length of exposure to silica and shall be decided by the examining physician. It need not be the same for all workers but shall be done at least once every two years. Additional information on the medical surveillance program for silica exposed workers can be found in Appendix 1.

Classification of Work

A key feature of this guideline is the classification of work. It is the classification of the work that determines the appropriate respirators, measures and procedures that should be followed to protect the worker from silica exposure. In this guideline, silica-containing construction operations are classified into three groups, Type 1, Type 2, and Type 3 operations, and can be thought of as being of low, medium and high risk. From Type 1 to Type 3 operations, the corresponding respirator, and measures and procedures become increasingly stringent.

The classification of typical silica-containing construction tasks is based on available and published exposure data.

Type 1, Type 2, and Type 3 operations, are based on the following airborne concentrations of respirable crystalline silica in the form of cristobalite, tridymite, quartz, and tripoli:

Type 1 Operations

- The drilling of holes in concrete or rock that is not part of a tunnelling operation or road construction.
- Milling of asphalt from concrete highway pavement.
- Charging mixers and hoppers with silica sand (sand consisting of at least 95 per cent silica) or silica flour (finely ground sand consisting of at least 95 per cent silica).
- Any other operation at a project that requires the handling of silica-containing material in a way that may result in a worker being exposed to airborne silica.
- Entry into a dry mortar removal or abrasive blasting area while airborne dust is visible for less than 15 minutes for inspection and/or sampling.
- Working within 25 metres of an area where compressed air is being used to remove silica-containing dust outdoors.

Type 2 Operations

- Removal of silica containing refractory materials with a jackhammer.
- The drilling of holes in concrete or rock that is part of a tunnelling or road construction.
- The use of a power tool to cut, grind, or polish concrete, masonry, terrazzo or refractory materials.
- The use of a power tool to remove silica containing materials.
- Tunnelling (operation of the tunnel boring machine, tunnel drilling, tunnel mesh installation)
- Tuckpoint and surface grinding.
- Dry mortar removal with an electric or pneumatic cutting device.
- Dry method dust cleanup from abrasive blasting operations.
- The use of compress air outdoors for removing silica dust.
- Entry into area where abrasive blasting is being carried out for more than 15 minutes.

Type 3 Operations

- Abrasive blasting with an abrasive that contains ≥1 per cent silica.
- Abrasive blasting of a material that contains ≥ 1 per cent silica.

Employers, supervisors, and workers should be able to recognize and correctly classify the types of operations carried out in the workplace, in order to select appropriate respirators, and implement appropriate measures and procedures. Respirator requirements are listed in Table 1 (below) for Type 1, Type 2, and Type 3 operations.

Table 1: Respirator Requirements

Classification of Silica-Containing Construction Operations Based on Airborne Concentrations of Respirable Crystalline Silica in the Form of Cristobalite, Tridymite, Quartz, and Tripoli.

	Type 1 Operations	Type 2 Operations	Type 3 Operations
Cristobalite and Tridymit	> 0.05 to 0.50 mg/m3	> 0.50 to 2.50 mg/m3	> 2.5 mg/m3
Quartz and Tripoli	> 0.10 to 1.0 mg/m3	> 1.0 to 5.0 mg/m3	> 5.0 mg/m3

[*]NIOSH APF = National Institute of Occupational Safety and Health Assigned Protection Factor

Note: It is recommended that compressed air that is used to supply supplied air respirators meet the breathing air purity requirements of CSA Standard Z180.1-00. Where an oil-lubricated compressor is used to supply breathing air, a continuous carbon monoxide monitor/alarm should be provided.

OPERATION:	REQUIRED RESPIRATOR
Type 1 (> 0.05 to 0.50 mg/m^3 of silica in the form of cristobalite and tridymite) (> 0.10 to 1.0 mg/m^3 of silica in the form of quartz and tripoli) •The drilling of holes in concrete or rock that is not part of a tunnelling operation or road construction. •Milling of asphalt from concrete highway pavement. •Charging mixers and hoppers with silica sand (sand consisting of at least 95 per cent silica) or silica flour (finely ground sand consisting of at least 95 per cent silica). •Any other operation at a project that requires the handling of silica-containing material in a way that may result in a worker being exposed to airborne silica. •Entry into a dry mortar removal or abrasive blasting area while airborne dust is visible for less than 15 minutes for inspection and/or sampling. •Working within 25 metres of an area where compressed air is being used to remove silica-containing dust outdoors.	**NIOSH APF[*] = 10** Half-mask particulate respirator with N-, R-, or P-series filter and 95, 99 or 100 per cent efficiency.

OPERATION:	REQUIRED RESPIRATOR
Type 2 (> 0.50 to 2.5 mg/m3 of silica in the form of cristobalite and tridymite) (> 1.0 to 5.0 mg/m3 of silica in the form of quartz and tripoli) •Removal of silica containing refractory materials with a jackhammer. •The drilling of holes in concrete or rock that is part of a tunnelling operation or road construction. •The use of a power tool to cut, grind, or polish concrete, masonry, terrazzo or refractory materials. •The use of a power tool to remove silica-containing materials. •The use of a power tool indoors to chip or break and remove concrete, masonry, stone, terrazzo or refractory materials. •Tunnelling (operation of the tunnel boring machine, tunnel drilling, tunnel mesh installation). •Tuckpointing and surface grinding.· Dry method dust clean-up from abrasive blasting operations. •Dry mortar removal with an electric or pneumatic cutting device. •The use of compressed air outdoors for removing silica dust. •Entry into area where abrasive blasting is being carried out for more than 15 minutes.	**NIOSH APF[*] = 50** Full-facepiece air-purifying respirator with any 100-series particulate filter. Tight-fitting powered air-purifying respirator with any 100-series particulate filter. Full-facepiece supplied-air respirator operated in demand mode. Half-mask or full-facepiece supplied air respirator operated in continuous-flow mode.
Type 3 (> 2.5 mg/m3 of silica in the form of cristobalite and tridymite) (> 5.0 mg/m3 of silica in the form of quartz and tripoli) •Abrasive blasting with an abrasive that contains ≥ 1 per cent silica •Abrasive blasting of a material that contains ≥ 1 per cent silica	**NIOSH APF ≥ 1000** Type CE abrasive-blast supplied air respirator operated in a positive-pressure mode with a tight-fitting half-mask facepiece. Type CE abrasive-blast supplied air respirator operated in a pressure-demand or positive pressure mode with a tight-fitting full-facepiece.