Silica Exposure Control Plan & Policy

This Model Exposure Control Plan is based on the template developed by Enform, a leading safety association for the upstream oil and gas industry, to address a particular contaminant, namely, silica. However, OHS managers in all industries can adapt the template for other airborne contaminants in accordance with the specific OHS requirements of their jurisdiction, especially with regard to occupational exposure limits (OELs), i.e., the maximum amount of exposure to silica to which a worker may be exposed. Recognize that while regulatory OELs are based on an 8-hour adjusted OEL, this Model uses a conservative, err-on-the-side-of-safety approach by incorporating OELs based on a 12-hour adjusted exposure. Result: The OELs in the Model may provide more protection than the OHS laws require.

1. **PURPOSE**

Crystalline silica such as quartz and cristobalite in the form of airborne dust can disable or even kill you if it gets into your body. Certain ABC Company work operations put workers at risk of inhaling crystalline silica. ABC Company has adopted this Exposure Control Plan (ECP) to ensure that workers are aware of and properly protected against such hazards in accordance with the ABC Company OHS Program and the requirements of [*insert jurisdiction name*] Occupational Health and Safety (OHS) laws.

2. **CRYSTALLINE SILICA HAZARDS**

When silica containing materials (generally greater than or equal to 0.1% by weight) are disturbed, moved or handled, airborne dust can be generated and silica exposure can occur. Worker exposure is primarily from inhalation of dust in the air or on skin, hair, clothing and PPE—their own or that of another worker.

Crystalline silica dust may cause a disabling and sometimes fatal disease called silicosis. The way it works: Inhaling the dust particles can cause the lungs to thicken and scar which makes it harder for the lungs to take oxygen from the air. Symptoms typically include weakness, shortness of breath and severe cough. Although the damage is permanent, sometimes it takes years for the symptoms to appear. There are three types of silicosis:

- **Chronic silicosis**, which develops gradually after 10 or more years of exposure to relatively low concentrations of crystalline silica;
- **Accelerated silicosis**, which develops 5 to 10 years after initial exposure to crystalline silica at high concentrations; and
- **Acute silicosis**, which develops within a few weeks to a few years, after exposure to very high concentrations of crystalline silica.

Exposure to silica has also been linked to other diseases, including bronchitis, tuberculosis, chronic obstructive pulmonary disease (COPD), kidney disease and lung cancer. Silica is classified as a human carcinogen (Group I) by the International Agency for Research on Cancer (IARC).

3. **ROLES & RESPONSIBILITIES**

Different persons have responsibilities in ensuring that this ECP is implemented effectively.

1. **Employers**

ABC Company and other employers of workers working at the site must ensure that:

- An ECP that meets OHS requirements, whether this ECP or a prime contractor or other employer's Plan that provides at least equivalent protection, is properly implemented.
- All tools, equipment, personal protective equipment (PPE) and other resources required to fully implement the ECP are readily available.
- All required regulatory materials and documentation, e.g., safety data sheets and WHMIS labels, are provided and maintained.
- Supervisors and workers are educated and trained in silica exposure hazards and working safely with silica.
- Such training and education is properly verified and documented.
- An annual review (or more often if conditions change) of the ECP's effectiveness is carried out, including a review of available control technologies.

1. **Prime Contractors**

Prime Contractors and their site personnel must ensure that the ECP is present on site and consistently and diligently enforced and that service provider selection is based on the engineering controls and control strategies it employs to minimize exposures.

1. **Supervisors**

Supervisors must:

- Provide adequate instruction to workers on the hazards of silica exposure associated with their work.
- Select and implement the appropriate control measures.
- Ensure that workers using respirators have been properly

trained and fit-tested, and that the results are recorded.
- Make sure that work is conducted in a manner that minimizes and adequately controls the risk to workers.

1. **Workers**

Workers must:

- Read, understand and comply with this ECP.
- Use the assigned PPE in an effective and safe manner.
- Follow established work procedures as directed by the supervisor.
- Report any unsafe conditions or acts to the supervisor.
- Report any exposure incidents or any signs or symptoms of illness from silica exposure to ABC Company (or their employer if they don't work for ABC Company).

4. **AIRBORNE EXPOSURE LIMITS**

OHS laws and nongovernmental organizations have established exposure limits for crystalline silica exposure limits described below in Table 1. When other hazards such as heavy metals are present, those hazards need to be considered as well.

Table 1 – Silica Exposure Limits

Jurisdiction	8-hour Exposure Limit	12-hour Adjusted Exposure Limit
ACGIH TLV[1]	0.025	0.0125
Alberta[2]	0.025	0.025
British Columbia	0.025	0.0125
Saskatchewan	0.05	0.05

Note. Exposure limits are subject to change by the agencies that set them. Excursion limits also exist for silica such as the 30-minute TWA, which is 3 times the full-shift

exposure level.[3]

The 8-hour exposure limit of 0.025 mg/m^3 is recommended to standardize risk management across the Western provinces. This is based on this value being adopted by two of the three western provinces and the risks of silicosis, lung cancer and other disease being markedly elevated at levels above 0.025 mg/m^3.

The current understanding of the risk of silicosis disease over 45 years of exposure at 0.025 mg/m^3 is between 5 to 40 cases of silicosis per 1,000 workers versus 20 to 170 cases per 1,000 workers at 0.050 mg/m^3. At the older 2006 ACGIH TLV of 0.1 mg/m^3 the silicosis risk ranged from 60 to 773 cases per 1,000 workers.[4] The range is a reflection of different industries and different studies and therefore may not be appropriate for all types of silica exposures.

5. **SKIN & INGESTION**

Skin and ingestion exposure to silica is generally not thought to be a concern in and of itself; however, the re-entrainment of silica back into the air creates an airborne hazard that warrants attention. Sometimes other hazardous ingredients, such as heavy metals and NORM (Naturally Occurring Radioactive Materials), may be present with silica. Such ingredients represent ingestion and skin hazards. Accordingly, good hygiene practices, gloves, body protection (coveralls), and proper hand washing is required. In general, workers should limit skin contact with silica whenever possible.

6. **HAZARD ASSESSMENT**

ABC Company shall ensure that competent personnel consider crystalline silica and other airborne dangers as part of the hazard assessment they are required to perform before work

operations are carried out. In conducting a silica exposure hazard assessment, the following factors will be taken into account:

- **Time:** Cumulative exposure is a better predictor of silica disease. As such, exposure levels are full-shift time-weighted averages (TWA) like 8-hour Exposure Levels (EL). Some task-based exposures may last only minutes, while others may last the entire work shift. It is important to remember that excursion limits also exist and require compliance; one example is the 30-minute TWA, which is 3 times the full-shift EL.
- **Proximity to Source:** The closer you are to the emission source, the higher the airborne silica concentration is likely to be. As a general rule of thumb, keep sources of exposure at least an arm's reach away.
- **Relative Dustiness:** The dustier the material, the more airborne dust it is likely to generate. It is important to recognize that the manner in which the material is disturbed can impact the dustiness. For example, a product that is not dusty, such as clean sand, can generate dust when it is ground to make silica flour. This is especially important since, for silica, the respirable fraction is hazardous. Relative dustiness is grouped into three categories – low, medium, and high – in accordance with Enform's Controlling Chemical Hazards Guideline.
- **Energy:** The more energy, the greater the airborne concentration of silica. Energy can come from the speed of telebelts, the speed of a chop saw blade, the pressure and associated speed of abrasive blasting media coming out of the gun nozzle, the air pressure used to pneumatically convey bulk materials, etc.
- **Quantity Used:** The more product in use, the greater the airborne hazard.
- **Percentage Silica:** Higher silica concentrations generally result in more risk, especially for pure

products.

- **Ventilation:** Can silica build up in the air? The amount of ventilation can make a significant difference to exposures. Exposures in well-ventilated environments, like wide-open windy outdoor locations, may be less significant than exposures in poorly ventilated indoor environments. This is particularly true when the source of exposure is greater than an arm's reach away from the workers breathing zone for small sources, but does not hold true for large sources. However, it does not hold true for large sources. Wind can dilute the hazard, but can also take the hazard from one area and make it a hazard for others downwind. This is of particular concern when the concentration is very high, as in hydraulic fracturing and abrasive blasting operations. In general, the benefits of dilution are negated by the difficulties that accompany a loss of hazard control.

7. **QUALITATIVE HAZARD ASSESSMENT**

Using the above factors, personnel conducting hazard assessment will classify each work site in which silica exposure hazards exist by assigning a Risk Category Tier based on degree of risk.

Table 2 – Risk Category

Risk Category	Airborne Silica Level (mg/m^3)[5]
Tier 0	<0.0125
Tier I	0.0125 – <0.125
Tier II	0.125 – <0.625
Tier III	≥0.625

8. **SELECTION OF CONTROLS**

ABC Company will implement appropriate controls to eliminate or, where elimination is not practicable, reduce silica exposure hazards to acceptable levels. Selection of controls will be based on the Risk Category of the work site following the principles of the hierarchy of controls which dictates that controls be selected in the following order of preference:

- Elimination and Substitution;
- Engineering controls (i.e. local exhaust ventilation, barriers);
- Administrative controls (i.e. limiting time workers are in a potentially contaminated area, procedures and signage); and
- Personal protective equipment (i.e. respirators and disposable coveralls).

1. **Elimination or Substitution**

Where practicable, ABC Company will take steps to ensure that the silica hazard is eliminated or that less hazardous materials and products are substituted.

1. **Engineering Controls**

Where elimination or substitution is not practicable, ABC Company will implement appropriate controls. First consideration will be given to engineering controls to control crystalline silica exposure, which may include:

- Wetting;
- Enclosed processes;
- Enclosed people spaces;
- Use of ventilation;
- Filtration;
- Barriers; and
- Remote monitoring systems such as cameras to remove the need for a worker to be present.

1. **Administrative/Work Controls**

ABC Company will also implement administrative/work controls which minimize exposure by affecting how the work is carried out, including but not limited to:

- Safe work procedures for conducting operations involving exposure risks;
- Training and instruction on how to carry out those procedures;
- Strict enforcement of safe work procedures which may include imposition of discipline for infractions in accordance with ABC Company HR policies and the terms of applicable collective agreements;
- Procedures for inspecting, maintaining and using engineering controls in place;
- Signs warning that a silica hazard is present and that respiratory protection is required when a Tier I, Tier II or Tier III hazard exists;
- Restrictive barriers such as banner tape to limit access;
- Time limits on how long workers can stay in danger zones;
- Maximizing distances from the emission source; and
- Use of control zones.

1. **PPE**

PPE will be considered as a measure of last resort to be used only when engineering and/or administrative/work controls are either not practical or not effective on their own. The goal will be to apply engineering and administrative controls to Tier III exposures first; so, over time, only Tier 0 exposures remain. PPE may include the following equipment:

1. <u>Respirators</u>

Respirators will be used for silica-generating activities based on the hazards and degree of protection needed. Options

will range from a half-face air purifying respirator (APR) with a protection factor of 10 to a tight-fitting full-face powered-air purifying respirator (PAPR) that has a protection factor of 1,000. At a minimum, the NIOSH-approved respirator must consist of a non-disposable elastomeric half-face respirator equipped with P100 filter cartridges.

The superior fitting qualities of a non-disposable face-piece paired with the oil-proof particulate and mist filter (P100) make this the best minimum respiratory protection for silica exposure (as opposed to disposable, N95 respiratory protection).

The biggest limitation of respirators is leakage where the respirator meets the face. As a result, respirators are assigned protection factors. For example, a half-face respirator has a protection factor of 10 meaning that it can reduce the concentration of the contaminant from outside the respirator to inside the respirator by 10 times. These protection factors are assigned by the CSA and NIOSH and adopted by the various health and safety regulatory jurisdictions.

Regardless of the type of respiratory protection used, a respiratory protection program must be in place to ensure that workers are clean-shaven, have been fit-tested and are trained in the use, care, and maintenance of their respirators. Respirators will be used, cleaned, and stored in accordance with the respiratory protection program.

The presence of other chemical hazards may necessitate the need for a higher degree or different type of respiratory protection.

Table 3 describes equipment and configurations necessary for certain situations.

Table 3 – Risk Category and Respirator Types

Risk Category	Required Protection Factor[6]	Respirator Type and Filter
Tier 0	None	Acceptable risk, no protection required
Tier I	10	Half-face & P100 filters
Tier II	50	Full-face & P100 filters
Tier III	1,000	Tight-fitting full-face PAPR & P100 filters or Supply Air[7]

Respirators are only effective if they are worn properly and consistently 100% of the time!
A worker in a Tier III exposure control zone who takes off their respirator for just 1 minute out of their 12-hour work shift may be 2 times overexposed.

The use of tight-fitting full-face PAPRs instead of full-face respirators for work situations that require full-shift use will be considered to increase comfort, reduce stress on the worker and improve adherence to proper use. PAPRs will not be used for Tier III exposures that are sustained for numerous hours, because the main limitation on use is filter dust loading. This requires the filter to be changed numerous times in a day.[8] A recommended filter change-out schedule is provided in Table 4; however, the filters should be changed whenever it becomes hard to breathe.

Table 4 – Respirator Filter Change-out Schedule

Respirator	Duration of Use	Change-out Frequency

Half-face APR (Tier I)	12-hour Shift	Daily
	<2 hours	Weekly
Full-face APR (Tier II)	Any	Daily
Tight-fitting Full-face PAPR[9] (Tier III)	Any	~Every Two Hours

1. Coveralls

Coveralls such as FR coveralls must not be worn off site and must be laundered on a regular basis. Inadvertent secondary inhalation may occur when silica dust that is present on PPE, skin or head hair is disturbed, re-entraining the silica into the air.

Disposable coveralls are required when working with bulk silica frac dust and for Tire III (PAPR or Supply Air) exposure risks.

In general, fire retardant coveralls and disposable coveralls should be sized and worn in a manner to limit exposed skin such as at the arms, ankles and neck. For more information on coverall selection, please refer to GS 400 and GS 403.

iii. Gloves

Gloves suited for the physical hazards of the task are recommended, but not required, for protection against silica. It is not generally considered a skin hazard.

9. **HYGIENE FACILITIES & DECONTAMINATION PROCEDURES**

Inadvertent secondary inhalation may occur when silica dust on PPE, skin or hair is disturbed, which reintroduces the silica into the air. To prevent inadvertent secondary inhalation of contaminants, ABC Company will ensure that appropriate steps

are taken to remove contamination from skin and PPE.

Workers will also be required to thoroughly wash their face and hands with a mild detergent before eating, drinking and leaving the worksite, solution. Adequate washing facilities will be provided on site to enable worker decontamination. Eating and drinking will be restricted to authorized areas only.

Adequate washing facilities must be provided on site to enable worker decontamination. A shower is not required, but may be advisable for those working with bulk silica dust and Tier III exposures.

Procedures will be implemented for decontamination and, specifically, use of disposable coveralls,including:

- Removing disposable coveralls (if applicable) and placing in waste receptacles;
- Removing FR coveralls and placing in laundry receptacles;
- Washing hands, face, head and respirator;
- Removing respiratory protection; and
- Properly storing respirators.

10. **HEALTH MONITORING**

ABC Company will implement a program of monitoring and evaluating worker health in accordance with the requirements of OHS Regulations. Such program will generally include the following elements:

- **Lung spirometry** to detect changes in lung function and the onset of lung disease for anyone who works in an environment at or above the exposure level (full-shift TWA) for 30 days in a year. Lung spirometry will be conducted both initially and every two years thereafter by competent medical health professionals and include forced vital capacity (FVC) and forced expiratory volume

in 1 second (FEV(1)).
- **A medical history** will be collected from exposed workers that includes past work and non-work related occupational exposures, any medical symptoms, and smoking status.
- **Contractors** will be required to implement an OHS program that addresses health and wellness issues with their employees, including with regard to general fitness for work expectations, ability to wear a respirator (often includes lung spirometry), and other related components, such as respirator fit testing.

11. **EDUCATION & TRAINING**

ABC Company will ensure that workers exposed to crystalline silica receive appropriate education and training covering, at a minimum:

- Health hazards of silica exposure;
- Operations that can produce silica exposure;
- Engineering controls and safe work practices used to protect workers;
- The importance of proper equipment control and maintenance;
- Housekeeping procedures;
- Proper use of respirators and the respirator program;
- Personal hygiene decontamination procedures to reduce exposures; and
- Review the details of the exposure control program for silica.

Training will be delivered by competent personnel and documented in records listing the worker’s name, trainer’s name, material covered and date provided. Steps will be taken to verify that workers have understood and are competent to carry out their training. Workers will receive additional or reinforcement training as needed and upon request.

12. **PRIME CONTRACTORS & CONTRACTORS**

ABC Company will ensure that any prime contractors, contractors and subcontractors hired to perform work involving exposure to crystalline silica hazards at an ABC Company work site are, before such work begins:

- Notified about the silica hazards at the site, the dangers they pose, and the respiratory protective equipment and other controls used to protect workers exposed to them;
- Given a copy of this ECP;
- Required to notify their own workers about and ensure they comply with the terms of this ECP.

Prime contractors, contractors, or subcontractors in control of work at an ABC Company site that involves exposure to silica hazards requiring the use of respiratory protective equipment under this ECP will ensure that exposed workers engaged in the contract work are adequately protected by either:

- Directly following this ECP and assuming all the employer obligations it imposes on ABC Company; or
- Developing and implementing an equivalent plan that meet the requirements of the applicable OHS Regulations and is coordinated with and provides at least the same level of protection as this ECP to workers exposed to silica hazards.

13. **EVALUATION**

This ECP will be reviewed, in consultation with the workplace Safety Committee or Safety Representative, at least once a year and more often in response to incidents, injuries, illnesses, changes to work conditions, and other developments suggesting the current ECP may no longer be suited to current work conditions.

Appendix A: Definitions

ACGIH – American Conference of Governmental Industrial Hygienists

APR – Air Purifying Respirator

CSA – Canadian Standards Association

DOP Testing – DOP or Dioctyl Phthalate is an aerosol that is used to test HEPA filters and the seal of the filter to the housing of a vacuum or negative air unit. It is recommended that this testing occur at least yearly.

ECP – Exposure Control Plan. A term referenced in WorkSafe BC legislation, but generally considered synonymous with the Code of Practice requirements of the Alberta OH&S legislation.

Exposure Level – the maximum allowable exposure to a chemical or other agent or hazard. It is often expressed as an average over eight hours or 15 minutes or as a ceiling above which no exposure is permitted at any time. Exposures longer than eight hours are often adjusted to account for extended exposure and reduced recovery time. Exposure levels can also be referred to as occupational exposure levels (OEL) or permissible exposure levels (PEL).

Heavy Metals – general a term used to describe metals with high atomic weights that are very toxic such as mercury, cadmium, lead, arsenic, manganese, chromium, etc.

IARC – International Agency for Research on Cancer

Mist – the presence of liquid droplets suspended in the air

(M)SDS – Material Safety Data Sheet or Safety Data Sheet

NIOSH – National Institute of Occupational Safety and Health – a federal department of the Centre for Disease (CDC) Control in the United States of America. NIOSH is responsible for conducting research and making recommendations for the prevention of work-related disease and injury.

NORM – Naturally occurring radioactive materials. These are typically decay products of thorium and uranium such as radium-226, radium-228, radon-222 and lead-210. NORM may be concentrated in oil and gas process equipment in the form of gas, sludge, scales and films. Certain products such as refractory brick insulation may naturally contain NORM.

PAPR – Powered Air Purifying Respirator. A respirator that is equipped with a filter and a blower motor such that a slight positive pressure within the face piece is created. PAPR's can be either tight-fitting or loose-fitting.

Respirable – Delineates a specific size of airborne contaminant that is capable of accessing the lower regions of the lung where gas exchange takes place. A variety of definitions exist but in general airborne particulate that has a diameter of less than 10 micrometers is regarded as respirable.

Silica (Quartz or Cristobalite) – an abundant crystal form of silica that can be present in many dry products, present in refractory brick insulation, and present in naturally occurring products such as sand, cement and soil and rock. It is highly toxic and can cause serious disease and lung cancer.

Silicosis – A progressive and often fatal lung disease that is caused by the inhalation of respirable crystalline silica such as quartz or cristobalite. Silicosis is an auto-immune disease where the body reacts to the presence of the silica in the lung with the formation of scar tissue that leads to difficulty in breathing and reduced gas exchange in the lungs.

Spirometry – tests that measure pulmonary lung function (PFT) in order to diagnose a variety of lung diseases. Often includes the forced vital capacity (FEV) and forced expiratory volume in one second (FEV(1)) tests.

[1] 12-hour adjusted exposure limits are calculated from published 8-hour TLV's by multiplying the 8-hour TLV's by a conversion factor (usually 0.5).

[2] Alberta OH&S intends to not adjust silica for extended shifts such as shift lengths greater than 8 hours or mwork hours equivalent to a typical 40-hour work week.

[3] Excursion limits are based on statistical relationships that exist between exceeding these values and increased likelihood of exceeding the full-shift exposure level. The ACGIH defines processes that exceed excursion limits as out of control.

[4] OSHA. (2010). Occupational Exposure to Respirable Crystalline Silica – Review of Health Effects Literature and Preliminary Quantitative Risk Assessment, Docket OSHA-2010-0034-0306. Page 351. https://www.osha.gov/silica/Combined_Background.pdf.

[5] Mg/m^3 – milligrams of respirable crystalline silica per cubic meter of air collected on a worker for a full work shift; however, excursion limits such as the 30-minute excursion limit of 3 times the full-shift exposure level must be considered as well. Exposure ranges are based on respiratory protection factors and a 50% action limit on the 8-hour EL of 0.025 mg/m^3. A protection factor of 50 is assigned to a full-face respirator in accordance with CSA Z94.4-2011. Currently this protection factor is used in British Columbia and is intended to be used in Alberta with the new OH&S Code revision.

[6] Protection factor of 50 is assigned to a full-face

respirator in accordance with CSA Z94.4-2011. Exposure ranges are based on respiratory protection factors and a 50% action limit on the 8-hour EL of 0.025 mg/m^3. Assumes quantitative fit testing.

[7] Any work situation requiring the use of a 1,000 protection factor respirator requires the use of a full-body disposable coveralls.

[8] Calculations are based on the following: a 200 mg maximum loading per filter, an inhalation rate of 85 L/min, a PAPR flow rate of 115 lpm and the maximum concentration permitted under that protection factor based on 0.0125 mg/m^3. A 4X margin of error has been introduced to account for non-quartz respirable dust loading as well as non-respirable dust loading.

[9] The use of tight-fitting PAPR for Tier III exposures is not recommended because of the impractical change-out schedule.

ADDITIONAL RESOURCES

Hazard Alert: Worker Exposure to Silica During Fracking

Ontario MOL Guideline: Silica on Construction Projects