



# Silica Exposure Control Plan (ECP) Template

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## Background

This Silica Exposure Control Plan (ECP) template has been developed for the upstream oil and gas industry to assist in managing silica exposures. Silica is an emerging exposure concern in oil and gas operations. This ECP has been developed to enable the oil and gas industry to manage these silica exposures in a proactive manner. Sector-specific guidance sheets, such as completions (hydraulic fracturing) have been created to work in conjunction with this ECP. In addition, several related guidance sheets from Enform's Controlling Chemical Hazards Guideline are referenced where appropriate. Exposures are grouped into tiers based on anticipated airborne levels. These tiers are based on the 12-hour adjusted Occupational Exposure Limit and as such may be overprotective for 8-hour exposures or jurisdictions where adjustment for extended work shifts is not required.

## Instructions for use

1. Use this Silica ECP along with relevant company and site-specific details, such as in the Silica ECP sections "Company Information" and "Annual Review".
2. Add in the relevant sector-specific guidance sheets to this Silica ECP as indicated in the Silica ECP section entitled "Guidance Sheet Selection and Implementation" (page 12).
3. Conduct the hazard assessment as indicated in the sector-specific hazard assessment guidance sheet. Check off which situations will apply to your work site. Conduct this hazard assessment twice: once as a planner and once as a supervisor. Document and retain these hazard assessment records.
4. Implement controls, as appropriate, determined by the hazard assessment and develop applicable procedures, as indicated in the control guidance sheet.
5. Conduct site inspections to verify that the controls indicated are in use.
6. Validate that the controls are effective by collecting exposure monitoring data.
7. As required, implement additional controls to mitigate risk. Seek also to use engineering or administrative controls in order to reduce dependency on personal protective equipment (PPE).



### *Company information*

[Name]

[Address]

[Contact information - names and phone numbers]

### *Worksite information*

[Project name]

[Address]

## **Purpose and responsibilities**

[Name] are responsible for protecting our workers and other workers on our worksites from overexposure to crystalline silica (herein referred to as silica) in the course of performing their duties. According to the Enform Controlling Chemical Hazards Guideline, silica exposure is ranked as an Extreme risk in industry work sites requiring special controls, including seeking the advice of experts. Studies such as those conducted by National Institute for Occupational Safety and Health (NIOSH)<sup>1</sup> and Alberta Jobs, Skills, Training and Labour<sup>23</sup> show that a variety of oil and gas activities generate airborne contaminants in excess of occupational exposure limits. Effective controls are available to protect workers from harmful exposure.

A combination of control measures are required to protect workers from silica exposure. [Name] commit to being diligent in our efforts to select the most effective control methods (or combination of controls) available, and to ensure that the best practices, as described in this exposure control plan (ECP), are followed at our work sites.

Procedures established will not only protect our workers, but also any other workers onsite who are not involved in these operations.

This ECP applies to the site prime contractor, the site owner, service providers such as the driller, the hydraulic fracturing company, the trucking company, and their employees, as well as any other service providers and their employees when at risk as determined by a hazard assessment.

This document applies only to exposure to silica; we acknowledge that this is not the only chemical hazard at our work sites and will ensure that these hazards are appropriately assessed and controlled, as required.

### *Employers are responsible for the following:*

- Ensure that, at a minimum, the ECP meets or exceeds provincial regulatory requirements.
- Ensure that the materials (for example, tools, equipment, and personal protective equipment [PPE]) and other resources (for example, worker training) required to fully implement and maintain this ECP are readily available.

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<sup>1</sup> Esswein EJ, Breitenstein M, Snawder J, Kiefer M, Sieber WK. Occupational exposure to respirable crystalline silica during hydraulic fracturing. J Occup Environ Hyg 2013;10:347–56.

<sup>2</sup> Radnoff D, Todor M, Beach J. Exposure to Crystalline Silica at Alberta Work Sites: Review of Controls. J Occup Environ Hyg 2015; 12,6:393-403

<sup>3</sup> Radnoff D, Todor M, Beach J. Occupational Exposure to Crystalline Silica at Alberta Work Sites. J Occup Environ Hyg 2014; 11, 9:557-570

- Provide required materials and documentation to comply with applicable health and safety legislation (e.g. safety data sheets). A copy of this plan, or a similar one, must be present on every oil and gas site where at-risk activities are underway.
- Ensure supervisors and workers are educated and trained in the hazards of silica exposure and work procedures and controls to work safely with silica.
- Maintain written records of training (e.g. proper use of respirators), respirator fit-test results, crew talks, exposure monitoring results, and inspections (of equipment, PPE, and work methods and practices).
- Conduct exposure monitoring as required and ensure that workers are informed of exposure measurements.
- Ensure that health assessments are performed in accordance with applicable health and safety legislation requirements.
- Conduct an annual review (or more often if conditions change) of the ECP's effectiveness. This includes a review of controls to ensure they are selected and used when required.
- Coordinate work with other employers to ensure a healthy and safe work environment.

Prime Contractors and their site personnel need to ensure that an exposure control plan is present on site and enforce compliance. Prime Contractors need to select a service provider based on which available control strategies, like engineering controls, it employs to minimize exposures.

*Supervisors are responsible for the following:*

- Provide adequate training and instruction to workers on the hazards of silica exposure associated with their respective oil and gas activities and the work procedures and controls to protect them.
- 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.
- Ensure that control equipment, including respirators and other PPE, is maintained in accordance with manufacturer specifications.
- Make sure that work is conducted in a manner that minimizes and adequately controls the risk to workers and others. This includes ensuring workers use the available engineering controls and administrative controls. PPE should only be worn as the last line of defense.
- Making sure that workers have been educated and trained in this exposure control plan. They must ensure that workers understand the plan's expectations and enforce it on the work site.

*Workers are responsible for the following:*

- Read, understand, and comply with the controls and procedures set out in this exposure control plan.
- Complete the training provided by the employer.
- Ensure their safety and the safety of other workers at the work site.

- Use the assigned protective equipment in an effective and safe manner in accordance with work site procedures developed by their employer. For example, if workers are required to use a respirator that's effectiveness depends on a tight facial seal, the workers must be clean-shaven where a respirator seals with the worker's face.
- Follow established work procedures and use controls as directed by the supervisor.
- Report any unsafe conditions or equipment to the supervisor.
- Report any exposure incidents.
- Confirm that they understand the ECP's requirements prior to commencing their work activities.

### Health hazards from silica exposure

Silica exposure usually results from the inhalation of airborne crystalline silica dust. Quartz is the most common form of crystalline silica; however, cristobalite does exist in certain materials. It is the respirable fraction of the dust, which is small enough to get deep into the lung that is of concern.

Crystalline silica dust can cause a disabling, sometimes fatal disease called silicosis. The fine particles are deposited in the lungs, causing thickening and scarring of the lung tissue. The scar tissue restricts the lungs' ability to extract oxygen from the air. This damage is permanent, but symptoms of the disease may not appear for many years.

A worker may develop any of three types of silicosis, depending on the airborne levels of silica dust encountered and the duration of exposure:

- Chronic silicosis—develops after 10 or more years of exposure to crystalline silica at relatively low airborne levels
- Accelerated silicosis—develops 5 to 10 years after initial exposure to crystalline silica at high airborne levels
- Acute silicosis—develops within a few weeks to a few years, after exposure to very high airborne levels of crystalline silica<sup>4</sup>

Initially, workers with silicosis may have no symptoms; however, as the disease progresses, a worker may experience:

- Shortness of breath
- Severe cough
- Weakness

These symptoms can worsen over time and lead to death.

Exposure to silica has also been linked to other diseases, including bronchitis, tuberculosis, chronic obstructive pulmonary disease (COPD), kidney disease, and lung cancer.

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<sup>4</sup> Buchanan D, Miller BG, and Soutar CA. (2003). Quantitative relations between exposure to respirable quartz and risk of silicosis, *Occup Environ Med* 6:159-164. <http://oem.bmj.com/content/60/3/159.full.pdf+html?sid=5259c728-aeef-4511-97a3-3e5af842dea6>

Silica is classified as a human carcinogen (Group I) by the International Agency for Research on Cancer (IARC).

Other hazardous materials may be present in the silica-containing materials or involved in the process such as heavy metals or NORM that have additional health effects. Examples of this include abrasive blasting dust, refractory brick removal or bauxite-based ceramic proppants.

### **Risk identification**

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, but dust on skin, hair, clothing and PPE can also become airborne and inhaled by the worker or other workers. Airborne dust containing silica may also cause mechanical abrasion to the eye or respiratory tract when airborne levels are very elevated.

Inhalation exposure to silica can occur as a function of:

- the work location
- the activity (task); and
- the occurrence of unplanned events

### **The nature of the hazard**

Silica dust is not ordinary dust and exposure to silica in the oil and gas industry can occur during a variety of dust generating activities. For a list of many silica exposures please refer to Guidance Sheet 003. The hazardous component of silica dust is the respirable fraction: this means the very small particles that can penetrate deep into the lung. Different types and sources of silica may have different size ranges. For example, dust generated from hydraulic fracturing may consist of a large portion of respirable particles. In contrast, silica dust generated while cutting concrete generally has a wider range of particle sizes. Airborne levels above the occupational exposure limit (OEL) of respirable silica may not be visible, because the particles do not significantly block, scatter, and reflect light. The net result is that with many silica hazards, by the time it is visible, the airborne silica levels are well above what would be considered acceptable risk.

The absence of visible dust may not mean the absence of an airborne silica hazard!

Silica dust generated from sand can come from existing fines in the dust, or it can come from breaking the sand grains apart during handling.

### **Airborne exposure limits**

Crystalline silica, such as quartz and cristobalite, has exposure limits described below in Table 1. When other hazards such as heavy metals or NORM are present, those occupational exposure limits (OEL) need to be considered as well.

**Table 1 - Silica occupational exposure limits (OEL)**

Jurisdiction	8-Hour OEL (respirable)	12-Hour adjusted OEL (respirable)
ACGIH TLV <sup>5</sup>	0.025	0.0125
Alberta <sup>6</sup>	0.025	0.025
British Columbia	0.025	0.0125
Saskatchewan	0.05	0.05
Manitoba	0.025	0.0125

Note. Occupational exposure limits are subject to change by the agencies that set them. Excursion limits also exist for silica such as the derived 30-minute time weighted average and derived ceiling, which are 3 times the full-shift OEL and 5 times the full-shift OEL respectively.<sup>7</sup>

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

The current understanding of the risk of silicosis disease over 45 years of exposure at 0.025 mg/m<sup>3</sup> 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<sup>3</sup>. At the older 2006 ACGIH TLV of 0.1 mg/m<sup>3</sup> the silicosis risk ranged from 60 to 773 cases per 1,000 workers.<sup>8</sup> The range is a reflection of different industries and different studies and therefore may not be appropriate for all types of silica exposures.

## Skin and 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. As a result, good hygiene practices, gloves, body protection (coveralls), and proper hand washing is required. In general, workers should limit skin contact with silica whenever possible.

## Hazard assessment

Exposure to silica has been recognized as a concern in several industries, including the oil and gas industry. NIOSH and Alberta OH&S have conducted and published independent studies of silica exposures in select oil and gas activities and identified exposures of concern.

<sup>5</sup> 12-hour adjusted OEL's are calculated from published 8-hour OEL's by multiplying the 8-hour OEL's by a conversion factor (usually 0.5). Please see legislation for particular details.

<sup>6</sup> Alberta OH&S intends to not adjust silica for extended shifts such as shift lengths greater than 8 hours or more work hours equivalent to a typical 40-hour work week.

<sup>7</sup> Excursion OEL's are based on statistical relationships that exist between exceeding these values and increased likelihood of exceeding the full-shift OEL. The ACGIH defines processes that exceed excursion limits as out of control.

<sup>8</sup> 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](https://www.osha.gov/silica/Combined_Background.pdf).

WorkSafeBC has created a variety of silica awareness campaigns, templates, and training videos. Links to these are provided in the Resources section of this ECP template.

While many assessments have been completed within industry, individual site variations, configurations, and activities, as well as other site-specific conditions, may affect the exposure risk.

### Factors of exposure risk

A variety of factors impact the degree of exposure risk on site. Some factors that commonly apply to the majority of silica exposures are detailed below. An understanding of these factors can assist in selecting controls.

- **Time** – How long is the duration of the exposure? Cumulative exposure is a better predictor of silica disease. As such, OEL's are full-shift time-weighted averages (TWA) like the 8-hour OEL. Some task-based exposures may last only minutes, while others may last the entire work shift. It is important to remember that excursion OEL's also exist and require compliance; one example is the 30-minute TWA, which is 3 times the full-shift EL.
- **Proximity** – How close are you to the emission source? The closer you are to the emission source, the higher the airborne silica concentration is likely to be.
- **Relative Dustiness** – How dusty is the material or process? The dustier the material is, the more airborne dust may be generated. 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 or used in abrasive blasting. Relative dustiness is grouped into three categories – low, medium, and high – in accordance with Enform's Controlling Chemical Hazards Guideline.
- **Energy** – Is energy being imparted into the silica-containing material? 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 drop distance, 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 in use** – How much is being used? Generally, the more product in use, the greater the airborne hazard created. Quantities are grouped into three categories including grams, kilograms, and tonnes, in accordance with Enform's Controlling Chemical Hazards Guideline.
- **Percentage Silica** – What is the bulk silica percentage? Higher silica concentrations generally result in higher airborne silica levels, especially for pure products rather than mixtures.
- **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. Wind can dilute the hazard, but can also take the hazard from one area and make it a hazard for others. This is of particular concern when the concentration is very high, as in hydraulic fracturing and abrasive blasting operations.

## Conducting the hazard assessment

Because silica is so toxic, it is categorized in Enform's Controlling Chemical Hazards Guideline and associated web-tool into Hazard Group E. This means that an exposure control plan and Control Approach 4 is required (i.e. seek expert advice). See Guidance sheet GS-304 for more information. This ECP template and its associated silica exposure guidance sheets provide some of that special advice.

Personnel at risk for silica exposure need to:

- conduct hazard assessments for their specific operations as a component of their health and safety program; and
- implement appropriate controls to mitigate hazards to acceptable levels

A series of questions are provided below to assist you in conducting a hazard assessment. Additional guidance is provided in the Controlling Chemical Hazards Guideline.

**Step #1:** Is Silica Present in Your Worksite? Look at Safety Data Sheets (SDS) and if disturbance of natural silica sources (soil, gravel etc.) are occurring. Involve workers in this process and conduct a worksite tour.

**Step #2:** If yes, determine who might be at risk.

**Step #3:** Look at each group of workers and determine specific tasks that they conduct.

**Step #4:** Determine if any Enform Guidance Sheets apply to the work environment. If so, use the control and hazard information to guide your assessment. If not, prioritize the exposures based on the workers/tasks that are anticipated to be the most elevated and by the number of workers at risk.

**Step #5:** Implement interim controls where elevated exposures are anticipated such as workers breathing visible dust that is known to contain silica and then conduct representative exposure measurements to determine airborne silica levels.

**Step #6:** Evaluate monitoring results and existing controls and determine if and what additional controls are required.

**Step #7:** Document and communicate results and control requirements to workers and management.

**Step #8:** Conduct inspections and periodic re-assessment or when change occurs. Examples of change may include a new site configuration, wind direction, introduction of new products, new controls, etc.

## Exposure measurement

Exposure measurement is used to answer a variety of questions. It is important that one first knows what questions you want to answer and then design your measurement strategy to answer those questions. For more information on exposure measurement, please refer to the Exposure Measurement Guidance Sheet (GS 305).

Specific to silica the generally agreed to best measurement method is NIOSH method 0600 and 7500. Sample pumps with respirable cyclones and filters are attached to workers to measure the amount of respirable dust and respirable quartz in the breathing zone over a set period of time (time weighted average). The filters are weighed and are then ashed (burned) and the resulting residue analyzed by x-ray diffraction for the quantity of silica present in the respirable dust.

In addition to traditional sampling involving filters and pumps, real-time monitoring for respirable dust may be a useful tool to augment air sampling. This type of real-time monitoring can assist in identifying sources and providing real-time feedback on the effectiveness of controls. Additionally, if silica percentages (quartz) are known, it may be possible to make real-time approximate predictions on the respirable silica (e.g. quartz) present in the air.

**Airborne hazard categories**

Four categories of airborne hazard are detailed below in Table 2.

**Table 2 – Airborne hazard categories**

Hazard category	Airborne silica level (mg/m <sup>3</sup> ) <sup>9</sup> (Based on 12-hour adjusted OEL)
Tier 0	<0.0125
Tier I	0.0125 - <0.125
Tier II	0.125 - <0.625
Tier III	≥0.625

**Controls**

Hazard assessment and evaluations should lead to the implementation of effective exposure controls. Most OHS legislation requires employers to select controls based on the following hierarchy:

- 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)

Because silica exposure may increase the risk of lung cancer, exposure should be maintained as low as reasonably practicable in keeping with the theory that even small exposures may represent a cancer risk.

<sup>9</sup> Mg/m<sup>3</sup> – 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 OEL must be considered as well. Exposure ranges are based on respiratory protection factors and the 12-hour adjusted OEL of 0.0125 mg/m<sup>3</sup>. A protection factor of 50 is assigned to a full-face respirator in accordance with CSA Z94.4-2011.

Ideally, the hazard should be eliminated or substituted. However, the substitution of non-silica based products is not applicable to many of the silica exposures associated with oil and gas activities, because many of the exposures come from naturally occurring silica such as sand, rock, and soil. One activity where substitution is appropriate is the use of non-silica abrasive blasting media. It is worth noting that contrary to what may be indicated in a product SDS some of these alternative media may still contain low concentrations of silica sufficient to result in airborne silica levels over the OEL. So, engineering (e.g. ventilation), administrative (e.g. work procedures) and personal protective controls (e.g. respirator) may still be needed.

Of these controls, the use of engineering controls is typically the most desirable and effective. Personal protective controls are required when engineering controls and/or administrative controls are either not practical or not effective on their own. The goal should be to apply engineering and administrative controls to Tier III exposures first; so, over time, only Tier 0 exposures remain.

### Engineering controls

Engineering controls can offer effective exposure control, because they separate or remove the hazard from the work environment. Engineering controls that are applicable to silica exposure control may include the following:

- Use of water in processes or for dust control
- Dust suppression agents
- Partial or full enclosures (around processes or people such as control rooms)
- Ventilation and filtration on processes or tools; and
- Automation of equipment and remote monitoring systems such as cameras to remove the need for a worker to be present

Implementing change in a process often creates other health and safety risks that require assessment and management. Engineering controls typically require on-going maintenance to be effective. Worker training and other administrative controls are also necessary.

For more information on engineering controls, please refer to the Controlling Chemical Hazards Guidance Sheets GS 300, GS 301, GS 302, and GS 303.

### Administrative controls

Personnel on site must follow established practices and procedures to reduce dust and/or limit contact with or exposure to silica. Where engineering controls are in place, procedures for their use and maintenance must also be present and followed.

Signs must indicate that an airborne 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 are recommended, when practical.



In general, proximity and duration of exposure can be managed by administrative controls. Examples include procedures limiting access, limiting time in exposure areas, maximizing distance from sources and control zones indicating where personnel are permitted.

Procedures are required for the use of a variety of PPE, including respirators, and for personal decontamination.

(Courtesy of MySafetySign)

## Personal protective equipment

### **Respirators**

Different types of silica-generating activities or operations require different levels of respiratory protection. Options range from a half-face air purifying respirator (APR) with an assigned protection factor of 10 to a tight-fitting full-face powered-air purifying respirator (PAPR) that has an assigned protection factor of 1,000. These different respirator types correspond with different exposure risk levels.



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. Fit testing is required for any respirator that relies on a seal between the mask and the face. As such, filtering face-piece respirators (dust masks) must be fit tested as well.

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 have been fit-tested and are trained in the use, care, and maintenance of their respirators. Where a facial seal is required for protection the worker must either be clean shaven or use respiratory protection that does not rely on a seal. Respirators will be used, cleaned, and stored in accordance with the respiratory protection program. For more information on a respiratory program please refer to GS 401 and the Alberta requirements for a Respiratory Code of Practice.

### **The presence of other chemical hazards may require a higher level or different type of respiratory protection.**

Table 3 describes equipment and configurations necessary for certain situations. This list is not exhaustive, please refer to the CSA Standard for a complete list of respiratory protection and assigned protection factors.

**Table 3 – Hazard categories and respirator types**

Hazard category	Required protection factor <sup>10</sup>	Respirator type and filter
Tier 0	NONE	No protection required
Tier I	10	Half-face with N95 or better filters <sup>11</sup>
Tier II	50	Full-face with P100 filters
Tier III	1,000	Tight-fitting full-face PAPR & P100 filters or Supply Air <sup>12</sup>

**Respirators are only effective if they are worn properly and consistently 100% of the time!**

The use of tight-fitting full-face PAPRs instead of full-face respirators for work situations that require full-shift use should be considered to increase comfort, reduce stress on the worker, and improve adherence to proper use. PAPRs are not recommended for Tier III exposures that are sustained, because the main limitation on use is filter dust loading. This requires the filter to be changed numerous times in a day. 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 <sup>13</sup>
Half-face APR (Tier I)	12-hour Shift	Daily
	<2 hours	Weekly
Full-face APR (Tier II)	Any	Daily
Tight-fitting Full-face PAPR <sup>14</sup> (Tier III)	Any	~Variable (Calculation Required)

<sup>10</sup> Protection factor of 50 is assigned to a full-face respirator in accordance with CSA Z94.4-2011. Exposure ranges are based on the 12-hour adjusted OEL of 0.0125 mg/m<sup>3</sup>. Assumes quantitative fit testing.

<sup>11</sup> Half-face includes elastomeric and filtering facepiece respirators.

<sup>12</sup> For any work situation requiring the use of a 1,000 protection factor respirator the use of full-body disposable coveralls is highly recommended.

<sup>13</sup> 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 protection factor (PF) required based on 0.0125 mg/m<sup>3</sup>. A dust factor (DF) is required to account for non-quartz respirable dust loading as well as non-respirable dust loading provided that silica is the driving hazard. A dust factor of 10 is recommended for hydraulic fracturing.  $T(\text{min}) = (200 \text{ mg} \cdot \# \text{ Filters} \cdot 1000 \text{ L/m}^3) / (0.0125 \text{ mg/m}^3 \cdot \text{PF} \cdot \text{DF} \cdot \text{Flow Rate L/min})$ .

<sup>14</sup> The use of tight-fitting PAPR for Tier III exposures is not recommended because of the impractical change-out schedule.

**Coveralls**

Decontamination is an integral component of exposure control. The goal is to remove contamination of skin and personal protective equipment to prevent the potential inadvertent secondary inhalation of contaminants.

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 worn over FR coveralls are highly recommended when working with uncontained bulk silica dust (powder) such as found in engineering control filters or ventilation systems and for Tier III (PAPR or Supply Air) exposure hazards.**

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.

**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. For more information on glove selection and use please refer to GS 404.

**Guidance sheet selection and implementation**

This is the most important part of this ECP. It is where you determine which category of hazard applies to your work site, implement controls to protect workers' health, and comply with the law.

An assortment of hazard assessment and control guidelines have been prepared. Take the guidance sheets that are applicable to your work site and check off the various hazards and control strategies that apply. Then, implement them on the work site. If guidance sheets are not available for your worksite you will need to add the relevant site-specific information here and indicate what controls are required for each group of workers and tasks.

Insert guidance sheets here as per Table 5.

**Table 5 – Guidance sheets to be inserted into ECP**

Industry sector	Guidance sheets
Completions (hydraulic fracturing)	<i>GS 407 Sources of Exposure, GS 408 Controls and GS 409 Hazard Assessment</i>
Other sectors	Coming soon.

## Hygiene facilities and decontamination procedures

In order to protect workers, decontamination is an integral component of exposure control. The goal is to remove contamination of skin and personal protective equipment to prevent inadvertent secondary inhalation of contaminants. Inadvertent secondary inhalation may occur when silica dust that is present on PPE, skin, or hair is disturbed, which reintroduces the silica into the air.



Prior to eating, drinking, and leaving the worksite, workers should thoroughly wash their face and hands with a mild detergent solution. Adequate washing facilities must be provided on site to enable worker decontamination. Eating and drinking is restricted to no exposure areas and 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.

(Courtesy of MySafetySign)

Decontamination should be conducted in the following order:

1. Remove disposable coveralls (if applicable) and place in waste receptacle
2. Remove FR coveralls and place in laundry receptacle
3. Wash hands, face, head and respirator  
(respirator should be wet wiped prior to removal)
4. Remove respiratory protection
5. Inspect respirator, replace cartridges and store properly

Contaminated coveralls must be laundered or disposed of in a controlled manner to prevent exposure to those handling or worker near the contaminated coveralls.

## Health monitoring

A program of monitoring and evaluating worker health is recommended and is required in some jurisdictions. Lung spirometry is recommended to detect changes in lung function and the onset of lung disease for anyone who works in an environment that is at or above the OEL (full-shift TWA) for 30 days in a calendar year. This is an Alberta OHS Code requirement that is tied to the definition of an "exposed worker". Additionally, chest x-rays are a requirement of Alberta and Saskatchewan legislation.

Lung spirometry must be conducted by competent medical health professionals. Please consult OHS legislation for your applicable jurisdiction in regards to the specific health monitoring requirements.

Supervisors must address health and wellness issues with their employees. Discussion should include general fit for work expectations, ability to wear a respirator, and other related components, such as respirator fit testing. These are elements of the health and safety program.

## Training

Training must be performed by the employer or the employer's designate. Records of attendance, dates of training, and training material must be documented and retained.

### *Training topics*

- Roles and responsibilities
- 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
- Review the details of the exposure control program for silica.

As with all hazard controls, training is paramount to the success of any program and is a legislated requirement.

## Annual review

This ECP will be reviewed at least annually and updated as necessary by the employer, in consultation with the workplace health and safety committee or the worker health and safety representative. This review should take into account any voluntary certification programs (i.e., COR Audit) in place, as well as any changes in regulatory requirements. Substitution and control technologies are evolving quickly and must be considered in the annual review. Proposed changes to this practice can be directed to the \_\_\_\_\_.

## Definitions and abbreviations

**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.

**Occupational 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. Occupational exposure levels can also be referred to as 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

**SDS** - Safety Data Sheet as a component of WHMIS 2015

**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. They also certify respirators.

**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 particles small enough to access the lower regions of the lung where gas exchange takes place. Generally this includes airborne particulate that has a diameter of less than 10 micrometers with a cut-point of 4 microns.

**Service Provider** - A company selected to perform a service for an owner or prime contractor such as pressure pumping or drilling.

**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.

**WHMIS** - Workplace Hazardous Materials Information System

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