

Employers' Guide on How to Conduct A Worker Exposure Assessment for Silica

INTRODUCTION

This publication is intended to provide direction on how to complete a worker exposure assessment to determine compliance with the Alberta occupational exposure limit (OEL) for silica.

The Occupational Health and Safety (OHS) Code requires a competent individual who is **adequately qualified, suitably trained and with sufficient experience** to complete the assessment. It is your responsibility as the employer to determine if your organization has in-house expertise to correctly conduct an assessment. If in-house expertise is not available, then you must hire a consultant who specializes in Occupational Hygiene to do the work. More details about selecting consultants are described in the publication [Tips on Selecting an Occupational Health and Safety \(OHS\) Consultant](#) available online.

Whether the employer or a third party consulting firm conducts the work, the assessment should be done in general accordance with the procedures outlined in this publication.

Collection of Occupational Samples

The silica OEL is based on what the worker is exposed to over a work shift representative of highest exposures or “worst-case scenario”. All measurements collected should represent worker exposure over the work shift and worker occupations/activities (including administrative and management functions). Area samples can be valuable tools to help an employer assess work site controls, but are not appropriate to assess compliance with the OEL. This is because workers typically do not remain in one spot throughout the work shift. The Alberta Occupational Health and Safety (OHS) Code requires that air monitoring for the purposes of evaluating compliance with an OEL be conducted using one of the validated methods listed in Section 20.

When conducting assessments for silica, the samples should be collected and analyzed according to the National Institute for Occupational Safety and Health (NIOSH) Method 7500. The samples must be collected in the worker's breathing zone for the full work shift. The breathing zone is the space below the worker's face as shown in the picture, and generally extends about 30 centimetres from the mouth. The air sampling equipment is mounted on the upper chest, close to the collar-bone, on the collar or on the shoulder, depending on the clothing and other protective equipment worn. If workers are wearing a respirator, the air sample is collected outside the face-piece.

Results of the Assessment Should Answer the Following Questions:

1. Does the airborne concentration of the substance measured on the day of the assessment exceed the OEL?
2. What controls are in place to protect the workers from exposure?
3. Are the controls effective at controlling worker exposure?



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Air is drawn through a pre-weighed polyvinyl chloride (PVC) filter cassette attached to a cyclone to collect the respirable particulate; the respirable dust collected on the filter is analyzed. The laboratory will determine the weight of particulate on the filter in milligrams (mg). If the volume collected on each sample is reported when samples are submitted for analysis; the laboratory will do the concentration calculation and report it on the analytical report.

Other important considerations:

- The minimum detection limit for most laboratories using NIOSH 7500 is 0.01 mg although some can detect as low as 0.005 mg. The maximum mass is usually 2 mg. If there is more than 2 mg of dust deposited on the filter, the laboratory may still be able to estimate the dust concentration, but the value will not be accurate. The laboratory report should indicate if this was the case.
- To evaluate full-shift worker exposure where airborne concentrations may be high, it might be necessary to collect numerous consecutive shorter duration samples to ensure that the filter is not overloaded.
- The air volume range for NIOSH 7500 is 400 to 1000 litres (L) ($1000\text{ L} = 1\text{ m}^3$). This is the amount of air that passes through the cassette over the sampling period. The volume of air collected will determine the concentration that can be measured. It is acceptable to collect a higher volume than 1,000 L as long as the maximum mass of 2 mg on the filter is not exceeded.

Air Sampling Equipment

1. **Pumps** should have as a minimum the following features:

- an automatic flow control keeping volumetric flow rate constant to within ± 0.1 litre/min in the case of changing back pressure;
- either a malfunction indicator, which following the completion of sampling indicates that the air flow has been reduced or interrupted during sampling; or an automatic cut-out, which stops the pump if the pump flow is reduced or interrupted;
- ability to adjust flow rate, but only with the aid of a tool (e.g. a screw driver) so as to prevent inadvertent adjustment of the flow rate during use.



2. **Pump Calibrator**

Pumps must be properly calibrated to ensure the volume of air collected during sampling can be accurately measured. Air volume must be known to calculate the airborne concentration of respirable silica. Calibration should be done before (pre) sample collection with a representative calibration cyclone plus filter cassette (sampling train) in-line to set the flowrate of the pump. It should also be done after (post) every sample collection with the same representative calibration sampling train in-line to verify the flowrate of the pump.



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Post-calibration must be done before recharging battery-operated pumps. The average of the pre-flowrate and post-flowrate is used to calculate the air volume. Usually a deviation of more than 10 percent between the pre- and post- calibration results indicates a pump failure during sampling. If this is the case, the sample should not be submitted for analysis as the sample volume will not be accurately known.

3. Cyclone

The OEL of 0.025 mg/m³ of silica is based on the respirable fraction of the airborne particulate. Therefore, the sampling train must include a cyclone before the filter cassette to separate the respirable fraction from the larger airborne particulate dust. The large particles fall into the red “grit pot” and the small particles are whirled up and deposited onto the filter in the cassette.

This is why when sampling with a cyclone, it is important to ensure the grit pot is attached; otherwise there is no size selection. There are a number of options for cyclones; the flowrate that the pump is set at depends on the cyclone selected. Follow the manufacturer’s specification for proper cyclone calibration to set the correct flow rate specified to achieve the right cut-point. The cyclone must be oriented vertically as shown in the adjacent picture. If the person conducting the air sampling observes that the cyclone orientation is not vertical, the orientation must be fixed right away and the person should make note of this interference incident.



4. Sample Cassettes and Filters

A PVC filter, 37 mm diameter, 5.0 micron pore size supported with a backup pad in a two piece or three piece 37 mm cassette filter holder is a required part of the sample train. The cassettes must be assembled in a clean area, away from potential contamination as per the NIOSH 7500 method. Typically, the laboratory can provide the filter cassettes already assembled. The cassette should be oriented upright as shown (direction of flow is from the red cap to the blue cap) and the tubing attached to the correct end of the cassette. The order of equipment is pump, tubing, cyclone and then cassette.



Direction of air flow

5. Quality Assurance/Quality Control

Blanks **must** be collected for each set of air samples analyzed. The NIOSH 7500 method requires that two field blanks be collected for every ten samples (if less than ten samples, collect at least one). Field blanks are prepared at the same time as air sampling cassettes. **The field blanks are handled and shipped exactly as the occupational samples, but no air is drawn through them.** The laboratory should report their quality assurance/quality control data along with the analytical results.

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Laboratory Analysis

Air samples should be analyzed by an American Industrial Hygiene Association (AIHA) accredited laboratory. This accreditation demonstrates that the laboratory has met defined standards of industrial hygiene analysis performance based on examination of a variety of criteria.

Using the NIOSH 7500 method, the samples are analyzed by X-ray diffraction to determine the amount of silica dust on the filter and to identify the type of silica found (quartz, cristobalite, and tridymite). **Note calcium carbonate will react with the silica in the furnace and form a calcium silicate thereby yielding biased low results therefore air samples must be treated with an acid wash prior to analysis.** Amorphous silica also presents similar low results. Acid washing will not affect the results if no interferences are present.

All air samples submitted to the laboratory should follow a chain-of-custody (COC) procedure that provides accountability and documentation of sample integrity. The form should be signed off by every party that handles the samples (e.g. courier, if one is used). COC information must include date of collection, sample volume, sample identification, analyses requested and whether an acid wash is requested.

Tips of Common Worker Exposure Monitoring Errors

Some common errors to avoid when conducting worker exposure monitoring include:

- Pre and post-calibration of air sampling equipment not according to manufacturer specifications;
- Post-calibration completed after re-charging battery-operated pumps;
- Calibration of the pumps without the representative calibration sampling train in-line;
- Operation of the pump at the incorrect flowrate for the cyclone;
- Using incorrect sampling media ;
- Not cleaning cyclones and grit pots prior to use;
- Failure to ensure the grit pot is in place on the cyclone prior to sampling;
- Inverting cyclone and filter cassette during sampling;
- The use of area samples to assess personal occupational exposures;
- Collected samples are not representative of the worker positions/activities on site;
- Insufficient air volume collected;
- Not accounting for the presence of other airborne substances that interfere with the results;
- No documentation of worker activities or site conditions at the time of sampling;
- Failure to collect and analyze blank samples;
- Use of a laboratory not accredited to do analysis of occupational hygiene samples; and
- Use of results which are not valid (for example due to pump failure, filter overloading, etc.).

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Worker Exposure Assessment Report

When occupational exposure monitoring is done, there is a minimum amount of information that is needed to properly assess the hazard and determine compliance with an OEL. The report should include:

- ✓ Description of the work site, including normal worker activities and site operations;
- ✓ Date of sample collection;
- ✓ Specific name of the method followed to collect and analyze the samples, including any deviations from the sampling or analysis method and why;
- ✓ Description of the equipment used to collect the samples and confirmation of equipment calibration (pre- and post-sampling);
- ✓ Flow rate of each sampling pump (average of pre and post calibration values);
- ✓ Time period for which each sample was collected;
- ✓ Air volume collected for each sample;
- ✓ Weather conditions at the time of sampling; this should include temperature, wind speed, amount of precipitation during the sample collection period (rain or snow), whether there was snow cover on the ground;
- ✓ Identification of the worker job titles or job functions for which occupational samples were collected, including the location of the worker at the work site;
- ✓ Description of worker activities during sample collection based on the direct observations of the person collecting the samples;
- ✓ Description of controls in place to protect the worker during sample collection (e.g. ventilation systems, personal protective equipment worn) and whether they were used;
- ✓ Description of quality control/quality assurance (QA/QC) samples collected;
- ✓ Laboratory QA/QC protocols and results including limits of detection (LODs);
- ✓ Calculated exposure concentrations based on the mass detected by laboratory and volume of air sampled expressed in mg/m^3 ;
- ✓ Discussion of the validity of the results; did they represent typical worker activities and work site conditions as well as the implications of the QA/QC sample results; and
- ✓ Identification of the person who collected the samples and prepared the report and their competencies.

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OHS Contact Centre

Edmonton & Surrounding area

- 780-415-8690

Throughout Alberta

- 1-866-415-8690

Deaf or hearing impaired:

- 780-427-9999 (Edmonton)
- 1-800-232-7215 (Alberta)

Website

[work.alberta.ca/ohs-contact us](http://work.alberta.ca/ohs-contact-us)

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