Office of the Chief Inspector of Mines

BC GUIDELINE

For use of the MINING SILICA CONTROL TOOL

Health, Safety and Reclamation Code for Mines in British Columbia

April 2024

Publication Information

Office of the Chief Inspector of Mines

Version 1.0 April 2024

Any questions regarding this document may be directed to the Occupational Health group at Mine.OccHealth@gov.bc.ca

Acknowledgements

The Mining Silica Control Tool has been developed in partnership with the BC Construction Safety Alliance (BCCSA) and with support from the BC Stone, Sand and Gravel Association (BCSSGA) and individual mines across the province. The Office of the Chief Inspector of Mines gratefully thanks these partners for their role in the development of the Mining Silica Control Tool.

Contents

Foreword

Who should use this Guideline?

This Guideline is intended for use by mine managers and personnel responsible for health and safety at a mine site producing sand, gravel and/or construction aggregate materials (e.g. a Q or G permitted operation). This guideline may also be used by workers or Occupational Health and Safety Committee members to learn more about silica, the Mining Silica Control Tool™ **("the Tool")** and the sections of the Health, Safety and Reclamation Code for Mines in British Columbia (the Code) that are relevant to the evaluation and control of silica exposures.

This Guideline is not intended for use by major mines (M or C permit holders), nor Q or G permit holders targeting industrial minerals such as magnesite, limestone, barite, silica, etc., as the Tool does not encompass representative exposure scenarios for these operations at this time.

Purpose of Guideline

The purpose of this guideline is to assist mine management and personnel responsible for health and safety of workers at sand, gravel and aggregate mine sites in recognizing where workers may be at risk of exposure to Respirable Crystalline Silica (RCS) dust and how the Mining Silica Control Tool™ **("the Tool")** can be used to help sites identify how they can reduce the risk of silica exposure for workers. This document also provides information on the key Code sections and regulatory requirements that regulate the evaluation and control of silica exposure at mines in BC.

Further detailed information on silica and its health effects, exposure monitoring, and exposure control strategies can be found in the Mining Silica Control Tool and in the Resource section of this document (Appendix 3).

Scope and Application

The Mining Silica Control Tool was developed as a resource for the mining industry to aid in understanding risk of exposure to Respirable Crystalline Silica (RCS) dust for specific silica processes and provides guidance in implementing effective controls to reduce the risk of exposure and improve worker health.

The Tool utilizes an exposure model developed by the BC Construction Safety Alliance. The model incorporates data collected in British Columbia (BC) by the mining industry and

Occupational Health Inspectors with the Office of the Chief Inspector of Mines and utilizes data from published peer-reviewed scientific literature. This data is considered appropriate for use by sites where conditions mirror the silica process and conditions outlined in the Tool.

Currently, the data included in the model is only reflective of exposures associated with producing sand, gravel and construction aggregate. Therefore, the use of the Tool is not suitable for major mines or operators targeting other industrial minerals such as silica. The Tool offers an opportunity for industry to provide feedback on tools, tasks, and materials that are missing from the Tool and will be regularly updated to include more data.

Mining Silica Control Tool users should have a background and knowledge in identifying potential or actual dangers to health or safety in the workplace.

Silica and Workers Health

Silica is the second most common mineral on earth and is a basic component of sand and rock. It can be found in varying amounts in almost all types of rocks, sands, clays, and gravel. The crystalline forms of silica, such as quartz, are the most common types of silica and are also the biggest health concern.

Respirable crystalline silica (RCS) is hazardous when airborne as breathing in this fine dust can cause serious lung diseases such as silicosis (scarring of lung tissue), lung cancer, pulmonary tuberculosis, and chronic pulmonary disease. Silica exposure has also been linked to kidney disease, reduced lung function, and autoimmune disorders. Damage can be **permanent** and symptoms can occur shortly after significant acute exposure, but often do not appear for many years after prolonged exposure has occurred. Symptoms can worsen over time and can even lead to death.

Worker exposure to RCS is a risk every day at sand, gravel and aggregate operations. Activities such as drilling, hauling, dumping, crushing, screening, maintenance and quality control lab sampling activities can result in RCS becoming airborne. Exposure to silica can occur even if you don’t see the dust because RCS particles are smaller than the diameter of a human hair.

Due to the significant health consequences that can result from exposure to silica and its classification by the International Agency for Research on Cancer (IARC) as carcinogenic to humans, it is important to ensure that exposures are maintained “as low as reasonably achievable” (ALARA). This means efforts should be made to reduce exposures even further below the regulatory allowable exposure limit.

Evaluating Exposure to Workplace Contaminants

The Code requires that the mine manager ensure workers are not overexposed to workplace contaminants, such as RCS, through the course of their work duties.

Section 2.1.1 of the Code states:

> *2.1.1 Notwithstanding section 1.1.4 of the code, employees shall not be exposed to airborne concentrations of chemical agents or noise in excess of the levels specified in Tables 2-1 and 2-2, or where not specified those listed in the 1994-1995 edition of the American Conference of Governmental Industrial Hygienists' book entitled "Threshold Limit Values and Biological Exposure Indices". Referenced material shall be made available to the OHSC.*

The Mine Manager must establish a written program, commonly called a Workplace Monitoring Program, for a qualified person to monitor workplace contaminants. This program is used to help demonstrate compliance with section 2.1.1 and that workers are not overexposed to workplace contaminants.

Section 2.1.3 (1) of the Code states:

> *2.1.3 (1) The manager shall establish a written program, in accordance with the chief inspector's publication "Workplace Monitoring Procedures Manual" for a qualified person to monitor workplace contaminants as often as necessary to ensure compliance with section 2.1.1. The program shall specify the substances and locations to be monitored and the frequency of monitoring. The results of the program shall be available for examination by an inspector.*
>
> *(2) A record of the monitoring program shall be kept on file for the life of the mine and transferred to the chief inspector upon abandonment of the mine.*

The Mining Silica Control Tool utilizes an exposure model developed for mines by the BC Construction Safety Alliance. The model is informed by a database of exposure monitoring results collected from mines across the province and from published peer-reviewed scientific literature. The Tool uses the aggregate data to identify the expected exposure for a specific task with and without controls. To ensure accurate use of the Tool the user

must ensure that the silica process being evaluated mirrors the definitions and conditions for that process as outlined in the Tool.

The Exposure Control Plan (ECP) generated by the Tool outlines the exposure risk for a specific silica process and identifies the steps that will be taken to address the risk. A separate ECP is required for each silica process identified at the mine. ECPs can be uploaded to your ***MineSpace*** account as a Code Required Report for the Workplace Monitoring Program. The Silica Control Tool only addresses respirable crystalline silica exposure risks. Exposure concerns for other contaminants such as noise, welding fumes, etc., must be evaluated separately.

If the ECP is being used to assist compliance with 2.1.1 and 2.1.3. it must be updated on an annual basis or anytime there is a change to the silica process. The Mining Silica Control Tool will be regularly updated with new data and silica processes. Requests for new processes to be added to the Tool can be made on the Work Activity page of the Tool. Exposure monitoring data can also be submitted through the request platform to support ongoing development of the Tool.

Further resources on exposure monitoring are provided in the Resources section of this document under the section for industrial hygiene best practices. Exposure monitoring plans and interpretation of results developed outside of the use of the Mining Silica Control Tool must be completed by a qualified person (e.g. Registered Occupational Hygienist or Certified Industrial Hygienist).

Where used to assist compliance with section 2.1.3 of the Code, records of all ECPs should be kept on file for the life of the mine and transferred to the chief inspector upon abandonment of the mine.

Controlling Exposure to Workplace Contaminants

Where workers may be at risk of exposure to contaminants, the mine manager must implement controls to ensure compliance with section 2.1.1 of the Code. The hierarchy of controls must be used when controlling workplace exposures (see Figure 1 below). Engineering controls offer the highest level of protection and are often more effective than administrative controls and personal protective equipment (PPE) for protection from RCS exposure. A combination of engineering and administrative controls as well as PPE is typically required to provide adequate protection.

Remember, when managing exposures to substances such as RCS that are known to cause cancer it is important to focus on keeping exposures “as low as reasonably

achievable" (ALARA). This means efforts should be made to reduce exposures even further below the regulatory allowable exposure limit.

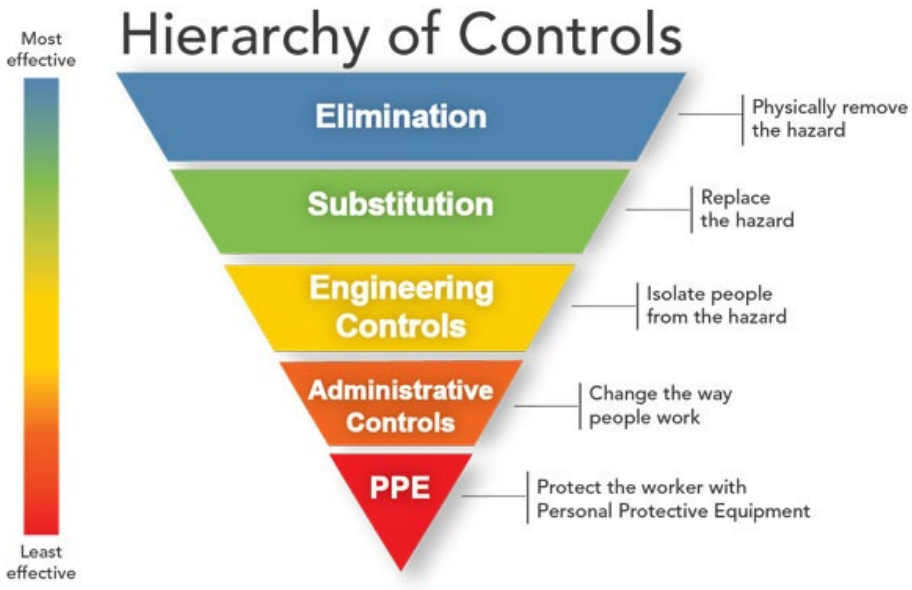

Figure 6. Hierarchy of controls (NIOSH 2016).

Controls at the Source

Section 1.9.1of the Code states:

> *1.9.1 The manager shall,*
>
> *(a) Take all reasonable and practicable measures to ensure that the workplace is free of potentially hazardous agents and conditions which could adversely affect the health, safety, or well-being of the workers,*
>
> *(b) where practicable, institute controls at the source to ensure that workers are not exposed to a level of any physical, chemical, or radiation hazard in excess of the limits prescribed in the code or by an inspector, with the exception of unusual short term or emergency situations, and*
>
> *(c) require that persons wear effective personal protective equipment in any situation where control at the source, as required by section 1.9.1(2), is impractical.*

The Code further specifies that where work carried out generates dust, water sprays or other dust suppression means and devices must be used.

Section 6.24.2 of the Code states:

> *6.24.2 Wherever practicable, water sprays or other dust suppression means and devices shall be used at every dusty place where work is carried out and where it is impractical to do so, personal protective equipment shall be supplied and worn by all persons working in that location.*

The Tool aids in choosing a combination of controls that will reduce worker exposures. It also provides valuable information, criteria and proper practices for adequate control implementation.

Controls at the source of exposure and engineering controls are prioritized in the Tool for determining exposure reduction values. Engineering controls are engineered methods that are built into the design of equipment, process, or plant to minimize a hazardous exposure. The Tool utilizes a site-wide approach to the application of engineering controls for reducing exposures to RCS for each activity. This is because most workers will spend time in various locations on-site throughout their shifts. For example, water sprays that are installed on a crushing plant will reduce exposure for all workers at the facility, depending on the placement and location of workers to the plant. Alternatively, workers conducting work nearby the plant may still be exposed to dust produced by the plant even if they are not involved in the plant's operation.

Enclosed, pressurized operator/equipment cabs are another critical engineered control used to reduce silica exposures. These are considered a control at the source, but are also described as "separation from source" systems. The Tool outlines specific criteria that must be met by an enclosed cab in order to ensure it is providing adequate protection for exposure reduction.

Administrative Controls

Administrative controls are policies and procedures that outline the knowledge and actions required to reduce the risk of exposure to RCS dust. For example, administrative controls can include exposure control plans, safe working procedures, maintenance procedures for engineered controls, worker training programs, and policies for reducing workers time in high risk exposure environments/scenarios (e.g. task rotation).

Section 1.6.9 1(c) and (2) of the Code states:

> *1.6.9 (1) The manager shall develop a Mine Health and Safety Program which includes the following sections*
>
> *(c) safe working procedures on a departmental basis*
>
> *(2) The OHSC shall review the Mine Health and Safety Program, including OHSC Training, for completeness and effectiveness on an ongoing basis and submit its findings to the manager.*

The Tool provides users with a series of administrative control options that can be selected for use in the exposure control plan for a silica process. These options currently include inspections and maintenance of engineering controls, housekeeping, hygiene of workers and PPE, and instruction and training of workers. Each option is provided with criteria parameters and proper practices to aid in supporting successful implementation of the chosen control.

If there are other administrative controls used by your site that are not available in the Tool, please submit a request through the Tool's request platform to help support ongoing development of new features.

As per section 1.6.9(2) of the Code, ensure that exposure control plans and any other supporting policies and procedures are reviewed on an ongoing basis by the site's OHSC (if applicable).

Personal Protective Equipment

Where controls at the source or engineered and administrative controls are not practicable or adequate to reduce exposures below the exposure limit, the use of Personal Protective Equipment (PPE) is required (see Code reference s.1.9.1 (3) on the previous page). Use of PPE may also be desired where exposures are determined to be below the exposure limit given the goal of keeping exposures to RCS "As Low As Reasonably Achievable" (ALARA).

Examples of typical PPE utilized to protect against exposures to RCS includes respiratory protection and washable or disposable coveralls and gloves. When exposed to RCS through silica processes, respiratory protective equipment is often required.

Section 1.8.1 of the Code states:

> *1.8.1 The manager shall*
>
> *(1) except for protective footwear and prescription eyeglasses, supply properly fitted personal protective equipment as required by the code,*
>
> *(2) ensure that workers are instructed in the use and maintenance of the equipment, the reasons for it, and also on its location and limitations, and*
>
> *(3) ensure that the equipment is adequate for its purpose.*

The Mining Silica Control Tool provides recommendations on the level of protection and type of respiratory protective equipment that is required for a work activity with residual exposures remaining after use of engineered controls. The Tool also highlights key criteria that must be achieved where respirators are required, such as fit tests, maintenance and selection requirements, and information that provides support on developing a Respiratory Protection Program. Further resources on respiratory protection are provided in Appendix 3.

APPENDIX 1 Definitions

“Exposure Control Plan” [Definition provided by BCCSA, Mining Silica Control Tool] The ECP is a document that sets out the plan the mine manager will implement to protect workers from hazardous exposure to RCS dust. The ECP co-ordinates and communicates what will be executed to address the RCS dust exposure risk for a particular silica process. A new ECP is required for each different kind of silica process identified as needed at the mine.

An ECP generated through the proper application of the Mining Silica Control Tool™ provides evidence that a compliant ECP has been prepared for the silica process. Various circumstances, however, including actual implementation of the ECP, change in any factors involved in the silica process, and appropriateness of the ECP to the silica process taking place at the mine, may warrant re-analysis through the Tool or the need for worksite sampling and testing.

“Silica process” [Definition provided by BCCSA, Mining Silica Control Tool] means a process, such as a work activity under particular conditions, that results in a hazardous level of RCS dust. The work activity alone does not define a silica process. There are factors that can impact the release of RCS dust in concentrations likely to exceed the acceptable level. These factors include (but are not limited to) mine and project details, work area characteristics, weather, and the duration of the work activity.

APPENDIX 2 Acronyms

ALARA	"As low as reasonably achievable" (in reference to reducing exposures)
BCCSA	British Columbia Construction Safety Alliance
ECP	Exposure Control Plan
EMLI	British Columbia Ministry of Energy, Mines and Low Carbon Innovation
IARC	International Agency for Research on Cancer
NIOSH	National Institute for Occupational Safety & Health
OCIM	Office of the Chief Inspector of Mines
OHSC	Occupational Health and Safety Committee
PPE	Personal Protective Equipment
RCS	Respirable Crystalline Silica
The Code	Health, Safety and Reclamation Code for Mines in BC
The Tool	Mining Silica Control Tool™

APPENDIX 3 Resources

This section contains resources for industrial hygiene best practices, exposure control strategies, and other important links. If there is a conflict between these resources and a Code requirement, the Code requirement must be met. All website links referenced in this manual were accessible as of the publication date. The organizations responsible for the content of these websites may update them from time to time and the Office of the Chief Inspector of Mines is not responsible for their content.

Important Links:

Institution - Title	Website Link
BCCSA – Mining Silica Control Tool™	https://mining.silicacontroltool.com/
EMLI - MineSpace	https://minespace.gov.bc.ca/
OCIM – Occupational Health Webpage	https://www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/health-safety/occupational-health

More information on silica and health effects:

Institution - Title	Website Link
Carex Canada – Silica (Crystalline) Profile	https://www.carexcanada.ca/profile/silica_crystalline/
NIOSH – Silicosis: Learn the Facts!	https://www.cdc.gov/niosh/docs/2004-108/default.html
WorkSafeBC – Silica	https://www.worksafebc.com/en/health-safety/hazards-exposures/silica

Specific exposure control strategies:

Institution - Title	Website Link
General Information:	
WorkSafeBC – Control Measures	https://www.worksafebc.com/en/health-safety/create-manage/managing-risk/controlling-risks
Dust Control:	
BCCSA - Mining Silica Control Tool	mining.silicacontroltool.com

NIOSH – Best Practices for Dust Control in Metal and Non-metal Mining	https://www.cdc.gov/niosh/mining/works/coversheet192.html
NIOSH – Dust Control Handbook for Industrial Minerals Mining and Processing	https://www.cdc.gov/niosh/mining/works/coversheet2094.html
NIOSH/CDC – Workplace Solutions: Reducing Hazardous Dust in Enclosed Operator Cabs	https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2009-123.pdf
Noise Control:	
NIOSH – Noise Control in Underground Metal Mining	https://www.cdc.gov/niosh/mining/works/coversheet1367.html
WorkSafeBC – Sound Advice	https://www.worksafebc.com/en/resources/health-safety/books-guides/sound-advice-a-guide-to-hearing-conservation-programs?lang=en
Respiratory Protection:	
WorkSafeBC – Breathe Safer	https://www.worksafebc.com/en/resources/health-safety/books-guides/breathe-safer-how-to-use-respirators-safely-and-start-a-respirator-program

Industrial hygiene best practices:

Institution - Title	Website Link
AIHA – A Strategy for Assessing and Managing Occupational Exposures	www.aiha.org
AIHA – The Occupational Environment: Its Evaluation, Control, and Management	www.aiha.org
NIOSH – Occupational Exposure Sampling Strategy Manual*	www.cdc.gov/niosh/docs/77-173/pdfs/77-173.pdf

APPENDIX 4 Figure References

National Institute for Occupational Safety and Health. (2016). Hierarchy of Controls. Retrieved from https://www.cdc.gov/niosh/topics/hierarchy/default.html.