

## **QGL02**

### **Guideline for Management of Respirable Crystalline Silica in Queensland Mineral Mines and Quarries**

***Mining and Quarrying Safety and Health Act 1999***

**May 2018, Version 2.0**

## Acknowledgements

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*This document is issued in accordance with PART 5—Guidelines and Section 63(1) of the Mining and Quarrying Safety and Health Act 1999.*

## **PART 5—Guidelines**

### **62 Purpose of guidelines**

*A guideline may be made for safety and health stating ways to achieve an acceptable level of risk to persons arising out of operations.*

### **63 Guidelines**

- (1) The Minister may make guidelines.*
- (2) The Minister must notify the making of a guideline by gazette notice.*
- (3) The chief executive must keep a copy of each guideline and any document applied, adopted or incorporated by the guideline available for inspection, without charge, during normal business hours at each department office dealing with safety and health.*
- (4) The chief executive, on payment by a person of a reasonable fee decided by the chief executive, must give a copy of a guideline to the person.*

### **64 Use of guidelines in proceedings**

*A guideline is admissible in evidence in a proceeding if—*

- (a) the proceeding relates to a contravention of a safety and health obligation imposed on a person under part 3; and*
- (b) it is claimed that the person contravened the obligation by failing to achieve an acceptable level of risk; and*
- (c) the guideline is about achieving an acceptable level of risk.*

*Control and management of risk*

### **26 What is an acceptable level of risk**

- (1) For risk to a person from operations to be at an acceptable level, the operations must be carried out so that the level of risk from the operations is—*
  - (a) within acceptable limits; and*
  - (b) as low as reasonably achievable.*
- (2) To decide whether risk is within acceptable limits and as low as reasonably achievable regard must be had to—*
  - (a) the likelihood of injury or illness to a person arising out of the risk; and*
  - (b) the severity of the injury or illness.*

### **34 How obligation can be discharged if regulation or guideline made**

- (3) if a guideline states a way or ways of achieving an acceptable level of risk, a person discharges the person's safety and health obligation in relation to the risk only by—*
  - (a) adopting and following a stated way; or*
  - (b) adopting and following another way that achieves a level of risk that is equal to or better than the acceptable level.*

The words 'shall', 'must' or 'mandatory' place a legal obligation on the identified person or entity. The word 'should' indicates a recommended course of action, while 'may' indicates an optional course of action.

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*This guideline is issued under the authority of the Minister for Natural Resources, Mines and Energy*

*[Gazetted 18 May 2018]*

## Table of contents

<b>1</b>	<b>Purpose and Scope</b> .....	<b>1</b>
<b>2</b>	<b>Introduction</b> .....	<b>2</b>
<b>3</b>	<b>Process</b> .....	<b>2</b>
3.1	Assess the RCS Risk .....	2
3.2	Measuring the RCS Risk .....	4
3.2.1	Monitoring Worker Exposure .....	4
3.2.2	Minimum Sampling Requirements .....	5
3.2.3	Exposure Limit for Workers.....	6
3.2.4	Communication of Exposure Monitoring Results.....	6
3.2.5	Exceedance of a Single Sample .....	7
3.2.6	Statistical Analysis of Exposure Monitoring Data .....	7
3.2.7	Periodic Monitoring for RCS .....	8
3.2.8	Review and Audit RCS Hazard Management.....	9
3.3	Health Surveillance .....	9
3.4	Records Retention Requirements .....	10
<b>4</b>	<b>Appendices</b> .....	<b>11</b>
	Appendix 1. Abbreviations.....	11
	Appendix 2. Glossary of terms .....	12
	Appendix 3. Extract from Mining & Quarrying Safety & Health Regulation.....	14
	Appendix 4. Monash Report Recommendations.....	17
	Appendix 5. Competencies for Exposure Monitoring Activities.....	20
	Appendix 6. Descriptive Statistics of Exposure Data .....	21
	Appendix 7. Adjustment to the OEL for Non-standard Work Cycles.....	22
	Appendix 8. Health Surveillance for Crystalline Silica.....	23
<b>5</b>	<b>References and Bibliography</b> .....	<b>24</b>

## Tables

Table 1 - Minimum sample numbers for statistical analysis of a workgroup or SEG .....	5
Table 2 - Periodic exposure monitoring - minimum sampling and frequency .....	8
Table 3 - Respirability of dust by particle size .....	13
Table 4 - Application of the Monash Report.....	17
Table 5 - Interpreting the GSD .....	21
Table 6 - Adjustment factor to RCS OEL for typical non-standard work cycles in mining .....	22

## Figures

Figure 1 - Hierarchy of controls.....	3
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# 1 Purpose and Scope

This Guideline:

- provides guidance to Site Senior Executives (SSEs) and other persons on:
  - how to manage the monitoring of workers' exposure to respirable crystalline silica (RCS) and
  - to manage their health surveillance to achieve an acceptable level of risk from the hazard of exposure to RCS associated with mining silica bearing minerals and rock, and
- adopts the recommendations from the Monash Review<sup>1</sup> (refer Appendix 4) that are applicable to mineral mines and quarries as defined by the *Mining and Quarrying Safety and Health Act 1999 (MQSHA)*.

The Guideline applies to all Queensland mineral mines and quarries.

This Guideline version 2.0 replaces version 1.0.

This Guideline commences from the date of gazettal, except for section 3.2.4 'Sampling results to be provided to the Mines Inspectorate', which commences on 1 July 2018.

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<sup>1</sup> *Review of Respiratory Component of the Coal Workers' Health Scheme for the Queensland Department of Natural Resources and Mines – Final Report – 12 July 2016 – Monash Centre for Occupational and Environmental Health, Monash University*

## 2 Introduction

### Occurrence of crystalline silica is widespread

Silica or silicon dioxide occurs in two forms, either crystalline or amorphous.

The most common type of crystalline silica, quartz, is found in most igneous, metamorphic and sedimentary rock. The potential for worker exposure to crystalline silica is widespread within the minerals mining and quarrying industry.

While amorphous silica may cause lung disease, crystalline silica, due to its chemistry and shape, is particularly harmful when it is of respirable size and deposited into the lower parts of the lungs. Crystalline silica is classified as causing cancer to humans by the International Agency for Research on Cancer.

### Exposure to airborne RCS may result in lung injury or disease

Crystalline silica is an aggressive, lung damaging dust when it is able to penetrate deep into the lung in sufficient quantities. In order for the crystalline dust particles to penetrate deep into the lung they must be very small (diameter less than 10 µm), a size fraction defined as respirable.

RCS has the potential to be generated during drilling, blasting, crushing, cutting and transporting, and is a hazard with the potential to cause a significant adverse effect on the health and safety of a person at a mine.

### RCS can travel into the deep part of the lungs

Workers exposed to elevated levels of RCS have an increased risk of developing simple pneumoconiosis, progressive massive fibrosis, silicosis, chronic obstructive pulmonary disease and lung cancer. In most cases these diseases may not become apparent for many years after exposure has occurred. The type of disease that occurs is influenced by the dust particle size, composition and concentration. Preventing exposure to RCS is an important part of the risk management process.

### Current OEL<sup>2</sup>

The occupational exposure limit (OEL) to RCS is an 8-hour Time Weighted Average of 0.1 mg/m<sup>3</sup>.

## 3 Process

### 3.1 Assess the RCS Risk

#### SSE must identify and evaluate RCS risk at their site

The SSE shall evaluate the RCS risk at their operations. The SSE should consider :

#### Almost all types of rocks, sands and gravel contain crystalline silica

- materials containing crystalline silica on site or brought to site:
  - substances being processed or used for processing,
  - products, by-products or waste products of operations.
- activities that may generate RCS include (release of crystalline silica into the air):
  - drilling
  - blasting
  - excavating
  - grading
  - mucking or loading

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<sup>2</sup> MQSHR Schedule 5 - General exposure limits for hazards

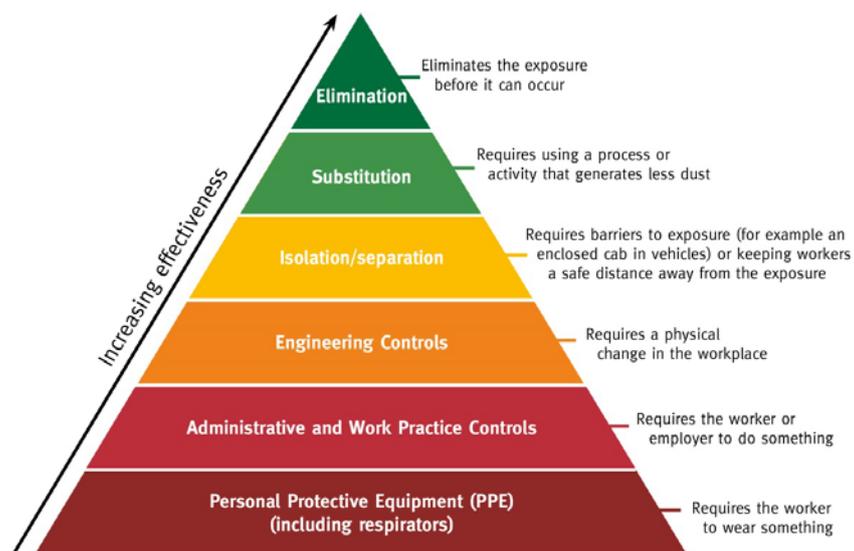
**The activities that create RCS will result in an unacceptable exposure if not controlled.**

- tipping or transporting
- crushing and conveying
- cutting or grinding
- drying or calcining
- pelletising
- bagging
- plant maintenance and cleaning
- how, where, and for how long workers may be exposed to RCS
- the control measures for RCS at the site
- how the effectiveness of control measures is monitored

The SSE shall implement control measures to reduce the exposure to an acceptable level for any activity or task that may create an unacceptable RCS exposure.

The SSE shall ensure that controls to reduce RCS exposure are applied according to the hierarchy of control as depicted below in Figure 1.

**Hierarchy of controls must be applied for the control of RCS<sup>3</sup>**



*Figure 1 - Hierarchy of controls*

**PPE or RPE is a short term control measure for RCS exposure**

The SSE shall ensure that use of personal protective equipment (PPE) is a short-term control until higher order controls are developed and implemented. The selection, use and maintenance of respiratory protective equipment must conform to AS/NZS 1715<sup>4</sup>.

Further guidance for the risk analysis arising from workplace exposures is provided in the following references:

- *A strategy for assessing and managing occupational exposures (Ignacio & Bullock, 2006).*
- *Simplified occupational hygiene risk management strategies (Firth, van Zanten & Tiernan, 2006).*

**Informing workers of RCS hazards**

The SSE must ensure that workers are made aware of potential RCS hazards at a mine

- as part of the induction and refresher training
- when RCS is a known hazard for a particular task or activity

<sup>3</sup> MQSHR Section 8 Risk reduction

<sup>4</sup> AS/NZS 1715 Selection, use and maintenance of respiratory protection

- whenever significant changes are made at the mine that affect the RCS risk

The information should provide workers with an understanding of RCS, any control measures relevant to their work and provide them with the ability to recognise substandard conditions or practices that can contribute to hazardous RCS exposure.

The following information about RCS hazards should be provided to workers:

- the distribution of crystalline silica at the mine
- activities that create RCS risk to workers and noting that a lack of visible dust is not a reliable indicator of RCS risk
- how RCS may affect workers – silicosis or lung cancer, noting that no symptoms may be present in the early stages of lung disease
- control measures that have been implemented at the mine
- selection, use, storage and maintenance of respiratory protection including respirator fit testing

## 3.2 Measuring the RCS Risk

### 3.2.1 Monitoring Worker Exposure

#### **Develop an exposure monitoring program<sup>5</sup>**

The SSE, in consultation with the occupational hygienist, shall develop an exposure monitoring program for activities that have been identified as having an RCS exposure risk.

In the development of the exposure monitoring program, consideration should also be given to monitoring other airborne contaminants at the mine that may have an additive effect on RCS exposure.

#### **Consider the use of similar exposure groups (SEGs)**

Rather than assess each worker's risk individually, it is possible to group workers of similar exposure to RCS. These groups are referred to as similar exposure groups (SEGs). SEGs should be based on logical associations, examples of SEG structure includes:

- work or functional groups
- physical location
- activity
- equipment used

The effective selection and use of SEGs may reduce the number of exposure monitoring samples that need to be collected for the assessment of RCS risk at a mine.

#### **RCS samples must be collected in accordance with AS2985**

Sampling to measure worker exposure to RCS must be undertaken by an occupational hygienist or a person who has a competency recognised by Mining Safety and Health Advisory Committee for the task, and adequate knowledge and understanding of mining activities (Appendix 5) and in accordance with *AS 2985 - Workplace atmospheres - Method for sampling and gravimetric determination of respirable dust*.

The sampling duration should span the full shift. If this is not possible, the sampling duration shall be as long as possible but not less than half the shift duration (that is, not less than 4 hours for an 8 hour shift or 6 hours for a 12 hour shift).

<sup>5</sup> MQSHR Section 136 - Monitoring workers' exposure

**Equipment must be calibrated**

The SSE shall ensure that the sampling equipment used for exposure monitoring has been tested and calibrated in accordance with AS 2985.

Workers shall take reasonable care not to interfere with the operation of the monitoring equipment or samplers.

**Sample integrity<sup>6</sup>**

If a worker thinks that the sample may have been compromised, then they should tell the occupational hygienist or occupational hygiene technician.

The SSE shall ensure that information is collected and recorded during the RCS exposure monitoring, including:

- worker activities during the exposure monitoring,
- environmental conditions,
- production rates,
- operating conditions.

**Analysis by an accredited laboratory.**

The SSE shall ensure that the collected samples are analysed by a laboratory with third party technical accreditation (for example NATA) for the RCS analysis method used.

### 3.2.2 Minimum Sampling Requirements

**Worker exposure monitoring measures RCS and does not consider the effect of PPE**

The purpose of worker exposure monitoring is to provide a time weighted average of the concentration of RCS that has entered the worker's breathing zone in the course of their activities during the day, including rest-breaks.

The workers to be monitored should be randomly selected on the day of monitoring.

A single exposure monitoring result, on its own, can only be used to assess the worker exposure for the day of monitoring.

**Sufficient sample numbers required for reliable exposure estimate**

Collecting too small a number of samples may lead to an inaccurate estimation of the exposure risk. For the SSE to be able to demonstrate that the RCS monitoring is applicable to a whole workgroup or SEG, additional samples and statistical analysis are necessary.

Table 1 identifies the minimum number of samples required to enable reliable analysis of a workgroup or SEG's exposure to be undertaken.

*Table 1 - Minimum sample numbers for statistical analysis of a workgroup or SEG.*

No. of workers in group	Samples to be Taken
≤6	6
7	7
8-9	8
10	9
11-12	10
13 -14	11
15 -17	12
18 -20	13
21 -24	14
25 -29	15
30 -37	16
38 -49	17
50	18

<sup>6</sup> MQSHR Section 137 - Tampering with samples

### 3.2.3 Exposure Limit for Workers

**The OELs are levels to protect nearly all workers.**

The OEL for a substance is based on the airborne concentrations of individual substances which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers.

The 0.1 mg/m<sup>3</sup> OEL for RCS is a time-weighted average based on a standard work cycle. A standard work cycle is:

- a shift no longer than 8 hours a day;
- not more than 5 shifts a week;
- at least 16 hours between consecutive shifts

**The OEL must be adjusted for non-standard work cycles<sup>7</sup>**

The SSE shall ensure that the OEL is adjusted for non-standard work cycles.

Examples of the adjustment for the OEL applied to typical shift patterns are provided in Appendix 7.

Further information on adjustment to exposure limits is provided in the Australian Institute of Occupational Hygienists (AIOH) guidance document *Adjustment of Workplace Exposure Standards (WES) for Extended Work Shifts*.

### 3.2.4 Communication of Exposure Monitoring Results

**Review results and compare to OEL**

The SSE shall ensure that an occupational hygienist reviews analysis results as soon as practicable after receipt.

The occupational hygienist shall compare the exposure monitoring results to the OEL or the shift-adjusted OEL for the worker.

**Report to SSE**

Within 28 days of any exposure monitoring, the Occupational Hygienist shall provide the SSE a written report on the exposure monitoring. The report shall include:

- worker(s) monitored,
- monitoring date(s)
- duration of monitoring
- each worker's duties, roles or tasks at the time of monitoring,
- workgroup or SEG affiliation
- comment for each sample as to whether it is representative of the worker exposure
- exposure monitoring results compared to the applicable OEL
  - including whether any result is an exceedance
  - whether the worker wore respiratory protective equipment (RPE), and the type if worn.
- for each exceedance, a summary of observed or reported activity for the worker on the day of monitoring.
- any invalid samples
- practicable recommendations for actions or control measures to reduce exposure to below the applicable OEL and as low as reasonably achievable.

**Recommendations to reduce exposure<sup>8</sup>**

<sup>7</sup> MQSHR Section 134 (1) *Adjusting exposure limits for hazards for workers*

<sup>8</sup> MQSHR Section 135 *Limiting workers' exposure*

**Information to monitored workers**

The SSE shall ensure that every worker who was sampled or monitored is provided with their exposure monitoring result as soon as practicable.

**Sampling results to be provided to the Mines Inspectorate**

The SSE shall notify the Mines Inspectorate within 28 days of becoming aware of the results of RCS sampling. The notification shall be in the form published by the chief inspector on the department's website and shall include:

- date of the sample
- unique sample identification
- first and last name of the worker
- hours worked in work week and shift duration
- departmental exposure monitoring reporting classes
- primary and secondary worker activity including location
- sampling time in minutes
- exposure monitoring result – RCS concentration mg/m<sup>3</sup>
- shift adjusted OEL concentration for RCS mg/m<sup>3</sup> and the adjustment method used
- any comments regarding validity of sample (all samples to be reported including invalid results)
- respiratory protection worn (or not) and what type
- corrective actions if exceedance of any type
- Any other matters in the form published by the chief inspector.

### 3.2.5 Exceedance of a Single Sample

**Single exposure exceedance must be investigated and reported**

The SSE shall ensure that an investigation is undertaken where exposure monitoring shows that there is an exceedance to the applicable OEL.

The investigation must identify the cause of the exceedance and the control measures or action that will be taken to prevent or eliminate further exceedance.

The SSE shall ensure that the investigation report and corrective actions are communicated to workers and recorded in the mine record<sup>9</sup>.

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### 3.2.6 Statistical Analysis of Exposure Monitoring Data

**Mine must conduct statistical analysis**

The SSE shall ensure that an occupational hygienist conducts statistical analysis on the mine's exposure data every two years.

The number of samples (n) required for the statistical analysis are dependent on a number of factors including

- number of workers in the SEG (refer Table 1).
- RCS exposure profile (refer Appendix 6 - Descriptive Statistics of Exposure Data)
- variation in workers' exposure monitoring results (Appendix 6 - Table 5)
- variations in processing or production

The occupational hygienist shall review the validity of exposure monitoring results older than 2 years for inclusion in the statistical analysis.

The Minimum Variance Unbiased Estimate (MVUE) is an estimate of the mean exposure for the group or SEG. The accuracy of the estimate may be improved with increased number of samples. However, the potential range of

<sup>9</sup> MQSHA Section 59 Mine record

**Land’s UCL must be below the OEL for compliance**

values for the true mean exposure may be evaluated. Land’s calculation of the confidence limits determines the upper and lower bounds of possible mean exposure for the dataset.

In determining whether the exposure for a SEG’s data is compliant, the Land’s upper confidence limit (UCL) must be below the OEL. This provides 95% confidence that the true mean exposure for the SEG will not be above the OEL.

Worker, workgroup or SEG exposure shall be considered unacceptable (non-compliant) if the Land’s Upper Confidence Limit (UCL<sub>95%</sub>) is greater than the applicable OEL.

The occupational hygienist shall provide a written report on the statistical analysis to the SSE. The report shall include:

- compliance status for each workgroup or SEG
- recommendations for the reduction of RCS exposure
- future exposure monitoring plan.

**Develop plan to reduce exposure<sup>10</sup>**

The SSE shall ensure that the report is reviewed and control measures are developed and implemented to eliminate over-exposure and reduce exceedances.

**Notify workers of results**

The SSE shall ensure that the report and a summary of the control measures implemented are recorded in the mine record and communicated to all workers in the workgroup or SEG.

### 3.2.7 Periodic Monitoring for RCS

**Evaluate the effectiveness of control measures by periodic monitoring**

The SSE shall ensure that exposure monitoring is undertaken periodically to ensure that the mine’s current control measures continue to be effective. The occupational hygienist shall develop an exposure monitoring plan for each worker, workgroup or SEG based on their exposure profile.

The number and frequency of samples required for each workgroup or SEG shall be determined with accordance to Table 2 or as directed by an Occupational Hygiene Inspector of Mines.

*Table 2 - Periodic exposure monitoring - minimum sampling and frequency*

Exposure Ratio	Samples per 10 workers
>1	1 per quarter
0.5 to 1	1 per six months
0.1 to 0.5	1 per year
< 0.1	1 per 3 years

*(adapted from Grantham & Firth, 2014)*

**Frequency of monitoring is dependent on effectiveness of control measures**

For the purposes of calculation, the ‘Exposure Ratio’ is the ratio of the MVUE for the worker, workgroup or SEG data to the applicable exposure limit for the workgroup or SEG:

$$\text{Exposure Ratio} = \frac{\text{group data MVUE}}{\text{OEL}}$$

<sup>10</sup> MQSHR Section 135 Limiting workers’ exposure

The occupational hygienist shall modify the exposure monitoring plan to include additional samples for workgroups or SEGs that have high variations in their RCS exposure, where the geometric standard deviation (GSD) of the group data is greater than 3.

### 3.2.8 Review and Audit RCS Hazard Management

**The effectiveness of the SHMS and any specific hazard management plan for the control of RCS must be periodically reviewed**

The Operator of the mine shall review and audit the effectiveness of the Mine's Safety & Health Management System (SHMS) including RCS management to ensure risk to persons is at an acceptable level, including:

- ensuring monitoring is undertaken at appropriate intervals
- sufficient samples are collected for statistical analysis
- sampling and analysis is undertaken by competent persons
- exceedances are identified, investigated and appropriate, effective, control measures are implemented
- health surveillance is appropriate to risks at the mine and completed to the required standard and at the required frequency

Guidance is provided in [Guidance Note QGN09 – Reviewing the effectiveness of safety and health management systems](#).

### 3.3 Health Surveillance

**Periodic health surveillance required for workers that may be exposed to RCS<sup>11</sup>**

The SSE, in consultation with an appropriate doctor, should implement a health surveillance program where there is a risk to worker health due to RCS exposure.

A worker or all workers in a workgroup or SEG shall be subject to health surveillance if the MVUE for the worker, workgroup or SEG is greater than 50% of the shift-adjusted OEL.

The SSE shall ensure that health surveillance is conducted for each worker:

- prior to a worker placed into a role where they may be exposed to RCS
- at least every five years
- on the worker leaving or retiring from the industry
- and applied to any other person, including employees, contractors or labour hire that may be required to perform duties or tasks of a worker, workgroup, or SEG that is subject to health surveillance

An exit medical for the worker should also be considered.

**Health surveillance to meet a minimum requirement**

Health surveillance must be conducted under the supervision of an appropriate doctor and shall conform with the requirements in Appendix 8, including:

- respiratory questionnaire
- lung function test – such as spirometry
- chest x-ray (reviewed against the ILO International Classification of Radiographs of Pneumoconioses)
- any other test deemed pertinent by the appropriate doctor.

The appropriate doctor shall provide the worker with a copy and an explanation of the health assessment report.

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<sup>11</sup> MQSHR Section 138 Health surveillance

The SSE shall ensure that they have received a copy of the worker's health assessment report, which is no older than 5 years, prior to engaging the worker in duties or activities with a potential (or actual) exposure to RCS.

Where a worker, workgroup or SEG are no longer subject to RCS exposure, the SSE shall consult the appropriate doctor on additional specific or future periodic surveillance for any or all of the workers.

**SSE to report on any case of silicosis<sup>12</sup>**

The SSE must report the occurrence of silica related diseases including silicosis, progressive massive fibrosis, chronic obstructive pulmonary disease or lung cancer to the Mines Inspectorate as soon as practicable after the SSE has become aware of the diagnoses in a worker or former worker. The SSE shall report the name of the worker and other relevant details related to the worker, including:

- name
- date of birth
- work history at the mine

**Managing workers with a silica related disease<sup>13</sup>**

The SSE must ensure that a worker who has been diagnosed with a silica related disease is protected from further exposure to RCS. In consultation with the worker and the appropriate doctor, the SSE shall develop and resource a RCS management plan for the worker, which may require modifications to workplace, the use of powered air purifying respirators or the removal of the worker from certain roles or tasks.

The worker with a diagnosed silica related disease should consider alternative occupations that do not involve exposure to substances hazardous to the lungs.

### 3.4 Records Retention Requirements

**Record retention<sup>14</sup>**

The SSE shall ensure records of monitoring conducted for the mine in relation to a hazard with a cumulative or delayed effect, such as RCS, are kept for 30 years.

**Which records must be kept**

The records of monitoring include

- medical record of workers made prior to their employment and in the course of their assessment
- workers' health assessment reports and health surveillance reports
- employment record of the workers at the mine
- exposure monitoring records for workers
- any workgroups or SEGs identified at the mine

The records may be retained either as hard copy or electronically in a form that is readily accessible, for example pdf.

A black and white or greyscale-version of a colour record is acceptable if colour is not an important aspect of a document.

**Maintain security of information<sup>15</sup>**

The SSE must ensure that any archiving system used maintains confidentiality and security of the records.

<sup>12</sup> MQSHA Section 195 Notice of accidents, incidents, deaths or diseases

<sup>13</sup> MQSHR Section 134 Adjusting exposure limits for hazards for workers

<sup>14</sup> MQSHR Section 138 (4) Health Surveillance

<sup>15</sup> MQSHR Section 120 Confidentiality of worker's medical record

Prior to the mine ceasing operation, the SSE shall ensure records of monitoring are securely archived and stored in accordance with directions from the Chief Inspector.

## 4 Appendices

### Appendix 1. Abbreviations

AHPRA	Australian Health Practitioner Regulation Agency
AIOH	Australian Institute of Occupational Hygienists
AQF	Australian Qualifications Framework
COPD	Chronic Obstructive Pulmonary Disease
GSD	Geometric Standard Deviation
DNRM	Department of Natural Resources and Mines
MSHAC	Mining Safety and Health Advisory Committee
MQSHA	Mining and Quarrying Safety and Health Act 1999
MQSHR	Mining and Quarrying Safety and Health Regulation 2001
MVUE	Minimum Variance Unbiased Estimate
NOHSC	National Occupational Health and Safety Commission
OEM	original equipment manufacturer
PPE	Personal Protective Equipment
RCS	Respirable Crystalline Silica
RPE	Respiratory Protective Equipment
SEG	Similar Exposure Group
SHMS	Safety and Health Management System
SSE	Site Senior Executive
TWA	Time Weighted Average
UCL	Upper Confidence Limit

### Units of measure

mg/m <sup>3</sup>	milligrams per cubic metre of air
µm	Micron or micrometre 1 micrometre = $\frac{1}{1,000}$ millimetre

## Appendix 2. Glossary of terms

<b>Appropriate Doctor</b>	A doctor registered with the Australian Health Practitioner Regulation Agency (AHPRA) as a specialist in occupational medicine or have an Australian Qualifications Framework (AQF) Level 8 or above in occupational medicine. The appropriate doctor must have demonstrated knowledge of the risks associated with activities performed by the mine's workers.
<b>Breathing zone</b>	A hemisphere of 300 mm radius extending in front of the face and measured from the mid-point of a line joining the ears.
<b>Chronic obstructive pulmonary disease (COPD)</b>	COPD is characterised by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases. The primary cause of COPD is cigarette smoking or exposure to tobacco smoke. Other causes or aggravators include airborne dust particles, pollution, infectious diseases and genetic predisposition. The two main forms are chronic bronchitis and emphysema
<b>Exceedance For Individual</b>	When the measured time weighted average (TWA) of a worker's exposure to RCS is above the shift-adjusted occupational exposure limit (OEL)
<b>Exceedance for SEG</b>	When the SEG Land's UCL <sub>95%</sub> is above the shift-adjusted exposure limit for RCS (determined after statistical analysis of the SEG exposure data)
<b>Health Assessment</b>	Medical assessment of the worker to evaluate the worker's ability to tolerate a hazard without harming the worker or the worker's offspring (MQSHR s131).
<b>Health Surveillance</b>	The monitoring or testing of a person to check for changes in the person's health because of exposure to a hazard (MQSHR s137).
<b>Health Surveillance Report</b>	Information, other than a medical record, about the effects on the worker's health related to the worker's exposure to a hazard at the mine and the need, if any, for remedial action.
<b>Land's Upper Confidence Limit (UCL)</b>	Land's calculation of exposure assessment determines the upper and lower bounds of the Minimum Variance Unbiased Estimate (MVUE) to a 95% certainty. Hence in the interpretation of SEG data, there is a 95% certainty that the MVUE is below Land's UCL for that dataset. See Appendix 6.
<b>Medical Record</b>	Medical results or clinical findings obtained from a fitness or health assessment or health surveillance of the person
<b>Mine Record</b>	<p>The collation of information that the operator must retain pursuant to section 59 of the MQSHA. Information that must be retained include reports of inspections and investigations, audits, directives issued and remedial action, reports about all serious accidents and high potential incidents and all other reports or information that may be prescribed under a regulation.</p> <p>Refer to QGN05 Guidance Note on Keeping and Using the Mine Record at Mining and Quarrying Operations in Queensland</p>
<b>Monitoring</b>	A program or strategy that uses sampling to estimate workers' exposure or assessing the magnitude of dust levels
<b>Minimum Variance Unbiased Estimate (MVUE)</b>	An unbiased estimate of the true arithmetic mean (AM) of a log normal dataset. The MVUE is especially useful when a dataset is heavily influenced by high results.

**Pneumoconiosis** Pneumoconiosis is a general term given to any lung disease caused by dusts that are breathed in and then deposited deep in the lungs causing damage. Pneumoconiosis can develop when respirable airborne dusts, particularly mineral dusts, are inhaled. The dust particles remain in the lung where they can cause inflammation or fibrosis (scarring). The effects of damage from inhaled mineral dusts may not show up for many years, so workers may not develop symptoms until long after they are no longer exposed to these dusts. The most common causes of pneumoconiosis are inhalation of asbestos, silica (sand or rock dust) or coal dust. Only some workers exposed to these dusts will develop pneumoconiosis.

**Respirable Fraction**

The proportion of airborne particulate matter that penetrates to the unciliated airways when inhaled. This fraction is further described in ISO 7708 as the percentage of inhalable matter collected by a device conforming to a sampling efficiency curve that passes through the points shown in Table 3.

Alternatively, it can be described by a cumulative log-normal distribution with a median equivalent aerodynamic diameter of 4.25 µm and a geometric standard deviation of 1.5 µm.

*Table 3 - Respirability of dust by particle size*

Equivalent aerodynamic diameter (µm)	Respirability (%)
0	100
1	100
2	97
3	80
4	56
5	34
6	20
7	11
8	6
10	2
12	0.5
14	0.2
16	0.1
18	0.0

**Sampling**

The process of collecting a measurement or series of measurements of worker exposure

**Significant change**

Any modification or change of process or equipment that has the potential to alter worker exposure to RCS. Examples of significant change include:

- changing the nature of operations, for example, from exploration to extraction and processing, transition to care and maintenance, rehabilitation or closure
- changing from an open cut to an underground mine or vice versa
- changing mining method, for example open stoping to block cave
- expansion of a pit operation from the original design
- upgrading or installing fixed plant (this may include new crushers, mills)
- replacing or introducing mobile plant
- reduction or downsizing of operational activities

**Silicosis**

A form of lung disease resulting from occupational exposure to silica dust over a period of years. Silicosis causes slowly progressive fibrosis (scarring) of the lungs and impairment of lung function. Workers with silicosis have a tendency to tuberculosis of the lungs and an increased risk of lung cancer.

**Similar Exposure Group (SEG)**

Group of workers who have the same general exposure to risk. (e.g. the same similarity and frequency of the tasks they perform; the materials and processes with which they work; or the similarity of the way they perform those tasks)

**Specialist radiologist**

Medical practitioner registered with Australian Health Practitioner Regulation Agency (AHPRA) as a Specialist radiologist

## Appendix 3. Extract from Mining & Quarrying Safety & Health Regulation

### Part 14 Subdivision 2 Limiting exposure to hazards

#### 133 Exposure limits for workers

- (1) This section applies if an assessment of a worker's health under section 131 shows the worker has an unacceptable level of risk from a hazard at a lower level of exposure than the general exposure limit for the hazard, including, for example, because a personal factor of the worker impairs the worker's ability to tolerate the hazard.

*Example of personal factor—*

fitness, diet, pregnancy, physical disability, allergy or phobia

- (2) The site senior executive must ensure a personal exposure limit is set for the worker for the hazard to reduce the risk to an acceptable level.

#### 134 Adjusting exposure limits for hazards for workers

- (1) This section applies if a hazard is present in a mine's work environment and at least 1 of the following apply to a worker at the mine—
  - (a) the worker's work cycle does not conform to the standard work cycle used in establishing the general exposure limit for the hazard;
  - (b) the worker's work cycle decreases the rate at which the worker recovers from adverse effects of the hazard;
  - (c) the effects of a hazard on the worker may increase if the worker does heavy strenuous work, or works under adverse climatic conditions.
- (2) The site senior executive must ensure the exposure limit applying to the worker for the hazard is adjusted to account for the circumstances mentioned in subsection (1).
- (3) If the national standard for the hazard or NOHSC's guidance note states a way of adjusting the general exposure limit for the hazard in the circumstances, the site senior executive must ensure the exposure limit applying to the worker for the hazard is adjusted in the stated way.
- (4) If the work environment at a mine contains hazards that interact with each other to increase their adverse effects on a worker, the site senior executive must ensure the exposure limits that apply to the worker for the hazards are adjusted to account for the interaction.
- (5) In this section—

**NOHSC's guidance note** means NOHSC's document entitled 'Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:3008]'.

**standard work cycle**, generally, means a work cycle consisting of the following—

- (a) a shift of not longer than 8 hours a day;
- (b) not more than 5 shifts a week;
- (c) at least 16 hours between consecutive shifts.

#### 135 Limiting workers' exposure

- (1) The site senior executive must ensure a worker's exposure to a hazard at the mine—
  - (a) does not exceed the exposure limit applying to the worker for the hazard; and
  - (b) is as low as reasonably achievable.
- (2) This section does not apply to the worker's exposure to the hazard during an emergency evacuation.

#### 136 Monitoring workers' exposure

- (1) This section applies to a hazard at a mine—
  - a. that has the potential to exceed the exposure limit applying to a worker for the hazard; or

- b. for which the level of risk may vary.
- (3) The site senior executive must ensure the worker's exposure to the hazard is monitored, and the monitoring results are analysed, regularly.
- (4) If a relevant Australian standard or national standard states a way of carrying out the monitoring or analysis, the site senior executive must ensure it is done in the stated way.

*Examples of relevant Australian or national standard for subsection (3)—*

- (1) for inspirable dust—AS 3640 'Workplace atmospheres—Method for sampling and gravimetric determination of inhalable dust'
- (2) for lead—NOHSC's document entitled 'National Standard for the Control of Inorganic Lead at Work [NOHSC:1012]'
- (3) for respirable dust—AS 2985 'Workplace atmospheres—Method for sampling and gravimetric determination of respirable dust'

### 137 Tampering with monitoring samples and results

A person must not tamper, or allow another person to tamper, with a sample or the results of a sample taken to monitor a worker's exposure to a hazard at a mine.

### 138 Health surveillance

- (1) The site senior executive must arrange for health surveillance of a worker at the mine if the site senior executive reasonably believes, or ought to reasonably believe—
  - a. exposure to a hazard at the mine may cause, or result in, an adverse health effect; and
  - b. the health effect may happen under the worker's work conditions; and
  - c. either—
    - i. a valid technique capable of detecting signs of the health effect exists; or
    - ii. a valid biological monitoring procedure is available to detect changes from the current accepted values for the hazard.

*Examples of changes from current accepted values—*

- 1 a higher than normal blood level of lead caused by exposure to substances containing lead
- 2 a raised urinary mercury level caused by exposure to mercury vapour

- (2) The site senior executive must—
    - a. arrange for the health surveillance to be done by, or under, the instruction of an appropriate doctor; and
    - b. ask the appropriate doctor to give—
      - iii. the site senior executive a health surveillance report; and
      - iv. the worker a copy and explanation of the health surveillance report.
  - (3) The worker's employer must pay for the worker's health surveillance and the health surveillance reports.
- Maximum penalty for subsection (3)—30 penalty units.
- (4) The site senior executive must ensure the health surveillance report is kept for the following period—
    - a. (a) for a hazard with a cumulative or delayed effect—30 years;

*Example for paragraph (a)—*  
silica, noise or vibration

- b. (b) for another hazard—7 years.
- (5) If the mine ceases operations in the period the health surveillance report is required to be kept under subsection (4), the site senior executive must ask for, and comply with, the chief executive's directions about the report's storage.
- (6) Subsection (3) is not a safety and health obligation for the Act.
- (2) In this section—

**health surveillance report** means information, other than a medical record, about—

- (a) the effects on the worker's health related to the worker's exposure to a hazard at the mine; and
- (b) the need, if any, for remedial action.

### 139 Removing affected worker from work environment

- (1) Subsection (2) applies if a worker has effects from a hazard, other than lead, at a mine exceeding the exposure limit applying to the worker for the hazard.
- (2) The site senior executive must ensure the worker is removed from, and does not resume, work involving exposure to a level of the hazard that would increase the effects or prevent the effects decreasing.
- (3) The site senior executive must ensure a worker—
  - a. is removed from a lead-risk job if the worker has a blood lead level at or above the worker's removal level; and
  - b. does not resume a lead-risk job until the worker's blood lead level is less than the level stated for the worker in the inorganic lead standard, section 15(27).
- (4) In this section—

***inorganic lead standard*** means NOHSC's document entitled 'National Standard for the Control of Inorganic Lead at Work [NOHSC:1012]'.

***lead-risk job***, for a worker, means work in which the blood lead level of the worker might reasonably be expected to rise, or does rise, above 1.45 µmo/L (30 µg/dL) or the worker's removal level, whichever is the lower.

***removal level***, for a worker, means the removal level stated for the worker in the inorganic lead standard, section 15(24).

### 140 Using personal protective equipment

- (1) This section applies if a person's exposure to a hazard at a mine can not be prevented or reduced other than by using personal protective equipment.
- (2) The site senior executive must ensure—
  - a. the person is given suitable and effective personal protective equipment; and
  - b. the person is competent in using the equipment; and
  - c. the person's work load and work cycles are reduced to allow for the increased physical load of the equipment.
- (3) A person who is given personal protective equipment under subsection (2) must use the equipment when the person's level of risk from the hazard is unacceptable.

## Appendix 4. Monash Report Recommendations

In 2015 the Queensland Government commissioned a review of the design and operation of the respiratory component of the Coal Mine Workers' Health Scheme. The multidisciplinary review team included expertise in occupational medicine, respiratory medicine, occupational hygiene, epidemiology, radiology and respiratory science from Monash University and the University of Illinois.

The aims of the review were to:

- determine whether the respiratory component of the health assessment performed under the Queensland Coal Mine Workers' Health Scheme is adequately designed and implemented, to most effectively detect the early stages of coal mine dust lung disease among Queensland coal mine workers, estimating the extent and providing feedback and, if not,
- recommend necessary changes to correct deficiencies identified under Aim A, recommend measures to follow up cases that may have been missed as a result of these deficiencies, and identify what additional capacity is needed in Queensland to improve this scheme

The recommendations made in the report were considered in the development of this guideline. In the table below, a summary of how each recommendation of the Monash report is addressed by this guideline.

The final report *The Review of Respiratory Component of the Coal Mine Workers' Health Scheme for the Queensland Department of Natural Resources and Mines* is available at [www.dnrm.qld.gov.au/\\_data/assets/pdf\\_file/0009/383940/monash-qcwp-final-report-2016.pdf](http://www.dnrm.qld.gov.au/_data/assets/pdf_file/0009/383940/monash-qcwp-final-report-2016.pdf)

**Table 4 - Application of the Monash Report**

Recommendation Summary	Comment on Applicability
1. The main purpose of the respiratory component of the scheme should explicitly focus on the early detection of Coal Mineworker Dust Lung Disease (CMDLD) among current and former coal mine workers.	This guideline provides guidance on the respiratory component with an explicit focus on detection of lung diseases including respiratory questionnaire, spirometry and chest x-ray
2. Clinical guidelines for follow-up investigation and referral to an appropriately trained respiratory or other relevant specialist of suspected CMDLD cases identified among current and former coal miner workers should be developed and incorporated into the scheme.	This guideline references the SafeWork Australia paper on RCS which includes clinical guidelines
3. DNRM should require the reporting of detected cases of CWP and other CMDLDs in current and former coal miners identified by the scheme.	Silicosis is now recognised in MQSHR Schedule 1A - Diseases for section 195(6) of the Act
4. There should be a separate respiratory section of the health assessment form which includes all respiratory components, including the radiology report using the ILO format and the spirogram tracings and results.	This guideline includes respiratory questionnaire and examination –with reference to ILO readers
5. The form should include a comprehensive respiratory medical history and respiratory symptom questionnaire.	Include as per recommendation 1

Recommendation Summary	Comment on Applicability
6. The criteria to determine workers “at risk from dust exposure” should be based on past and current employment in underground coal mines and designated work categories in open-cut coal mines and CHPPs.	This guideline specifies ‘at risk’ workers as being a worker, workgroup or SEG at a mine that has a mean RCS exposure level greater than 50% of the shift-adjusted OEL
7. There should be a much smaller pool of approved doctors undertaking the respiratory component of health assessments under the scheme, taking into account geographical considerations and other workforce needs.	This guideline specifies competencies for appropriate doctor as being an occupational physician or respiratory specialist.
8. Doctors should undergo a formal training program, including visits to mine sites, prior to being approved by the DNRM, to ensure they reach a suitable standard of competence and have the necessary experience to undertake respiratory health assessments under the scheme.	This guideline specifies health surveillance is supervised by a doctor registered AHRPA as a specialist in occupational medicine or have an AQF Level 8 or above in occupational medicine.
9. The approval of doctors to undertake the respiratory health assessments for the early detection of CMDLD under the scheme should become the sole responsibility of the DNRM.	Not applicable, no equivalent process available in MQSHA or MQSHR
10. Doctors approved to undertake respiratory health assessments should have a different designation from ‘NMA’, which should reflect their specific responsibility for respiratory health assessments under the new scheme.	As per recommendation 8
11. Chest x-rays should be performed by appropriately trained staff to a suitable standard of quality and performed and interpreted according to the current ILO classification by radiologists and other medical specialists classifying CXRs for the scheme.	This guideline specifies that the chest x-ray for a worker be assessed against the ILO classification
12. Spirometry should be conducted by appropriately trained staff and performed and interpreted according to current ATS/ERS standards.	Standardised respiratory function tests (spirometry) shall be conducted by a person who has successfully completed the Queensland Health Spirometry Training Program or equivalent. (Appendix 8)
13. DNRM should transition to an electronic system of data entry and storage, whereby doctors undertaking these respiratory assessments enter the data for their assessment and can access previously collected data for the mine worker and to facilitate auditing.	Data entry and storage is not DNRM responsibility in mineral mines and quarries. This guideline requires that the mine’s medical provider retain the workers medical records, that the SSE retains a copy of each worker’s health assessment report

Recommendation Summary	Comment on Applicability
14. All coal mine workers, including contractors, subcontractors and labour hire employees, who meet the revised criteria for being “at risk from dust exposure” should be registered in the DNRM database on entry into the industry for the purposes of ongoing medical surveillance.	Not applicable to mineral mines and quarries.
15. DNRM should conduct ongoing individual and group surveillance of health data collected under the scheme, to detect early CMDLD and analyse trends to disseminate to employers, unions and coal mine workers.	This guideline and the MQSHR require periodic health surveillance and notification of the incidence of silicosis and other occupational lung diseases.
16. Coal mine workers should have exit respiratory health assessments regardless of whether they leave the industry due to ill-health, retirement or other reasons.	This guideline has guidance for the inclusion of exit medicals
17. An implementation group, including representatives of stakeholders and relevant medical bodies, should be established to ensure that the necessary changes to correct the identified deficiencies with the respiratory component of the current scheme are implemented in a timely manner.	<p>No current scheme applicable to mineral mines and quarries – advice from the DNRM occupational physician and review of this guideline by MSHAC</p> <p>Development of a Structured Inspection Guide and inclusion of silica as a risk in the Mines Inspectorate Inspection Schedule database</p>
18. There should be a further review of the revised respiratory component of the scheme within 3 years to ensure that it is designed and performing according to best practice.	As per recommendation 17

## Appendix 5. Competencies for Exposure Monitoring Activities

### Occupational Hygienist

An occupational hygienist must, as a minimum, be recognised as a Full Member of the Australian Institute of Occupational Hygienists (MAIOH) or hold an equivalent competency under an international certification scheme (for example Certified Industrial Hygienist), or have an Australian Qualifications Framework (AQF) Level 8 or above in occupational hygiene with a minimum of 5 years' experience.

The occupational hygienist is deemed competent to carry out the following work at a mine or quarry

- develop or review a mine's workgroups or SEGs
- estimate worker, workgroup or SEG exposure using qualitative analysis
- develop a sampling plan for RCS, representative of worker exposure as well as environmental and operating conditions
- conduct exposure monitoring at a mine
- determine exposure of workgroups or SEGs using descriptive statistics;
- review and update the RCS monitoring plan

### Occupational Hygiene Technician

An occupational hygiene technician must have completed competency-based training that;

- is recognised by the Mining Safety and Health Advisory Committee for the task, and
- has adequate knowledge and understanding of mining activities ( e.g. operating methods, conditions and environment) and
- includes sampling to AS2985- *Workplace atmospheres—Method for sampling and gravimetric determination of respirable dust.*

## Appendix 6. Descriptive Statistics of Exposure Data

Statistical analysis provides descriptive statistics that are generated to summarise the data set and estimate exposure.

Statistical Measure	Description
Number of samples (n)	At least 6 samples are required to perform statistical analysis of a data set; Number of samples required for statistical assessment of the SEG should be based on the estimate of exposure and the number of workers in the workgroup or SEG; Table 2be used as guidance on sampling numbers required statistical analysis.
Minimum (min) / Maximum (max)	Describes the range of exposure values in a given data set for a SEG.
Minimum Variance Unbiased Estimate (MVUE)	The estimated average exposure of the SEG for a lognormal population. This datum may also be referred to as the Estimated Arithmetic Mean (est AM)
Geometric Standard Deviation (GSD)	A measure of the spread of data in a dataset. It is expected that most exposures in a SEG are generally the same. Where there is significant variation in a dataset, this will be reflected by the value of the GSD.  High GSD values may indicate a need to undertake additional sampling or to review the accuracy of the SEGs definition.

*Table 5 - Interpreting the GSD*

GSD Value	Degree of data spread
1.0 – 2.0	Data clustered around the mean – minimal variation
2.0 – 3.0	Moderate variation in the data set – potentially due to: elevated individual exposure results samples below the limit of reporting insufficient number of samples
>3.0	Significant variation in data set – potentially due to: Significant outliers in data set Incorrectly defined SEG Insufficient number of samples

Lands Upper and Lower Confidence Limits

95% Upper Confidence Limit (UCL)

Land's calculation determines the error boundary of the MVUE to a 95% certainty. In the interpretation of the RCS risk to a SEG, it is certain (to 95% confidence) that the MVUE will not be greater than the upper confidence limit (UCL).

If SEG's Lands UCL is below the OEL, the SEG exposure is deemed compliant.

## Appendix 7. Adjustment to the OEL for Non-standard Work Cycles

As specified in [Section 3.2.3 - Exposure Limit for Workers](#), the SSE must ensure that the occupational exposure limit (OEL) for the hazard is adjusted for non-standard work cycles.

Supporting information for the adjustment of the OEL is provided in the AIOH document '*Adjustment of Workplace Exposure Standards for Extended Work Shifts*' with further reference to the spreadsheet utilising the Quebec Model for exposure adjustment.

In Table 6 (below), the Quebec model was used to calculate the adjustment to the OEL for RCS. The application of the adjustment factor to other parameters may only be made after reference to the supporting information for the adjustment model.

*Table 6 - Adjustment factor to RCS OEL for typical non-standard work cycles in mining*

Roster work cycle	shifts worked in roster	number of days break in roster	hours per day	number of days in work cycle	number of hours worked per cycle	average number of hours per week	adjustment factor	shift-adjusted OEL (mg/m <sup>3</sup> )
7 on/7 off - 12.5 hour days	7	7	12.5	14	87.5	43.75	0.91	0.09
4 on/3 off - 12 hour days	4	3	12	7	48	48	0.83	0.08
10 hour days, 5 day workweek	5	2	10	7	50	50	0.8	0.08
14 on/7 off	14	7	12	21	168	56	0.71	0.07
8 on/6 off - 12.5 hour days	8	6	12.5	14	100	50	0.8	0.08
short work week	4	3	7.2	7	28.8	32.4	1	0.10

## Appendix 8. Health Surveillance for Crystalline Silica

Health surveillance includes a standardised respiratory questionnaire, spirometry, physical examination of the respiratory system and if required chest x-ray.

The forms for health surveillance are available at <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards/recognised-standards>

- Health Surveillance (Respiratory) Assessment Questionnaire.  
(<https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards/recognised-standards>)
- Health Surveillance (Respiratory) Assessment Report.  
(<https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards/recognised-standards>)

Health surveillance assessment shall be conducted under the supervision of doctor registered with the Australian Health Practitioner Regulation Agency (AHPRA) as a specialist in occupational medicine or who has have an AQF Level 8 or above in occupational medicine.

Supervision is defined as availability for consultation of the appropriate doctor at the time of the health monitoring assessment directly, either in person or by electronic communication. Supervision shall also include the oversight, interpretation and reporting of the health surveillance assessment.

A Medical Practitioner or a Registered Nurse shall administer the standardised respiratory questionnaire.

A Medical Practitioner shall perform physical examination including an examination of the respiratory system.

Standardised respiratory function tests (spirometry) shall be conducted by a person who has successfully completed the Queensland Health Spirometry Training Program or equivalent.

The Medical Practitioner shall ensure that calibration and maintenance of equipment conforms to Queensland Health Guidelines for spirometry testing.

Chest X-ray, full size PA view

- A chest X-ray must be taken at least every 5 years for all workers.
- Chest x-rays shall be conducted by a Radiographer.
- Chest x-rays shall be reported by a Specialist Radiologist (<http://www.ranzcr.edu.au/register-of-clinical-radiologists-for-cwp-screening/register>) and shall be reported according to current International Labour Organisation classification.

A copy of the Health Surveillance (Respiratory) Assessment Report must be provided to the SSE and the worker. The appropriate doctor must ensure that the results have been explained to the worker.

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