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Recognised Standard 14

Monitoring respirable dust in coal mines

Coal Mining Safety and Health Act 1999

Resources Safety & Health Queensland

Contents

Contents

Recognised Standards may be updated from time to time. To ensure you have the latest version, check the website: https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards or contact your local office.

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Recognised standards

This document is issued in accordance with PART 5—RECOGNISED STANDARDS and section 37(3) of the *Coal Mining Safety and Health Act 1999*.

PART 5 - RECOGNISED STANDARDS

71 Purpose of recognised standards

A standard may be made for safety and health (a "recognised standard") stating ways to achieve an acceptable level of risk to persons arising out of coal mining operations.

72 Recognised standards

(1) The Minister may make recognised standards.

(2) The Minister must notify the making of a recognised standard by gazette notice.

(3) The CEO must publish on a Queensland government website each recognised standard and any document applied, adopted or incorporated by the standard.

(4) In this section—

Queensland government website means a website with a URL that contains 'qld.gov.au', other than the website of a local government

73 Use of recognised standards in proceedings

A recognised standard 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 recognised standard is about achieving an acceptable level of risk.

PART 3 - SAFETY AND HEALTH OBLIGATIONS

37 How obligation can be discharged if regulation or recognised standard made

(3) …. if a recognised standard 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.

Where a part of a recognised standard or other normative document referred to therein conflicts with the *Coal Mining Safety and Health Act 1999* or the Coal Mining Safety and Health Regulation 2017, the Act or Regulation takes precedence.

Issued under the authority of the Minister for Resources.

Gazetted 27 August 2021

1.0 Purpose

To state ways to achieve an acceptable level of risk to persons arising out of coal mining operations by providing the minimum requirements that must be included in a coal mine's safety and health management system (SHMS) for monitoring, preparing records and reporting concentrations of respirable dust levels as required under sections 49, 89 and 89A of the Coal Mining Safety and Health Regulation 2017 (CMSHR).

Section 49 of CMSHR states a mines SHMS must provide for the periodic monitoring of the level of risk from hazards at the mine that are likely to create an unacceptable risk. Strategies for developing personal monitoring programs for respirable dust as detailed in this Recognised Standard (RS) could also be considered for other airborne contaminants such as inhalable dust, diesel particulate matter (DPM) and welding fume.

2.0 Scope

This RS applies to all underground and surface coal mines in Queensland, and includes all on-site activities as defined by the *Coal Mining Safety and Health Act 1999* (CMSHA).

3.0 Introduction

Coal mine workers (CMWs) may be exposed to a range of respiratory hazards, such as coal and mineral dust from development, production and processing as well as welding fumes and diesel engine exhaust emissions.

Dust is a word often used to describe the fine, dry particles of dirt and waste on the ground and in the air. In coal mines, dust particles may be much finer than the body will normally encounter elsewhere. The mine atmosphere contains coal, silica, rock dust and other mineral dust particles, some of which are so small they cannot be seen by the naked eye.

Any coal mine dust able to enter a worker's respiratory system poses a potential health risk. However, it is the respirable dust fraction capable of reaching the lower bronchioles and alveolar (or gas exchange) regions of the lungs that is a priority to manage. Once dust particles enter the lower lungs, it becomes more difficult for the respiratory system to clear that dust. Therefore, exposure to respirable dust and protecting the health of workers is an important part of the risk management process at a coal mine.

The behaviour, deposition and fate of any individual particle after entry into the human respiratory system and the response that occurs, depends on the toxicity and size of the particle.

Occupational exposure to harmful levels of respirable dust can lead to a range of diseases collectively known as mine dust lung disease (MDLD).

3.1 What is MDLD?

A CMW with MDLD may present with one or more of the following diseases:

- pneumoconiosis
  - coal workers' pneumoconiosis (CWP)
  - mixed dust pneumoconiosis (MDP)
  - silicosis
- chronic obstructive pulmonary disease (COPD), including:
  - chronic bronchitis
  - emphysema
- diffuse dust-related fibrosis (DDF)
- asbestosis and asbestos pleural disease
- lung cancer.

MDLD may take several years to develop, commonly 10 years or more. However, in some instances, early signs of disease appear after less than 10 years. Lung damage is irreversible, however if the damage is detected early, the progress to more severe stages of disease may be prevented or slowed. The risk of developing disease might be higher if you are sensitive to the effects of dust or are a smoker.

CMWs may also develop other lung diseases, including cancer, by breathing in harmful fumes or particulates, for example diesel exhaust or welding fumes. For more information, visit the Miner Health Matters website at https://www.rshq.qld.gov.au/miners-health-matters.

3.2 Risk management process

Assessing and managing risk associated with respirable dust can be a complex process due to the requirement to undertake specific risk management techniques. RS 02: Control of risk management practices provides details for coal mines in identifying hazards, assessing, controlling and evaluating risk. Figure 1 outlines the risk management process described in this RS.

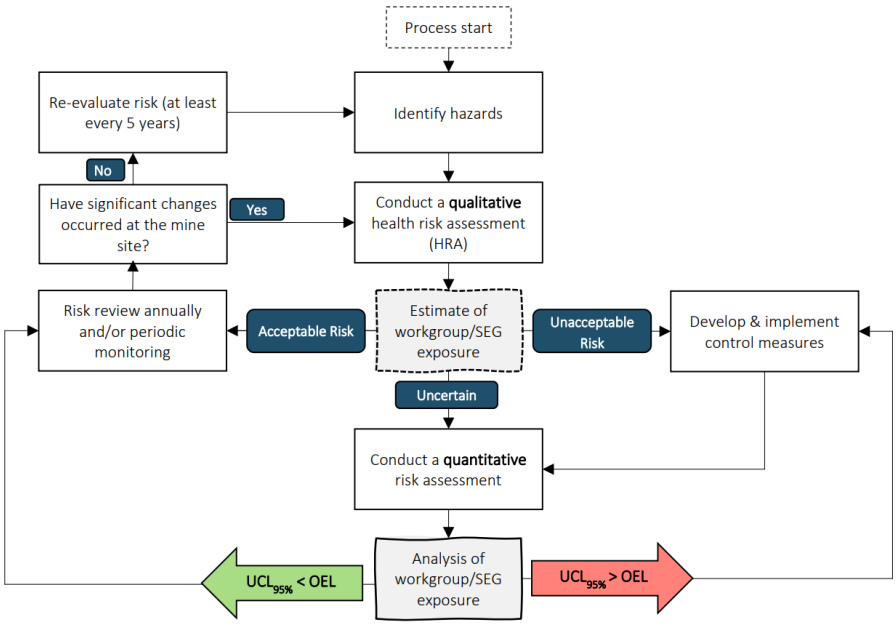

Figure 1: Risk management process

The approach to monitoring occupational exposure in Figure 1 is based on two important assumptions:

1. A monitoring strategy must be based on multiple measurements of a similar exposure group (SEG) for it to be meaningful.
2. In order to understand if risk is at an acceptable level, appropriate sampling, statistical procedures and professional judgement by a competent person must be used to interpret measurement data.

As with other risks, the Site Senior Executive (SSE) must document and maintain a management structure for the mine in a way that allows development and implementation of the SHMS. The management structure must state the names, responsibilities and competencies held by senior persons in the structure with an obligation to manage respirable dust risks at the mine.

4.0 Accountability and competencies

4.1 Accountability for monitoring respirable dust in coal mines

The SSE is responsible for ensuring an airborne contaminants risk assessment is undertaken for the mining activities conducted at the site under their control. The purpose is to:

- Identify the type of airborne contaminants CMWs are exposed to and frequency of exposure.
- Assess CMWs exposure in comparison to exposure limits.
- Assess the effectiveness and sustainability of existing controls.
- Identify and implement new controls where required to ensure CMWs do not develop acute or chronic respiratory illnesses.

RS 15 and RS 20 provide details for coal mines in identifying hazards, assessing, controlling and evaluating risk. Figure 1 outlines the risk management process described in this document.

The SSE must ensure:

- The mine has a respirable dust monitoring program as part of the mine's SHMS.
- The respirable dust exposure sampling plan has been developed by a competent person.
- Respirable dust exposure sampling is only conducted by a competent person.
- When a personal exposure sample exceeds the exposure limit:
    - relevant persons are notified within the specified timeframes.
    - an internal investigation is conducted to identify causes and corrective actions, including issues and changes required within the safety health management system.
    - further repeat sampling is scheduled and completed within specified timeframes.
- The respirable dust exposure monitoring program is reviewed by a competent person at regular intervals.
- Exposure monitoring records are submitted to Resources Safety and Health Queensland (RSHQ) on a quarterly basis using the approved 'dust data import template' and by the specified due date.
- De-identified records of exposure monitoring data are kept at a location which is easily accessible to all CMWs at the mine.

4.2 Competencies required to develop and review a respirable dust exposure monitoring program

A person who has a recognised competency as a certified occupational hygienist (COH), or an equivalent competency under an international certification scheme (e.g. certified industrial hygienist), must review the adequacy of and endorse the coal mines respirable dust monitoring program, and specifically:

- Establish SEGs.
- Develop a respirable dust exposure sampling plan that is representative of worker numbers, workers, shiftwork, tasks performed and conditions at the mine.
- Estimate exposure of a SEG using inferential statistics.
- Submit their review of the respirable dust monitoring program to the SSE.

4.3 Competencies required to conduct respirable dust exposure sampling

Carrying out personal respirable dust exposure sampling at a coal mine in accordance with Australian Standard (AS) 2985 is a prescribed task under section 76A of CMSHA. Only a person who has a competency recognised by the Coal Mining Safety and Health Advisory Committee (CMSHAC) for the task, and adequate knowledge and understanding of mining activities (e.g. operating methods, conditions and environments) may conduct personal respirable dust exposure sampling at a coal mine for the purpose of assessing exposure.

The list of recognised competencies is available on the Queensland Government website - Coal mining competencies | Commissioner for Resources Safety & Health.

5.0 Minimum Technical Requirements

5.1 Sampling equipment

Instruments purported to sample and/or measure ‘respirable dust’ and used for personal exposure sampling under this RS, must be certified by an accredited third party to conform with the requirements of the Standards (EN 481-1993; BS EN 13205-1,2:2014; ISO 7709-1995) for sampling in accordance with the ‘respirable convention’.

Equipment used to sample respirable dust must be fit for purpose and maintained to achieve the objectives stated in AS2985 and this RS. Sampling equipment must be subjected to periodic calibration and performance checking, at least annually, as per the minimum requirements stated in Table 1.

Equipment	Reference	Requirements
Sampling pumps	ISO13137	Calibration to ISO 13137 – Annex C - C.1 to C.4 (User tests for pumps), Clause 7.10 and Clause 7.11 (Timer Accuracy). Pumps must be tested to the specific application and with flow rates commonly operated.
Flow meters	AS2985	AS2985 – Appendix B
Sample heads	AS2985	AS2985 – Clause 6.2

Table 1: Sampling equipment requirements

All calibration, performance checking and maintenance must be conducted by trained and competent personnel. Equipment used in the calibration and performance checking of sampling pumps and flow meters must be traceable to national standards and certificates issued must contain measurement uncertainty. Records of calibrations performed must be maintained.

Electrical equipment used to monitor dust in underground coal mining environments must have relevant certification and/or be used in accordance with the coal mine's SHMS, as per section 202 of CMSHR. In open cut mines, electrical equipment must have relevant certification and be used in accordance with the coal mines SHMS where an explosion risk may exist.

5.2 Standard for collecting and analysing respirable dust samples

All samples collected for the purpose of personal exposure assessment (section 6.1) must be collected and analysed in accordance with AS 2985.

Laboratories performing analysis of respirable dust samples must be accredited by NATA to AS ISO/IEC17025:2018 General requirements for the competence of testing and calibration laboratories for the gravimetric determination of respirable dust and for the analysis of respirable crystalline silica.

Analysis for Respirable Crystalline Silica (RCS) must be in accordance with a recognised method. Examples include but are not limited to the following:

- Health and Safety Executive (HSE) 2014 – Crystalline silica in respirable airborne dust: directon-filter analyses by infrared spectroscopy or x-ray (Method MDHS101).
- National Health and Medical Research Council (NHMRC) 1984 – Methods for measurement of quartz in respirable airborne dust by infrared spectroscopy and x-ray diffractometry.
- National Institute for Occupational Safety and Health (NIOSH) 2003 – Silica, crystalline by infrared (IR) (KBr pellet) (Method 7602).
- NIOSH 2003 – Quartz in coal mine dust by IR (redeposition) (Method 7603).

Each laboratory sample exposure measurement report must incorporate the essentials of measurement uncertainty information and make it readily available to the mine operators.

5.2.1 Limit of Reporting (LoR) for Respirable Dust

Suitable sampling and analysis methodologies for personal exposure monitoring must be chosen to ensure that the LoR, limit of quantitation and measurement uncertainty for respirable dust concentration is provided by the laboratory.

6.0 Types of Sampling

Sampling is the process of conducting a measure or series of measures of the concentrations of airborne contaminants. Types of sampling and applications include:

- personal exposure sampling (health risk assessment)
    - baseline monitoring
    - periodic monitoring
    - investigative monitoring
- static sampling (hazard identification, control verification)
    - area monitoring

The purpose of conducting monitoring must first be established before the type of sampling can be determined.

- Personal exposure monitoring is conducted for the purpose of assessing health risk and is a requirement for assessing compliance with the legislated exposure limits.
- Control monitoring is conducted for the purposes of hazard identification, investigating potential sources and/or causes of dust exposure and to evaluate the performance of dust controls.

6.1 Personal exposure sampling

Personal exposure sampling is the process used to measure an individual's unprotected exposure to respirable dust during the course of their usual activities, and includes both exposed and non-exposed time (e.g. breaks). Personal exposure sampling requires a dust sample to be collected from within the breathing zone of the worker and must be collected in accordance with AS 2985.

The results of personal sampling for groups of workers performing similar tasks or working in the same area (e.g. SEGs) are combined and analysed using statistical tools to provide an estimate of exposure for the SEG. In accordance with sections 89 and 89A of CMSHR, personal exposure sampling is the type of sampling required to assess compliance.

Personal exposure sampling should be collected as part of either a periodic or baseline monitoring program specific to the coal mine:

- Baseline monitoring is conducted to establish an initial estimate of exposure for an existing, new or modified process or activity, to enable comparison with exposure limits and identify areas requiring additional exposure control.
- Periodic monitoring commences when baseline monitoring is completed. Periodic monitoring provides information on the ongoing adequacy of exposure controls to ensure the exposure of workers remains compliant with relevant exposure limits, and the risk of adverse health effects to CMWs from coal mining operations is at an acceptable level.

6.2 Static sampling

Static (or fixed) sampling can be used to measure area-specific dust levels and identify sources and causes of dust generation, to enable dust control efforts to be focused and prioritised. Dust samples collected at static sampling points are not representative of actual worker exposure and must not be compared to an exposure limit for health risk assessment or legislative compliance purposes. Static sampling is a valuable tool for assessing the effectiveness of process controls, for example, sampling before and after the implementation of controls so the effectiveness of those controls can be verified.

6.3 Control monitoring

Control monitoring is the systematic sampling of a process and has been deliberately designed to investigate the specific sources and/or causes of dust exposure, to validate the effectiveness of new dust controls under trial, or to assess the ongoing performance of existing dust controls. Control monitoring may be applied to assist with the validation of control effectiveness or the application of dust control trigger action response plans (TARPs), referred to in the RSs for Dust Control (RS15 Underground and RS20 Surface).

Sampling conducted for control monitoring purposes must not:

- form part of the personal exposure monitoring program.
- be used for exposure risk assessment where results are compared with exposure limits
- be used to assess compliance with sections 89 and 89A of CMSHR

Where any personal sampling is conducted for control monitoring purposes, a separate sampling plan must be documented prior to commencement. The control monitoring sampling plan must be entirely separate to and in addition to any personal exposure sampling plan. The control monitoring sampling plan must include clearly defined objectives, the types and methods of sampling being applied, the timeframes for sampling and must state that any results obtained will not be suitable for assessing exposure risk or compliance with sections 89 and 89A of CMSHR. Control monitoring may include personal and/or static types of sampling and a range of sampling devices including real time instruments.

Records of control monitoring and sampling results must be kept at a location which is easily accessible to all CMWs at the mine.

6.4 Real-time sampling

Real-time sampling instruments use a direct-reading detector to measure airborne dust concentrations within very short time intervals (seconds-minutes). Real-time sampling can be used to observe time varying changes in dust concentration that occur within the period of a single event, task or shift length, which makes them very useful for control monitoring purposes.

The main types of real time dust sampling instruments available use two distinctly different detector technologies to measure the quantity of dust collected within the sampled volume of air, from which dust concentration is calculated. One type uses an optical light scattering sensor and the other uses a tapered element oscillating microbalance (TEOM) to measure the mass of particles. These devices are currently not

valid for assessing exposure risk for compliance with sections 89 and 89A of CMSHR. Notwithstanding to this limitation, real-time devices can be used for control monitoring purposes and to give a relative indication of dust exposure, if sampled from within the breathing zone of the worker and the duration of sampling is representative of normal shift activities.

The benefits of real time dust sampling are that multiple events or task-based measurements can be quickly made to investigate the source or cause of dust exposure, and to evaluate the effectiveness of dust controls. This data can then be used to activate a response (such as a TARP) and/or provide timely communication of relative risk to CMWs, within the shift.

7.0 Personal Exposure Monitoring

7.1 Establishing SEGs

The SSE must ensure that applicable SEGs are established for the coal mine's operations, and cover activities in the following areas:

- underground coal mines
    - longwall operations
    - development operations
    - outbye operations
    - drilling operations (including gas drainage, bore hole drilling and exploration)
    - return roadways
    - stone drivage (including drift construction)
    - surface operations (including workshops, warehouses and lay down areas)
    - projects (e.g. civil construction, longwall move, shaft sinking)
    - coal processing plants (including load out, stockpiles and laboratories)
- surface coal mines
    - coal processing plants (including stockpiles, load out and laboratories)
    - drill and blast operations
    - excavation operations
    - haulage operations
    - in pit support services (e.g. pumps, inspections, surveys)
    - exploration drilling
    - highwall/auger mining
    - crushing plants (e.g. coal and / or stone)
    - workshops and warehouses
    - shutdowns
    - projects (e.g. civil construction)
    - mine site rehabilitation

For simplicity, SEGs can generally be based on work or functional groups, but in some instances may be more specific due to particular exposure circumstances (e.g. if a discrete work group has a unique exposure not experienced by other workers).

Mines should establish and use their own SEGs based on observations and exposure profile of their specific work groups. However, to facilitate the periodic (quarterly) reporting of SEG data to the Mines Inspectorate, all data must be assigned to one of the appropriate SEGs listed in the generic SEG list provided in the factsheet – 'Queensland Coal Mine Similar Exposure Groups' (RSHQ 2021).

7.2 Baseline monitoring program

Baseline monitoring must be conducted initially after establishing the SEGs based on the potential for exposure to respirable dust. Baseline sampling must be conducted over a suitable period of time of not more than two years and selected so as to be representative of the normal variations in respirable dust exposure across the mine environment. A representative period should consider variations associated with the range of activities, seasonal and operational variations, between groups of workers (crew), between workers and within worker (individual) variations.

Following the collection of sufficient samples, statistical analysis of the data must be conducted and compared with the relevant shift adjusted occupational exposure limit (OEL). By using the minimum number of samples (n) specified in Table 2, there can be 95% confidence that at least one CMW selected at random from the SEG will be in the highest 10% of all exposure in that SEG.

Number of CMWs in SEG (N)	Number of samples to be collected (n)
≤11	n = N*
12	11
13 – 14	12
15 – 16	13
17 – 18	14
19 – 21	15
22 – 24	16
25 – 27	17
28 – 31	18
32 – 35	19
36 – 41	20
42 – 50	21
>50	29

Table 2: Minimum sample numbers for baseline monitoring

*** A minimum number of 6 samples (n) must be collected where the number of CMWs (N) is equal to or less than 6.**

7.3 Periodic monitoring program

The intention of periodic monitoring is to ensure that controls are effective, and exposure profiles conform as specified in section 7.10.2. Periodic monitoring requirements for each SEG must be risk based. Considerations also include, but are not limited to the following:

- relevant existing exposure data
- the geometric standard deviation (GSD) or spread of data
- the SEGs exposure profile
- control strategies
- number of results at or above 50% of the shift adjusted OEL
- number of CMWs in the SEG
- frequency of sampling
- toxicity of dust

The number of samples required as part of periodic monitoring for each SEG can be determined using Table 3. Consideration of all existing data is also valuable in determining ongoing monitoring program requirements and may justify the need to set sampling targets above those in Table 3.

Ratio of exposure to OEL (R)		No. of crews/shifts to be monitored per 10 CMWs
> 0.75		1 per month
0.5 – 0.75		1 per quarter
0.1 - <0.5	(R_{LoR} - <0.5)*	1 per year
< 0.1	(<R_{LoR})*	Discretionary

Table 3: Minimum sample numbers and frequency for periodic monitoring when using this methodology (adapted from Grantham, 2014)

*** An adjusted ratio value (R_{LoR}) is applied where the LoR for RCS is greater than 0.1 OEL.**

Ratio of Exposure Calculation:

$$R = \frac{\text{Average SEG Exposure (Arithmetic Mean)}}{\text{Shift Adjusted OEL}}$$

Online Calculator: An online calculator to assist with the determination of required baseline or periodic samples based on this RS has been developed and is available on Queensland Government 'Business Queensland' website.

Discretionary sample numbers are to be determined at the discretion of the Certified Occupational Hygienist (COH) based on professional judgement, where there is inherent variability and a need to continually confirm SEG exposure risk. A minimum of six samples would be required to perform statistical analysis, to ensure that the SEG ratio of exposure remains reliable.

To determine the ratio (R) of exposure to the OEL and ongoing monitoring requirements for respirable dust and RCS (where an adjustment to the ratio is not required), the following worked example applies:

Worked example 1:

Known SEG Information	
Arithmetic Mean	**0.7 mg/m³**
SEG Shift Adjusted OEL	**1.37 mg/m³**
Number of Crews	**4**
Number of CMWs per crew	**5**
Total SEG CMWs	**20 (4x5)**

STEP 1: Calculating the SEG ratio of exposure (R) to determine monitoring frequency	
=	Arithmetic Mean ÷ Shift Adjusted OEL
=	0.7 mg/m³ ÷ 1.37 mg/m³
=	0.51
=	**Quarterly**

STEP 2: Calculating number of crews to be monitored per 10 workers	
=	Total SEG CMWs ÷ Number of crews to be monitored per 10 CMWs
=	20 ÷ 10
=	**2 Crews**

STEP 3: Calculating number of samples required per specified frequency	
=	Required crews to be monitored x Number of CMWs per crew
=	2 x 5
=	**10 samples per quarter**

Where the LoR for RCS concentration is greater than 0.1 OEL, an adjusted Ratio value shall be applied. The adjusted R value (RLoR) must be calculated using the LoR reported by the laboratory in compliance with their NATA certification. Only valid results collected from a minimum sample volume of 1.2m3 may be applied in the calculation of an RLoR. See below for a worked example:

Worked example 2 (Adjusted Ratio for RCS):

Known Information for RCS	
Limit of Reporting as stated by the laboratory (LoR)	**0.01 mg/m³**
Shift Adjusted OEL	**0.045 mg/m³**
10% of Shift Adjusted OEL	**0.0045 mg/m³**
The LoR is greater than 10% of the Shift Adjusted OEL therefore apply R_{LoR} (0.01 > 0.0045)	

STEP 1: Calculating the Adjusted Ratio Value (R_{LoR}) to determine monitoring frequency	
=	LoR ÷ Shift Adjusted OEL
=	0.01 ÷ 0.045
=	0.2

STEP 2: The <u>new</u> minimum sample numbers and frequency for periodic monitoring for that SEG for RCS	
Ratio of exposure to OEL (R)	**No. of crews/shifts to be monitored per 10 CMWs**
> 0.75	1 per month
0.5 – 0.75	1 per quarter
0.2 - <0.5	1 per year
<0.2	Discretionary

In the instance where the R_{LoR} is greater than 0.1, it should be recognised that 'at risk' SEGs may fall into the 'Discretionary' sampling category and the COH must determine a suitable sampling plan to ensure that exposure is being adequately monitored, and an acceptable level of risk is achieved for these SEGs. The COH

shall apply a structured qualitative risk assessment approach to rank and identify which SEGs to monitor and the number and frequency of sampling. The following options should be considered in the qualitative assessment process for these SEGs:

- Using respirable dust in conjunction with percent silica composition derived from historical exposure samples, as a surrogate measure of exposure to respirable silica for the SEG.
- Using laboratory results which are between the Limit of Detection and the LoR, as a qualitative estimate of relative exposure for the SEG.
- Collecting a minimum of six samples in any period not exceeding one year.

This model is suitable for SEGs that have a small population, however, it is not suitable for large SEGs. For large SEGs an upper limit of crews / shifts may be applied. An upper limit of 29 samples is consistent with the sampling targets that would be specified for a baseline assessment of a SEG, as defined in Table 2. This limit does not preclude the collection of a greater number of samples if desired and is a decision that should be guided by the statistical analysis of the data.

Where monitoring is required for any SEG, a minimum of six samples over the length of the program should be collected to allow for statistical analysis.

7.4 Censored Data

Personal exposure sample results that are reported as below the laboratory LoR are referred to as censored data or non-detects. These results are reported as a less than (<) reportable concentration and therefore cannot be effectively processed using many statistical programs such as IHStat, unless treated prior to analysis.

For the purposes of determining SEG exposure and establishing ongoing periodic monitoring program requirements, professional judgement by a competent person should be exercised in the event:

- there is a high proportion (e.g. more than 60%) of samples within the SEG dataset reported as non-detects (below the LoR).
- there are less than three valid results within that dataset that are above the LoR.
- the LoR is more than 10% of the shift adjusted OEL.

To reduce bias in the dataset, censored data should be treated using a recognised approach and there are a number of tools available to complete this analysis, including NDexpo and BWStats.

7.5 Minimum personal exposure monitoring requirements

Historical monitoring results and diagnosed MDLD cases from the Queensland coal mining industry have indicated that certain SEGs contribute to a higher risk of exposure to respirable dust and silica. The sampling results also indicate that average yearly exposure concentrations for some SEGs, in the coal mining environment, can fluctuate significantly from year to year and may provide a poor indication of long-term exposure trends. The ongoing sampling of known higher risk SEGs shall be conducted in order to effectively monitor long term exposure trends and to ensure an acceptable level of risk is maintained.

Notwithstanding the sampling requirements determined in previous sections, the minimum monitoring requirements for SEGs are detailed in Table 4.

SEG	Sampling interval	Minimum samples per interval
Longwall production	Quarterly	8
Development production	Quarterly	8
Production support / bullgang	Yearly	8
Blast crew	Yearly	8
Blast hole drillers	Yearly	8
Field maintenance	Yearly	8

Table 4: Minimum samples & frequency for monitoring SEGs

7.6 Monitoring Itinerant SEGs

The methodologies detailed in this RS have been developed for workers undertaking routine activities in operating coal mines. There may be some SEG based activities undertaken on coal mines or coal mine leases that are considered non-routine or intermittent. The process of establishing a baseline, or ongoing periodic monitoring programs and single exceedance resampling in accordance with this standard may not be practicable. Examples of SEGs in this category may include:

- civil projects
- exploration drilling
- major shutdowns
- longwall moves
- drift construction
- topsoil removal

Notwithstanding to the above, it is still a requirement under section 89 of CMSHR that dust exposures for these activities are controlled and monitored. The SSE must consider itinerant SEGs when establishing the respirable dust monitoring program. This program must be developed and reviewed by a COH (section 4.2) as well as giving consideration to section 7.

7.7 Monitoring program review

If there are significant changes to the plant, equipment, operating environment, operating methods, or SEGs that have the potential to impact dust exposure levels, or there is a significant change to the exposure estimate following periodic monitoring, the frequency of sampling must be reviewed and, in some instances, a new baseline established.

Notwithstanding the above, the respirable dust monitoring program must be regularly reviewed and endorsed by a COH, at intervals not exceeding 12 months. This review must include the:

- review of all personal exposure samples collected during the period

- exposure estimate update for each SEG using statistics in accordance with section 7, using valid samples from periodic monitoring and/or baseline monitoring
- identification and evaluation of changes in exposure
- review and update of SEG composition, shifts / rosters and population

At the end of each respirable dust monitoring program review, a report summarising the items above should be documented and communicated to the following:

- mine operator
- SSE
- employer (where applicable)
- appointed medical advisor (AMA) for the mine

7.7.1 Baseline monitoring review

A new baseline must be established when either an updated exposure estimates from periodic monitoring indicates a significant change or within a maximum period of 5 years from the previous baseline. Establishing the new baseline must include:

- reviewing the composition and population of SEGs; and
- developing the baseline monitoring program in accordance with section 7.2.

The baseline monitoring may include samples collected as part of periodic monitoring completed if collected in accordance with section 7.2. The COH should review the validity of periodic monitoring data older than two years for the inclusion in statistical analysis.

7.7.2 Periodic monitoring review

The periodic monitoring sampling plan for each SEG must be reviewed and updated following the completion of a new baseline; or an updated exposure estimate indicates a significant change in exposure.

7.8 Additional personal exposure sampling requirements

7.8.1 Sample duration

All personal exposure samples collected to estimate exposure must be collected in the breathing zone of the selected worker and performed over a period representative of normal shift activities.

Full shift sampling is preferred but, as a minimum, the sample period should be at least 80% of the shift length. Where samples run for less than 80% of the shift, they should be reviewed by the competent person undertaking the monitoring to determine whether the personal exposure sample is representative. Any samples that run for less than 80% of the shift but are still determined to be representative and comply with AS 2985 must still be reported to the RSHQ exposure database for the appropriate quarterly period.

7.8.2 Random sampling

Personal exposure sampling must be conducted randomly (to the extent practical), ensuring coverage of a range of workers, crews, shifts, rosters, operating and seasonal conditions.

7.8.3 Data collection

Records of personal exposure sampling performed for respirable dust must be kept for 30 years at the coal mine. If the coal mine ceases operations during this 30-year period, the records are required to be kept and the SSE must ask for, and comply with, the Chief Inspector's directions about the storage of the records.

Records of personal exposure sampling must include:

- certificate of analysis for samples; and
- applicable information contained in Tables 5 and 6. This information may be recorded within the final hygiene report, on the CMW daily diary or a similar method and be available on request.

Worker information	Shift information
• Full name • Employment status (if contracting, incl. company) • Job title • Primary SEG • Shift length and roster • Crew	• Tasks undertaken, including timeframes (start and end), duration and location. • Vehicle/s operated (if applicable) and corresponding ID. • Equipment used (e.g. if performing maintenance). • Plant maintained (e.g. Mobile equipment electrical cabinets). • Use and type of personal protective equipment. • Dust controls available and used. Operating as intended (Y/N). • Whether the shift was representative of normal work activities performed. • Any events or conditions that may have contributed to significant dust exposure.

Table 5: Minimum information requirements to be recorded by CMW

Sample information	Environmental and operational information
• Sampler (competent person) • Date • Lab ID • Filter ID • Size selective sampler ID • Equipment information (i.e. pumps & calibrator asset/serial no.) • On & off time • Flow rates (pre, post & avg) • Total runtime • Invalid reason (if required)	• Controls in use and their effectiveness • Production – shears / tons / cutting sequence (UG) • Ventilation (UG) / Wind conditions (OC) • Housekeeping details • Exposure sources • Operational conditions • Material handled • Weather conditions • Seasonal factors

Table 6: Minimum information requirements to be recorded by competent person

7.9 Invalid samples

Personal exposure samples that do not meet the minimum sampling or quality requirements specified in AS2985 for the sampling and analysis of respirable dust are invalid and must not be used for estimating exposure. The criteria for which samples are classified to be valid may include:

- equipment conforming to AS 2985
- equipment calibrated
- equipment performance maintained during sampling and analysis
- sample flow rate as specified for respirable dust (+/- tolerance)
- sample inside breathing zone
- sample duration (representative of full shift)
- sample integrity maintained throughout sample collection, freight, analysis

The reason for which the sample was found to be invalid must be documented with supporting evidence (e.g. note recorded on field sheet by wearer or competent person, correspondence from laboratory, photographic image). Additional personal exposure samples must be collected for the relevant SEG to replace invalid samples. Under no circumstances must invalid samples be included in SEG datasets or used to estimate exposure.

The following invalid reasons (with examples of use) must be selected when submitting data to RSHQ:

- flow fault – indicates that flow was disrupted during the sample period and sample volume is not accurately known
- damage to filter / sample head
- failed post flow – post flow is more than the ± 5% tolerance when compared with the designated pre-flow rate
- pump damaged – damage that interferes with the pumps ability to maintain flow
- pump failure – i.e. battery errors
- pump not collected / returned
- short run time – less than 4 hours in accordance with AS2985 or sample period not representative of full shift exposure (i.e. less than 80% of shift)
- invalidated by lab – sample damaged or contaminated (non-respirable sized particulate, wetted filter, foreign material on filter), failure of analysis / equipment
- tubing detached - sample head or pump detached
- filter overloaded
- worker removed pump
- other – comments and supporting evidence must be provided

7.10 Estimating SEG exposure

Following the collection of sufficient samples, inferential statistics must be generated to summarise the dataset and estimate the exposure profile of the SEG. Various tools can be used to generate descriptive statistics, including the free IHSTATS excel tool from the American Industrial Hygiene Association (AIHA) – AIHA Risk Assessment Tools.

7.10.1 Geometric standard deviation (GSD)

The GSD is a measure of the spread of data in a dataset and should be reviewed for every SEG exposure assessment using Table 7.

It is expected that most exposures in a SEG are generally the same. If 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.

Value	Degree of data spread
1.0 – 2.0	Data clustered around the mean – minimal variation.
2.0 – 3.0	Moderate variation in the dataset, potentially due to: • elevated individual samples. • low to moderate percentage of samples less than <LoR. • insufficient number of samples.
> 3.0	Significant variation in the dataset, potentially due to: • significant outliers in the dataset. • high percentage of samples below <LoR. • incorrectly defined SEG. • insufficient number of samples.

Table 7: GSD degree of spread

7.10.2 SEG exposure assessment (95% UCL)

Where the data distribution is log-normal or normal, the appropriate 95% upper confidence limit (95% UCL) for the SEG exposure data should be compared against the respective shift adjusted OEL. If the dataset does not align to either a lognormal or normal distribution, then the most conservative 95% UCL should be selected to assess exposure.

A SEG must be considered non-conforming if the 95% UCL of the SEG exceeds the relevant 8-hour equivalent OEL (shift adjusted). Figures 2 and 3 show the lognormal distribution curves for two different example datasets:

- Figure 2: 95%UCL is greater than the OEL and is therefore considered non-conforming.
- Figure 3: 95%UCL is less than the OEL and is therefore considered conforming.

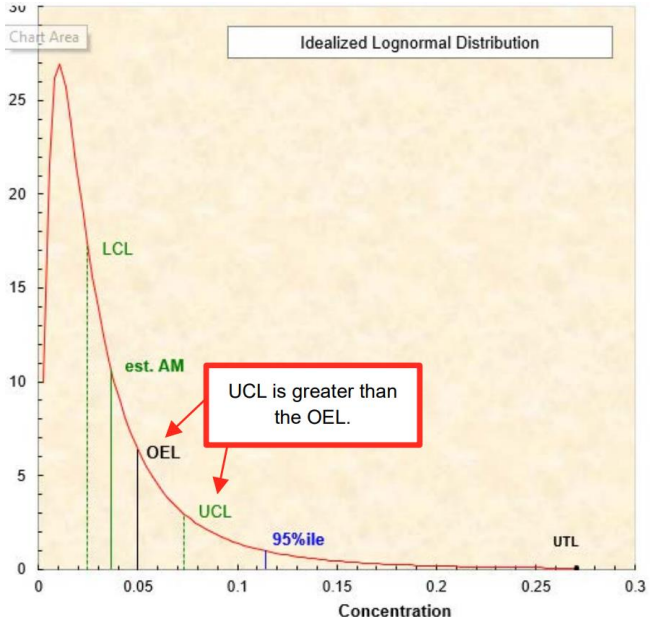

Figure 2: Example Non-Conforming Dataset

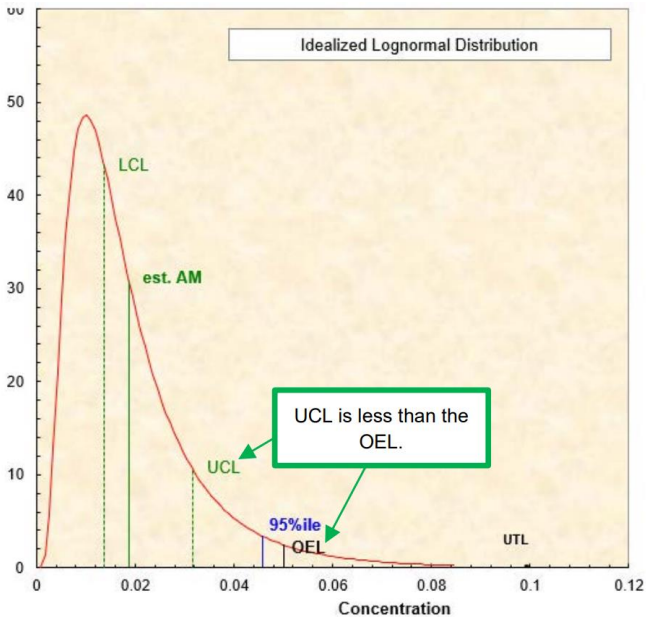

Figure 3: Example Conforming Dataset

In addition to conformity, if the 95% UCL of any SEG exceeds 50% of the OEL, this should be considered a trigger to undertake a review of the existing exposure controls and their effectiveness. A control plan for that SEG should be developed and implemented. The control plan should consider both short- and long-term actions to reduce exposures to acceptable limits.

In certain situations, the use of the 95% UCL for a SEG dataset may not be the appropriate metric for assessing exposure risk and establishing triggers for control intervention. These situations may include but are not limited to:

Small sample population (e.g. n<6)

High proportion of results in dataset <LoR

High variability in the dataset (e.g. GSD >3)

On these occasions the COH may select an alternative statistical parameter and / or apply professional judgement to undertake the SEG assessment. Alternate metrics may include but not limited to the percentage exceedance fraction.

7.10.3 Single personal exposure sample exposure measurement

A single personal exposure sample measurement result in excess of the relevant 8-hour equivalent OEL (shift adjusted) must be considered a trigger for investigation and review of exposure controls.

8.0 Reporting

8.1 Single sample exceedance result

Figure 4 shows the SSE action requirements relating to a single sample exceedance result with reference to the applicable sections of CMSHR. These requirements apply if a single personal exposure dust sample result shows that the average concentration of respirable dust in the atmosphere of the work environment exceeds the levels stated in section 89 (1) of CMSHR.

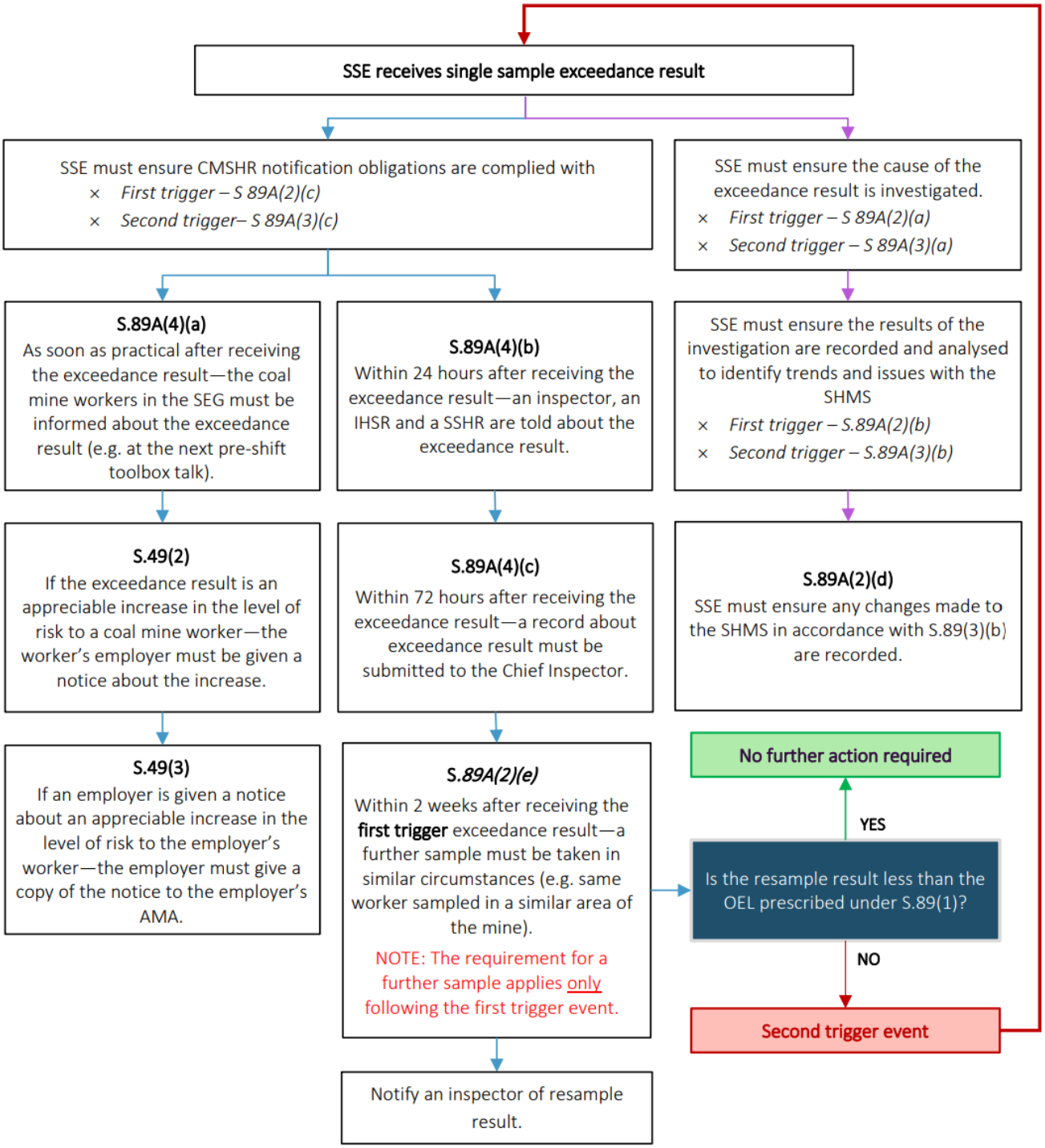

Figure 4: Single sample exceedance requirements

8.2 Quarterly dust sampling results

All coal mines must report their personal respirable dust monitoring results to the Chief Inspector every quarter:

- If monitoring was conducted – submit the completed 'quarterly dust data approved format for submission' upload spreadsheet to AirborneContaminants@rshq.qld.gov.au by the due date.
- If monitoring was not conducted – submit a confirmation email to that effect to AirborneContaminants@rshq.qld.gov.au. This information will be recorded.

All results must be supplied within one month of the end of each quarter as specified Table 8.

Sampling Quarter	Date Range	Submission due by
Quarter 1	1 January to 31 March	1 May
Quarter 2	1 April to 30 June	1 August
Quarter 3	1 July to 30 September	1 November
Quarter 4	1 October to 31 December	1 February

Table 8 – Quarterly respirable dust reporting dates

All results must be classified into the SEGs outlined in the department's factsheet – 'Queensland Coal Mine Similar Exposure Groups' (RSHQ 2021) and submitted in a format approved by the Chief Inspector.

8.3 Communication of personal exposure results

At the end of each sampling period, personal exposure sample results should be communicated to all CMWs that participated in the monitoring and de-identified results must be made available to all CMWs at the mine.

9.0 Investigating Exposure Exceedances

If a single personal exposure sample result exceeds the relevant exposure limit, an investigation must be initiated. The aim of the investigation must be to determine the absent or failed control/s that contributed to the measured exposure, and to define the actions required (short and/or long term) to prevent a reoccurrence and the time frame for their completion.

At a minimum, the investigation must consider the following:

- Date of sample
- SEG
- Work location
- Crew
- Activities/tasks carried out (including times)
- Personal protective equipment used and for what activities/tasks (including times)
- Controls in place (e.g. refer to controls prescribed in RS 15 and RS 20)

- Production information (e.g. metres cut/number of shears, banked cubic metres)
- Material handled (e.g. coal, stone, overburden, fine, blocky)
- Operational conditions (e.g. normal/maintenance, shift/downtime)
- Environmental conditions
    - underground—face ventilation, rate/direction, maingate, tailgate
    - open-cut weather conditions
- Operator location (operating out of dust plume)
- Adjacent activities contributing to exposure
    - inbye road conditions (wet/dry)
    - support activities
- Maintenance schedule vs actual—maintenance records for all equipment (e.g. belts, curtains, sprays, picks)
- Equipment pre-start checks / status of dust controls
- Sampling data (determine if sample valid)
    - Sampler
    - sampling time
    - flow rate (pre, post, average)
    - calibration records of equipment (e.g. pump, microbalance)
    - analysis (interference and treatment)
    - sampler worn in breathing zone for duration of sample period.
- Engineering control performance as per RS 15 and / or RS 20.
    - curtains/seals (number/locations/effectiveness)
    - sprays (system in place/operational as designed/effectiveness)
    - belts (wet down)
    - operator cabin sealing, pressurisation and filtration
    - local exhaust ventilation.

The results of the investigation must be recorded and analysed in conjunction with previous investigation findings, to identify any trends and issues with the coal mines SHMS. Any subsequent changes made to the SHMS must also be recorded and communicated to affected CMW.

9.1 Resampling following an investigation

The requirements to resample a SEG following a single personal exposure sample exceedance must be determined as an outcome of an investigation. Resampling would generally occur following the implementation of additional controls to verify their effectiveness at reducing exposure levels. For some SEGs the investigation may trigger a review of the respirable dust sampling plan requirements, resulting in an increase in the number of samples and/or frequency of monitoring required.

Notwithstanding the previous paragraph, there is also a requirement under section 89A(2)(e) of CMSHR for a further sample to be taken within 14 days of an individual exceedance result being received by the coal mine. The resample should, as far as practicable, be taken in the same circumstances as the initial sample (to which the exceedance relates) – for example, by resampling the same CMW (or another CMW in the same SEG undertaking a similar role) in an area of the coal mine similar to the area in which the initial sample was taken.

A resample should not be counted as a sample number required under the sites periodic monitoring requirements outlined in section 7.3. However, the sample must still be included in the quarterly data report and identified as an exceedance resample in the comments column. In addition, the mine should notify the Inspector of the date and the result of the resample.

10.0 Tampering with Samples or 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 respirable dust at a coal mine.

The SSE must ensure that conditions at the mine, or tasks being performed are not deliberately altered to reduce personal exposure sampling results for compliance purposes (i.e. use of additional water carts / task rotation, when this is not routinely used as a control).

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12.0 Appendix 1

Average concentration	Time-weighted average (TWA) calculated under AS 2985 for a single sample
Arithmetic Mean (AM)	The sum of all values in the data set divided by the number of samples.
Breathing zone	A hemisphere with a 300 mm radius extending from to front of the face and measured from the mid-point of a line joining the ears
Chief Inspector	Means the Chief Inspector of Coal Mines under CMSHA.
Competence	For a task at a coal mine, is the demonstrated skill and knowledge required to carry out a task at a coal mine to a standard necessary for the safety and health of persons.
Competent person	For the purposes of this RS a competent person is a person who has been certified as having acquired the necessary qualification specified in section 4.2 or 4.3, to perform the relevant task in relation to personal exposure monitoring. Competencies specified for tasks associated with developing and reviewing a dust exposure monitoring program (section 4.2) are different to and separate from competencies specified for tasks involving the sampling of personal dust exposure (section 4.3).
Crystalline silica (or free silica)	The terms free silica and crystalline silica are used interchangeably; and represent the most toxic form of silica.
Estimated Arithmetic Mean (EAM)	The estimated arithmetic mean (average) of a lognormal distribution. It is also known as the Minimum Variance Unbiased Estimate (MVUE).
Itinerant SEGs	Groups of peripatetic workers who travel to different sites/ locations for limited periods (blocks) of time (days-months), to perform a specialist range of tasks. The composition and duration of tasks vary significantly within or between shifts and the tasks typically generate the source of exposure. The discontinuous and itinerant nature of this work can preclude the effective completion of a baseline or periodic sampling program as otherwise specified for routine SEGs.
Limit of Detection (LoD), Limit of Quantitation (LoQ), Limit of Reporting (LoR)	These terms are defined within published documents referenced in the Bibliography section of this Standard, including “General Accreditation Guidance — Validation and verification of quantitative and qualitative test methods”, Jan 2018 (NATA)
May	The use of the word “may” in this recognised standard indicates that an action is undertaken or not undertaken at discretion.
Minimum (min) / maximum (max)	Describes the range of exposure values in a given dataset for a SEG.
Must	The use of the word “must” in this recognised standard directs a regulatory action to be undertaken.
Monitoring	An ongoing program or strategy that uses sampling to estimate workers’ exposure to dust levels or to assess the magnitude of dust levels.
Number of Samples (n)	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. At least six random samples are required to perform statistical analysis of a dataset.

Occupational exposure limit (OEL)	The airborne concentration of a particular chemical or substance in the workers' breathing zone that should not cause adverse health effects or cause undue discomfort to nearly all workers.
Periodic monitoring	The process of checking for changes to a SEG's estimate of exposure—used to assess if each coal mine worker's exposure to airborne contaminants is kept to an acceptable level, or if there has been an appreciable increase in the level of risk to a CMW, or the effectiveness and efficiency of dust control measures (periodic monitoring measurements are added to baseline SEG data and statistically analysed to make these assessments).
Personal sampling	Sampling conducted on a person, where the person wears a portable sampling device while performing their work.
Personal exposure sampling	Personal sampling conducted in the persons breathing zone to measure the person's exposure concentration for an airborne contaminant. Personal exposure sampling is conducted in accordance with the requirements of this RS and AS 2985, such that the sampling results are valid for assessing exposure risk and compliance with sections 89 and 89A of CMSHR.
Respirable dust	Respirable dust is the mass fraction of inhaled particles which penetrate to the unciliated airways of the lung. The 'respirable convention' is the specification for sampling instruments when the respirable fraction is of interest. This is further defined (by AS2985 & ISO 7709) as being described by a cumulative log-normal distribution with a median aerodynamic diameter of 4.25 µm and geometric standard deviation of 1.5, when expressed as a percentage of the inhalable fraction (or 4.0 µm, when expressed as a percentage of the total airborne particles). **For the purposes of Recognised Standard 14, unless otherwise stated, references to 'respirable dust' should be interpreted to be synonymous with and including respirable crystalline silica, where analysis for the later has been completed.**
Sampling	The process of collecting a measurement or series of measurements to assess a worker's unprotected exposure.
Significant change	Where a change occurs to those processes or arrangements of work which give rise to exposure and this change is likely to cause a sustainable increase in the exposure category for a SEG, as set out in Table 3.
Similar exposure group (SEG)	SEGs are used to identify a group of workers who have the same general exposure to risks. This can include: • Similarity and frequency of the tasks performed. • The types of materials and processes used to complete tasks. • Similarity of the way tasks are performed.
Shift adjusted OEL	The occupational exposure limit (OEL) for respirable dust and respirable crystalline silica (RCS) must be adjusted, where appropriate, for non-standard work cycles (anything greater than 8 hours a day, 40 hours a week). The AIOH document 'Adjustment of Workplace Exposure Standards for Extended Work Shifts' provides further support information and models for use.
95% Upper Confidence Limit (95% UCL)	This represents the value below which a person can be 95% confident, lies the true value of the SEG's mean exposure.

13.0 Appendix 2

AIOH	Australian Institute of Occupational Hygienists
AMA	Appointed Medical Advisor
AM	Arithmetic mean
CMSHA	*Coal Mining Safety and Health Act 1999*
CMSHAC	Coal Mining Safety and Health Advisory Committee
CMSHR	Coal Mining Safety and Health Regulation 2017
CMW	Coal Mine Worker
COH	Certified Occupational Hygienist
DNRME	Department of Natural Resources, Mines and Energy
GM	Geometric Mean
GSD	Geometric Standard Deviation
ISHR	Industry Safety and Health Representative
MVUE	Minimum Variance Unbiased Estimate
NIOSH	National Institute of Occupational Safety and Health
OEL	Occupational Exposure Limit
RSHQ	Resources Safety and Health Queensland
SEG	Similar Exposure Group
SHMS	Safety and Health Management System
SSHR	Site Safety and Health Representative
SSE	Site Senior Executive
SWA	Safe Work Australia
TARP	Trigger Action Response Plan
TWA	Time Weighted Average
95% UCL	95% Upper Confidence Limit
<LOR	Less than Limit of Reporting