NSW Resources
Resources Regulator

Technical reference guide

Monitoring and control of worker exposure to airborne dust

All surface and underground mines, including coal and non-coal mines

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- Recognised Standard 14 - Monitoring respirable dust in coal mines (2021)
- Recognised Standard 15 – Underground respirable dust control (2017)
- Recognised Standard 20 – Dust control in surface mines (2019)
- QGL02 – Guideline for management of respirable dust in Queensland mineral mines and quarries (2021)

Amendment schedule		
Date	Version	Amendment
August 2024	Consultation draft	This TRG is for coal mines and large underground and open cut non-coal mines. It is not intended to apply to tier 3 quarries.
May 2025	1.0	Stakeholder feedback addressed.

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1. Introduction

1.1. Purpose

This technical reference guide (TRG) has been developed to help mine operators fulfil their work health and safety (WHS) obligations by providing guidance on:

- strategies for developing personal exposure monitoring programs for airborne dust including inhalable dust, respirable dust and respirable crystalline silica (RCS)
- strategies to control worker exposure to airborne dust.

1.2. Scope

This TRG applies to all surface and underground mines, including coal and non-coal mines.

This TRG does not apply to Tier 3 quarries and future references to 'mine operators' in this document are taken to exclude Tier 3 quarries.

The scope of the guidance in this TRG is limited to helping mine operators to meet their obligations relating to airborne dust under the:

- Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHS (MPS) Regulation):
  - section 41: ensuring exposure standards for airborne contaminants are not exceeded,
  - section 42: monitoring exposure to airborne contaminants,
  - section 89: sampling and analysis of airborne dust.
- Work Health and Safety Regulation 2017 (WHS Regulation):
  - section 49: ensuring exposure standards for substances and mixtures are not exceeded
  - section 50: monitoring airborne contaminant levels
  - part 8A.1: crystalline silica - preliminary

1.3. Interaction with the WHS laws, codes of practice, guidelines and Australian and international standards

Mine operators must prepare a principal hazard management plan (PHMP) if airborne contaminants are a risk at the mine. The PHMP must set out how the mine operator will manage the risks associated with airborne contaminants that includes airborne dust at the site. This should include personal exposure monitoring for airborne dust.

This document should be read in conjunction with:

- NSW work health and safety (WHS) laws, including the *Work Health and Safety Act 2011* (WHS Act), Work Health and WHS Regulation, *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHS (MPS) Act) and WHS (MPS) Regulation[1].
- NSW Resources Regulator (Regulator) guidance material, for example:

[1] This includes the *Work Health and Safety Act 2011*; Work Health and Safety Regulation 2017; *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022.

  - Code of practice – Safety management systems in mines
  - Guide - Preparing a principal hazard management plan
  - Guide – Airborne contaminants principal hazard management plan .
  - Guide - Managing risks in mining and petroleum operations
  - Position Paper – Preventing worker exposure to respirable crystalline silica
- Relevant Australian and International Standards, for example:
  - AS ISO 31000: 2018 Risk Management — Guidelines
  - AS 2985:2009 Australian Standard: Workplace Atmospheres — Method for Sampling and Gravimetric Determination of Respirable Dust
  - AS 3640:2009 Australian Standard: Workplace Atmospheres — Method for Sampling and Gravimetric Determination of Inhalable Dust

Monitoring worker exposure and the controlling airborne dust forms part of a mine's safety management system (SMS). For more information about safety management systems refer to the NSW Code of Practice, Safety management systems in mines.

The mine operator should consider how to integrate worker exposure monitoring and the control of airborne dust with other plans. The system would usually interact closely with the following:

- Airborne contaminants PHMP
- Health control plan
- Ventilation control plan (underground mines)
- Mechanical engineering control plan
- Electrical engineering control plan
- Mine emergency plan.

1.4. Consultation

When managing risks, the mine operator must consult with all affected workers and their representatives plus other duty holders at the mine. This includes other persons conducting a business or undertaking (PCBUs) such as contractors. Details are found in the Guide – Preparing a principal hazard management plan. Further guidance on consultation, cooperation and coordination can be found in the:

- NSW Code of practice: Work health and safety consultation, cooperation and coordination
- Contractors and other businesses at mines and petroleum sites guide

2. Monitoring worker exposure

This section provides guidance to mine operators and other relevant duty holders on monitoring worker exposure to airborne dust.

2.1. Risk management process

Once the mine operator has identified an airborne dust hazard, the mine operator must investigate and analyse the hazard using appropriate risk assessment methods. A competent person or group must conduct the risk assessment. The risk assessment should include all operations, activities, areas or phases of operations and address all aspects of the hazard (e.g., likelihood and consequence, different ways the hazard may arise, or different impacts it may have in different circumstances).

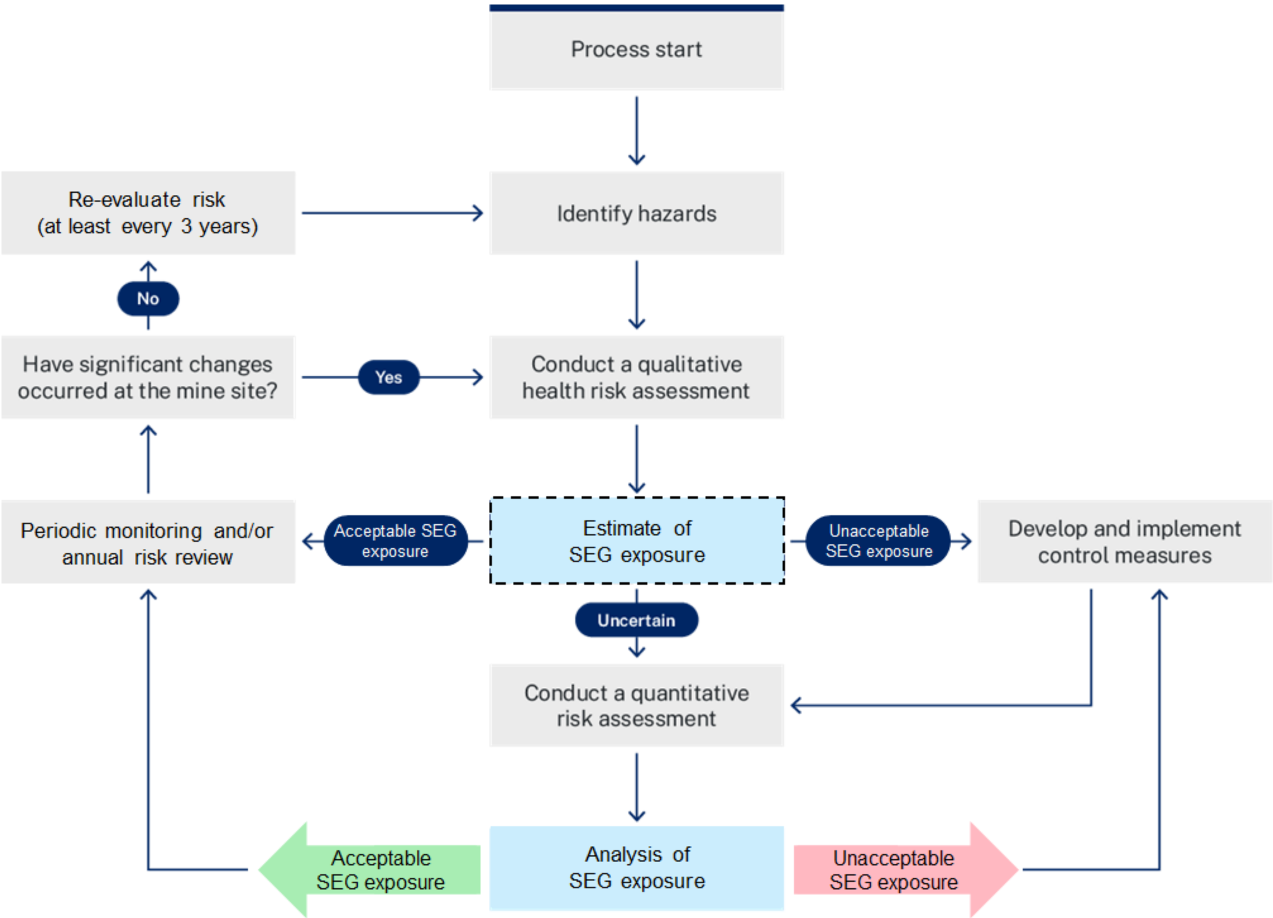
Monitoring worker exposure to inhalable dust, respirable dust and respirable crystalline silica is an important component of a risk assessment. To comply with section 50 of the WHS Regulation, PCBUs must monitor worker dust exposure if they are unsure whether the airborne dust concentration exceeds the workplace exposure standards (WES), or whether the concentration poses a risk to worker health.

A summary of a risk management process for identifying hazards, assessing, controlling and evaluating the risk of airborne dust in mining is shown in Figure 1.

Two important assumptions underpin the approach to monitoring occupational exposure in Figure 1:

1. A monitoring strategy must be based on multiple measurements of a similar exposure group (SEG) for it to be meaningful.
2. Risk assessments should be supported by appropriate sampling and statistical procedures, and by a competent professional using their judgment to interpret measurement data.

Figure 1: Risk management process



Further detailed guidance on risk management strategies are detailed in:

- Simplified Occupational Hygiene Risk Management Strategies (AIOH, 2020)
- Good Practice Guide on Occupational Health Risk Assessment (ICMM, 2016)

2.2. Competent persons

2.2.1. Competency definitions

2.2.1.1. Occupational hygienist

In this document the term occupational hygienist refers to an individual who:

- holds a professional grade of membership (Provisional, Full Member, or Fellow) of the Australian Institute of Occupational Hygienists (MAIOH); or
- is recognised as a certified occupational hygienist (COH) by the Australian Institute of Occupational Hygienists (COH); or
- holds an equivalent competency under an international certification scheme (e.g. Certified Industrial Hygienist); or
- holds an Australian Qualifications Framework Level 8 or above qualification (i.e. bachelor honours degree, graduate certificate, graduate diploma, master's degree or doctoral degree) in occupational hygiene with a minimum of 5 years' experience in the field of occupational hygiene.

2.2.1.2. Occupational Hygiene Technician

In this document the term occupational hygiene technician refers to an individual who is trained to undertake sampling within an organisation that is NATA accredited to ISO 17025 as well as sampling for a relevant air sampling method (i.e. AS2985, AS3640); or an individual who operates under the supervision of an Occupational Hygienist whilst holding one of the following qualifications:

- W201 / OHTA201 Basic Principles of Occupational Hygiene
- M501 / OHTA501 Measurement of Hazardous Substances
- BSBWHS419 / BSBWHS409 Monitoring Respirable Dust in Coal Mines, Mineral Mines and Quarries (QLD)
- Mine Air Quality Technician (WA)
- Mine Air Quality Officer (WA).

2.2.2. Competency requirements for developing and reviewing an airborne contaminant exposure monitoring program

The mine operator should ensure that a competent person such as an Occupational Hygienist develops and reviews the adequacy of the airborne contaminant exposure monitoring program for the mine. Specifically, the hygienist should have knowledge and experience in:

- establishing similar exposure groups (SEGs)
- developing an exposure sampling plan that is representative of worker numbers, working shifts, tasks performed and conditions at the mine

- estimating exposure of a SEG using inferential statistics.

2.2.3. Competency requirements for dust exposure sampling

2.2.3.1. Competent person to undertake risk-based sampling

Under section 50 of the WHS Regulation, mine operators that have identified an airborne dust hazard must undertake initial exposure monitoring to assess the risk. A competent person such as an occupational hygienist, or occupational hygiene technician should perform the exposure monitoring.

2.2.3.2. Competent person to undertake statutory sampling and analysis

Section 89 of the WHS (MPS) Regulation requires mine operators to ensure compliance sampling and analysis of airborne dust, as required under Schedule 6 of the WHS (MPS) Regulation, is undertaken by a Regulator-licenced provider,[2] independent of the mine.

A list of licenced providers to carry out sampling, analysing or reporting of airborne dust is available on the Regulator's website.

2.3. Minimum technical requirements - monitoring worker exposure

2.3.1. Sampling equipment

The mine operator should ensure persons carrying out worker exposure monitoring:

- use sampling equipment that is fit for purpose and maintained to achieve the objectives obtained in the relevant sampling methodology (e.g. AS2985, AS3640 etc.)
- can demonstrate calibration and performance checks of sampling pumps, flow meters and sample heads as per the minimum requirements of the relevant sampling methodology; and are traceable to Australian/national standards
- use electrical equipment used to monitor dust in underground coal mining environments has the relevant intrinsic safety certification and/or is approved for use under the mine's SMS.

2.3.2. Standard for sampling and analysing dust samples

All samples collected for the purpose of personal exposure assessment must be undertaken using the following standards:

- for inhalable dust AS3640 (2009)
- for respirable dust AS2985 (2009)

Laboratories analysing dust samples must have National Association of Testing Authorities (NATA) accreditation to *AS ISO/IEC 17025:2018 General requirements for the competence of testing and calibration laboratories* for the gravimetric determination of inhalable dust, respirable dust and for the analysis of respirable crystalline silica.

Respirable crystalline silica (RCS) analyses must follow a recognised method. Examples include but are not limited to the following:

- Health and Safety Executive (HSE) 2015 – Crystalline silica in respirable airborne dust: direct- on-filter analyses by infrared spectroscopy or x-ray (Method MDHS101/2)

[2] Part 10, of the WHS (MPS) Regulation, 'licensed activities'.

- 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) Method 7602 (2017) Silica, respirable crystalline, by IR (KBr pellet) (Method 7602)
- National Institute for Occupational Safety and Health (NIOSH) Method 7603 (2017) Quartz in coal mine dust, by IR (redeposition)
- ISO 16258-1:2015 Workplace Air – Analysis of respirable crystalline silica by X-ray diffraction. Part 1: Direct-on-filter method.

2.3.2.1. Limits of test methods

The laboratory should provide the Limit of Reporting (LoR), Limit of Quantitation (LoQ) and Measurement Uncertainty (MU) for the measured dust concentration.

2.4. Types of sampling

Sampling is the process of conducting a measurement or series of measurements of the airborne dust concentration.

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 be established before determining the type of sampling to be used. The purpose of monitoring worker personal exposure is to assess health risk and comply with legislated workplace exposure limits.

The purpose of control monitoring includes identifying hazards, investigating potential sources and/or causes of exposure and evaluating the performance of controls.

2.4.1. Personal exposure sampling

Personal dust exposure sampling is the process used to measure an individual's exposure to airborne dust, without taking into account any respiratory protective equipment (RPE) worn. It includes both exposed and non-exposed time (e.g., breaks).

A personal dust exposure sample must be collected from within the breathing zone of the worker and in accordance with the relevant Australian Standard or accepted standard method.

Section 50 of the WHS Regulation and section 41 of the WHS (MPS) Regulation require personal exposure sampling to ensure workplace exposure limits are not exceeded.

Personal exposure sampling should be undertaken as part of baseline and periodic monitoring programs specific to the mine.

Mine operators should conduct baseline monitoring to establish an initial estimate of exposure for an existing, new or modified process or activity. This enables comparison with workplace exposure limits and identification of areas requiring additional control measures.

Periodic monitoring commences when baseline monitoring is completed. Periodic monitoring provides information on the ongoing adequacy of exposure control measures. This ensures the visibility of worker exposure levels is maintained and allows for ongoing identification of tasks or areas where controls may require review.

2.4.2. Static sampling

Mine operators can use static (or fixed) sampling to measure specific airborne dust levels in areas and identify sources and causes of dust generation. This enables dust control efforts to be focused and prioritised. Airborne dust samples collected at static sampling points are not representative of actual worker personal exposure. They must not be used to assess worker exposure for health risk assessment or legislative compliance purposes. Static sampling is nevertheless a valuable tool for assessing the effectiveness of process controls. For example, sampling before and after implementing controls to verify their effectiveness.

2.4.3. Control verification monitoring

Control verification monitoring may be used as a way of verifying a control measure's effectiveness. Control verification monitoring is sampling of a dust generating process for the purpose of:

- investigating the specific primary sources and/or causes of dust generation, or
- validating the effectiveness of new dust control measures under trial, or
- assessing the ongoing performance of existing dust control measures.

Control verification monitoring may be useful to assist with validating control effectiveness or the application of dust control trigger action response plans (TARPs).

Sampling conducted for control verification monitoring purposes must not:

- form part of the personal exposure monitoring program
- be used to assess compliance with the prescribed sampling requirements in section 89 of the WHS (MPS) Regulation.

Control verification monitoring may include personal and/or static types of sampling and a range of sampling devices, including real-time instruments.

2.4.4. Real-time sampling

Mine operators can use real-time sampling to observe changes in dust concentration over time. These changes may occur within the period of a single event, task or shift length, which makes them useful for control verification monitoring purposes. Real-time sampling instruments use a direct-reading detector to measure airborne dust concentrations within short time intervals (seconds-minutes).

There are two main types of real-time dust sampling instruments available. Each use distinct detector technologies to measure the quantity of dust collected within the sampled volume of air, from which a dust concentration is calculated. One measures particle mass by an optical light scattering sensor and the other uses a tapered element oscillating microbalance (TEOM). These devices are currently not valid for assessing worker exposure risk under section 89 of the WHS (MPS) Regulation. Despite the limitations, real-time devices can be used for control verification monitoring purposes. They give a relative indication of worker dust exposure if sampled from within the breathing zone and the sample duration is representative of normal shift activities.

Real-time dust sampling can benefit mine operators by allowing for rapid multiple event or task-based measurements. This can assist with investigating the source or cause of dust exposure, and to evaluate the effectiveness of dust controls. This information can then be used to activate a response (such as a TARP) and/or provide timely communication of relative risk to mine workers, within the shift.

2.5. Personal exposure monitoring

2.5.1. Establishing similar exposure groups

Mine operators should establish and use similar exposure groups (SEGs) for their sites based on observations and exposure risk estimates of their specific work groups. Logical associations, for example work or function groups, physical location, activity or equipment used should also be considered when establishing SEGs. To facilitate the reporting of exposure data to the Regulator, all data is to be assigned to one of the appropriate SEGs listed in the generic SEG list provided in Appendix A.

2.5.2. Exposure monitoring strategies

There are many reputable documented monitoring strategies available which provide methods for monitoring and evaluation of workplace exposure, particularly in respect to compliance with WESs. Selection of a suitable monitoring strategy will enable valid estimates of workplace exposures to be determined and assist in the development of robust control strategies.

Mine operators should seek guidance from a competent person such as an occupational hygienist on the most suitable monitoring strategy to use at their site. The selected strategy should be documented either in the PHMP or an associated separate document in the SMS.

Acceptable documented monitoring strategies include, but are not limited to:

- EN689:2018 Workplace exposure - Measurement of exposure by inhalation to chemical agents - Strategy for testing compliance with occupational exposure limit values
- BOHS NVvA - Testing Compliance with Occupational Exposure Limits for Airborne Substances (2022)
- NIOSH Occupational Exposure Sampling Strategy Manual (1977)
- AIHA strategy for assessing and managing occupational exposure (2006)
- HSE Measurement Method – Exposure Measurement: Air Sampling, COSHH Essentials General Guidance G409 (2022).

Detailed information on the selection of a suitable monitoring strategy is provided in AIOH - Occupational Hygiene Monitoring and Compliance Strategies (2019).

2.5.3. Baseline monitoring program

Mine operators should conduct baseline monitoring to assess the current exposure of workers. This should be conducted after establishing SEGs based on the potential for worker exposure to airborne dust. Baseline sampling should be conducted over a suitable period typically ranging between 12-24 months. This period is considered to be representative of the normal variations in dust exposure across the mine environment. A 12-24 month representative period will allow consideration of variations between:

- the range of activities in the mine
- seasons and operations
- groups of workers (crew)
- individual workers.

Minimum sample numbers for baseline monitoring should be determined by a competent person such as an occupational hygienist in accordance with the accepted monitoring strategy selected.

At the completion of the baseline monitoring program, or when collection of sufficient samples indicate clear evidence of acceptable exposures, statistical analysis of the data should be conducted and compared with the relevant shift adjusted WES.

2.5.4. Periodic monitoring program

The mine operator should conduct periodic monitoring to ensure the effectiveness of dust controls measures implemented. Periodic monitoring also provides an estimate of the exposure profile of the SEG. The periodic monitoring requirements for each SEG must be risk-based.

While not an exhaustive list, for a periodic monitoring program, the mine operator should consider including the following:

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

All data is valuable, and the mine operator should consider all existing data in determining ongoing monitoring program requirements.

Minimum sample numbers and frequency for periodic monitoring should be determined by a competent person such as an occupational hygienist in accordance with the accepted monitoring strategy selected.

2.5.5. Censored data

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

For the purposes of determining SEG exposure and establishing ongoing periodic monitoring program requirements, a competent person should assess the data using reputable techniques which address bias arising from censored data. Bayesian statistical methods (such as Expostats) are available to complete this analysis.

2.5.6. Minimum statutory personal exposure monitoring requirements

The minimum statutory monitoring requirements in NSW mining operations are detailed in Schedule 6 of the WHS (MPS) Regulation and are outlined in **Tables 3 and 4 below.**

Any data collected as part of statutory monitoring should be included in the risk-based monitoring data for the site for the purpose of conducting statistical analysis.

Table 3: Minimum statutory samples & frequency for monitoring coal mines[3]

Location	Frequency – Respirable Dust	Frequency – Crystalline Silica	Frequency – Inhalable Dust	Samples Required
Longwall – in each part of a coal mine where longwall mining is carried out	Each producing shift at 6-monthly intervals	Each producing shift at 6-monthly intervals	Each producing shift at 12-monthly intervals	Minimum 5 persons, including: 1 x Shearer Operator 2 x Roof Support Operator 1 x Deputy 1 x Person exposed to dust
Continuous Miner – in each part of a coal mine where continuous mining machines operate	Each producing shift at 12-monthly intervals	Each producing shift at 12-monthly intervals	12-monthly intervals	Minimum 5 persons, including: 1 x Continuous Miner Driver 1 x Sideman / Cable Handler 1 x Shuttle Car Driver 1 x Deputy 1 x Bootend Attendant or person exposed to dust
Cement Product Appliers – in each part of an underground coal mine where cement products are being applied	Nil	Nil	12-monthly intervals	Minimum 2 persons, including: 1 x person loading cement into mixer 1 x person spraying/applying cement products
Any other places in an underground coal operation, including crusher stations	12-monthly intervals	12-monthly intervals	12-monthly intervals	1 x person
Any place in an open cut coal mine where dust may be present	12-monthly intervals	12-monthly intervals	12-monthly intervals	Minimum 5 persons, including: • Drill Operator, Shotfirer, Stemmer • Mobile Equipment Operator

[33] Schedule 6 WHS (MPS) Regulation

Table 4: Minimum statutory samples & frequency for monitoring for non-coal mines[4]

Location	Frequency – Respirable Dust	Frequency – Crystalline Silica	Frequency – Inhalable Dust	Samples Required
▪ Extraction areas of a non-coal mine where respirable crystalline silica has been identified as a hazard, and ▪ Each part of the non-coal mine (where respirable crystalline silica has been identified as a hazard) where dust is, or may be present.	12-monthly intervals	12-monthly intervals	Nil	Minimum 5 persons, including: • Drill Operator, Shotfirer, Stemmer • Mobile Equipment Operator

[4] Schedule 6 WHS (MPS) Regulation

2.5.7. Monitoring itinerant similar exposure groups

The monitoring processes detailed in this TRG have been developed for monitoring workers carrying out routine activities at mining operations. There may also be some non-routine or intermittent SEG based activities carried out at mining operations. The process of establishing a baseline, or ongoing periodic monitoring programs and single exceedance resampling may not be practical. Examples of SEGs in this category may include:

- civil projects
- exploration drilling
- major shutdowns
- longwall moves
- raise boring
- road construction/maintenance
- topsoil removal
- rehabilitation.

The mine operator should consider itinerant SEGs when establishing a worker airborne dust exposure monitoring program. Mine operators must ensure worker airborne dust exposures for these activities are controlled and monitored as required by section 41 of the WHS (MPS) Regulation.

2.5.8. Monitoring program reviews

The mine operator should ensure a competent person such as an occupational hygienist conducts a review of the adequacy of the airborne dust monitoring programs at the site. This review should be undertaken at the completion of each program's sampling period, and at any time where there are:

- changes to the plant, equipment, operating environment, operating methods or SEGs that have the potential to impact dust exposure levels, and or
- statistically significant changes to the exposure estimates following periodic monitoring.

The review should include:

- all personal exposure measurements collected during the monitoring program period
- an exposure estimate update for each SEG through statistical analysis described in this TRG following completion of the periodic monitoring program
- review and update of SEG composition, shifts / rosters, and population.

A review may affect the sampling frequency. It may also lead to the establishment of a new baseline. At the end of each airborne dust monitoring program review, the mine operator should document the review outcomes and update any associated management plans and procedures.

2.5.9. Additional personal exposure sampling requirements

2.5.9.1. Sample duration

All personal samples collected to estimate exposure must be collected over a period representative of normal shift activities. While Schedule 6 of the WHS (MPS) Regulation prescribes that samples should be collected over a period covering a minimum of 80% of a shift length, it is good practice to take samples over the full duration of the shift, where possible.

2.5.9.2. Random sampling

As far as reasonably practicable, the mine operator must ensure that any personal exposure monitoring undertaken as part of a risk-based exposure monitoring program are collected randomly. This ensures coverage of a range of workers, crews, shifts, rosters, operating and seasonal conditions.

2.5.9.3. Data collection

The mine operator must keep records of personal airborne dust exposure sampling for a minimum period of 30 years. Records of personal exposure sampling must include:

- certificate of analysis for samples
- applicable information contained in **Tables 5** and **6.** This information may be recorded within the final hygiene report, on the monitoring task sheets, or other suitable method. All data must be available on request.

Table 5: Minimum information to be recorded for each worker

Worker Information	Shift Information
– Full name – Date of birth – Employment status (if contracting, incl. company) – Job title / Occupation – Primary SEG – Shift length and roster – Crew – Facial hair description	– Tasks undertaken, including timeframes (start and end), duration and location – Vehicle/s operated (if applicable) and corresponding ID – Equipment used or plant maintained (e.g., if performing maintenance) – Use and type of respiratory protective equipment (RPE) and if fit-tested for the RPE used – 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 6: Minimum information to be recorded by competent person when conducting the monitoring, so far as reasonably practicable.

Sample Information	Environmental and Operational Information
– Sampler (competent person) – Date – Analysis Laboratory – 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 rates (equipment used, mining method, production over the shift) – Ventilation (UG) / Wind conditions (OC) – Housekeeping observations – Exposure sources – Operational conditions – Material handled – Weather conditions – Seasonal factors

2.5.10. Invalid samples

Samples that do not meet the minimum sampling or quality requirements specified in relevant Australian Standards or the requirements of Schedule 6 of the WHS (MPS) Regulation are deemed invalid. The mine operator must not use invalid samples for estimating worker exposure in any circumstances.

A sample must be deemed invalid in the event of the following:

- equipment used does not conform to relevant standards (e.g., AS2985, AS3640)
- equipment used is not within specified calibration requirements
- equipment performance is not maintained during sampling
- sample flow rate does not comply with that specified by relevant standard (+/- tolerance)
- sample is not collected from inside the workers' breathing zone
- sample duration is not representative of full shift (or minimum 80% shift as per WHS (MPS) Regulation)
- sample integrity is not maintained throughout sample collection, freight, and analysis.

The reason for which a sample is deemed to be invalid should be documented in the monitoring report with supporting evidence (e.g., note recorded on field sheet by wearer or competent person, correspondence from laboratory, and photographic image).

Additional personal exposure samples should be collected for the relevant SEG to replace invalid samples.

The following statements provide examples of the documentation of invalid samples:

- 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 required 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 duration required in accordance with relevant standard/Regulation, or sample period not representative of full shift exposure
- invalidated by lab – sample damaged or contaminated (incorrect 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 – the mine operator must provide comments and supporting evidence.

Where there is a difference of opinion as to whether a sample is invalid or not, the validity of the sample should be at the discretion of a competent occupational hygienist.

2.6. Interpreting exposure monitoring results

2.6.1. Single sample exceedance result

Any valid single personal exposure sample result for inhalable dust, respirable dust or respirable crystalline silica (quartz) that is greater than the relevant 8-hour equivalent WES (shift adjusted) is considered an exceedance.

Single personal exposure sample results greater than the relevant WES are still considered an exceedance even if workers are wearing appropriate and correctly fitted respiratory protective equipment.

2.6.2. Estimating similar exposure group exposure profiles

Following the collection of sufficient samples, a competent person such as an occupational hygienist should generate inferential statistics in accordance with the sampling strategy methodology chosen to summarise the dataset and estimate the exposure profile of the SEG.

Various tools can be used to generate descriptive statistics including, but not limited to the following:

- IHDA-AIHA, IHSTAT and IHSTAT_Bayes from the American Industrial Hygiene Association (AIHA)
- BWStat web-based tool from the Belgian Society for Occupational Hygiene
- Expostats Bayesian calculator web-based tools from the University of Montreal.

Common measures used in various sampling strategies to describe SEG exposure profile conformance are provided in Table 7. A competent occupational hygienist may use alternative suitable statistical metrics to determine the conformance of SEG exposure profiles in respect to WESs.

Table 7: SEG exposure profile conformance

Sampling Strategy	Details	Measures of SEG conformance to WES
EN689:2019	**Preliminary Test**: Simple comparison of individual results to fractions of WES. **Statistical Test**: ≥ 6 samples / SEG Uses BWStat or Expostats analysis tool Calculations based on Geometric Mean (GM), Geometric Standard Deviation (GSD) and the WES. Calculates Group and Individual compliance.	**Preliminary Test**: SEG conforms if: 3 results <0.1xWES 4 result <0.15xWES 5 results <0.2xWES **Statistical Test:** Group exposure conforms if, with 70% confidence, <5% of the exposures in the SEG exceed the WES (95^{th} percentile is <WEL). Calculated using values of U parameter. SEG conforms in terms of individual exposure if there is <20% probability that >5% of the exposures of any individual >WES.
BOHS NVvA[5]	**Screening Test**: Simple comparison of 3 full shift samples to WES **Group Compliance Test**: minimum of 9 samples with at least 2 samples from multiple workers Uses BWStat or Expostats analysis tools Tests the likelihood that the probability distribution of SEG measurements will comply with the WES.	**Screening Test:** compliance if all 3 samples <0.1 x WES **Group Compliance Test:** SEG exposure conforms if, with 70% confidence, <5% of the exposures in the SEG exceed the WES (95^{th} percentile is <WES) calculated using values of U parameter.
NIOSH[6]	Requires sampling individuals **once only** out of a SEG to obtain a high probability of sampling the highest exposed worker. Single sample results (X) can be used by converting to standardized concentration ($x = \frac{X}{WEL}$) Accommodates analytical method variation Assumes constant conditions and	SEG exposure conforms if one sided 95% UCL of the arithmetic mean is <WES ($UCL_{1,95}$ ≤WES).

[5] BOHS NvVA https://www.bohs.org/app/uploads/2022/11/Testing-Compliance-with-OELs-for-Airborne-Substances-2022.pdf

[6] Liedel & Busch (NIOSH) (1977) Occupational exposure sampling strategy manual

Sampling Strategy	Details	Measures of SEG conformance to WES
	normal distribution of results.	
AIHA[7]	Can use IHSTAT, IHDA, IHSTAT_Bayes. Sample sizes / SEG >6	SEG exposure conforms if one sided 95% UCL of the arithmetic mean is <WES ($UCL_{1,95}$ ≤WEL). Preferred estimator of the arithmetic mean is Minimum variance unbiased estimator (MVUE). Preferred estimate of UCL is calculated using Lands "Exact" method.
HSE[8]	Can use a variety of statistical packages IHSTAT, BWStat, Expostats Results need to be log-normal, GSD <2.5 and most exposed workers sampled.	SEG exposure conforms if 75% of 12 or more exposures in the SEG are <33% of the WES.

2.7. Reporting

2.7.1. Single sample exceedance result

Any single personal exposure sample result for inhalable dust, respirable dust or respirable crystalline silica (quartz) that is greater than the relevant 8-hour equivalent WES (shift adjusted) must be reported to the Resources Regulator[9], as per section 124 of the WHS (MPS) Regulation.

Each exceedance of the WES should be investigated and mine operators must also review and revise the control measures implemented to prevent worker exposure to airborne dust for the respective process/task performed during monitoring (refer section 2.8).

2.7.2. Communication of personal exposure results

At the end of each survey period (round of monitoring), the mine operator should communicate personal exposure sample results to all workers that participated in the monitoring. De-identified results must be displayed and made available to workers at the mine.

2.8. Investigating exposure exceedances

The mine operator must investigate any single personal exposure sample result exceeding the relevant WES (even if RPE is used as a control measure). The aim of the investigation is to:

- determine the absent or failed control/s that contributed to the measured exposure
- define the actions required (short and/or long term) to prevent a reoccurrence and the timeframe for their completion.

[7 & 9] BOHS NvVA https://www.bohs.org/app/uploads/2022/11/Testing-Compliance-with-OELs-for-Airborne-Substances-2022.pdf

[9] Reporting must be performed through the Regulator Portal, using the Incident Notification function. Details of the sampling event must be entered into the exposure exceedance database using the *Add Exposure Exceedance* function.

The mine operator's investigation, at a minimum, should consider the following:

- date of sample
- SEG
- work location
- work crew
- activities/tasks carried out (including times)
- personal protective equipment used (including RPE) and for what activities/tasks (including times)
- control measures in place (including engineering and administrative controls)
- production information
- material handled (e.g., coal, ore, stone, overburden, fine, blocky)
- operational conditions (e.g., normal/maintenance, shift/downtime)
- environmental conditions, such as:
  - underground — ventilation, rate/direction
  - open-cut - weather conditions
- operator location (operating out of dust plume)
- adjacent activities contributing to exposure, such as:
  - 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 undertaken:
  - sampling data (determine if sample valid)
  - 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, including (but not limited to):
  - 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

- performing resampling following implementation of additional controls.

The mine operator should document and record the results of the investigation. The results should be analysed in conjunction with previous investigation findings to identify any trends and issues with the mining operations' SMS. The mine operator must also record any subsequent changes made to the SMS and communicate them to affected workers.

2.8.1. Resampling following an investigation

Following a single personal exposure sample exceedance and investigation the mine operator should resample the SEG. Resampling should 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 dust sampling plan requirements. This may result in an increase in the number of samples and/or frequency of worker exposure monitoring required.

The resample should, as far as practicable, be taken in the same circumstances as the initial sample (to which the exceedance relates). For example, resampling the same worker (or another worker in the same SEG undertaking a similar role) in an area of the mine similar to the area where the initial sample was taken.

A resample may be counted in the number of samples required under the sites periodic monitoring requirements outlined in Section 2.5.4 of this TRG.

3. Control of worker exposure

3.1. Introduction

3.1.1. Scope

This section provides guidance to mine operators and other relevant duty holders on how to identify the key operational areas of dust generation at underground and surface mining operations. This section also guides mine operators on managing the risks of worker exposure to airborne dust. This also includes validating the effectiveness of the controls and implementing corrective actions if controls have been found to be ineffective. Mine operators must use suitable control measures that are relevant to their mining operation as part of its airborne contaminants PHMP. This section provides some examples of suitable control measures.

3.1.2. Dust control

The mine operator when controlling dust exposure should:

- identify sources of dust generation in all areas of the mine
- develop and implement dust control measures for each activity, including identification of critical controls[10]
- follow the hierarchy of control principles to manage the risk of dust exposure to acceptable limits (implement engineering controls before resorting to RPE)
- develop a TARP for the purpose of mitigating personal exposure when dust controls are not

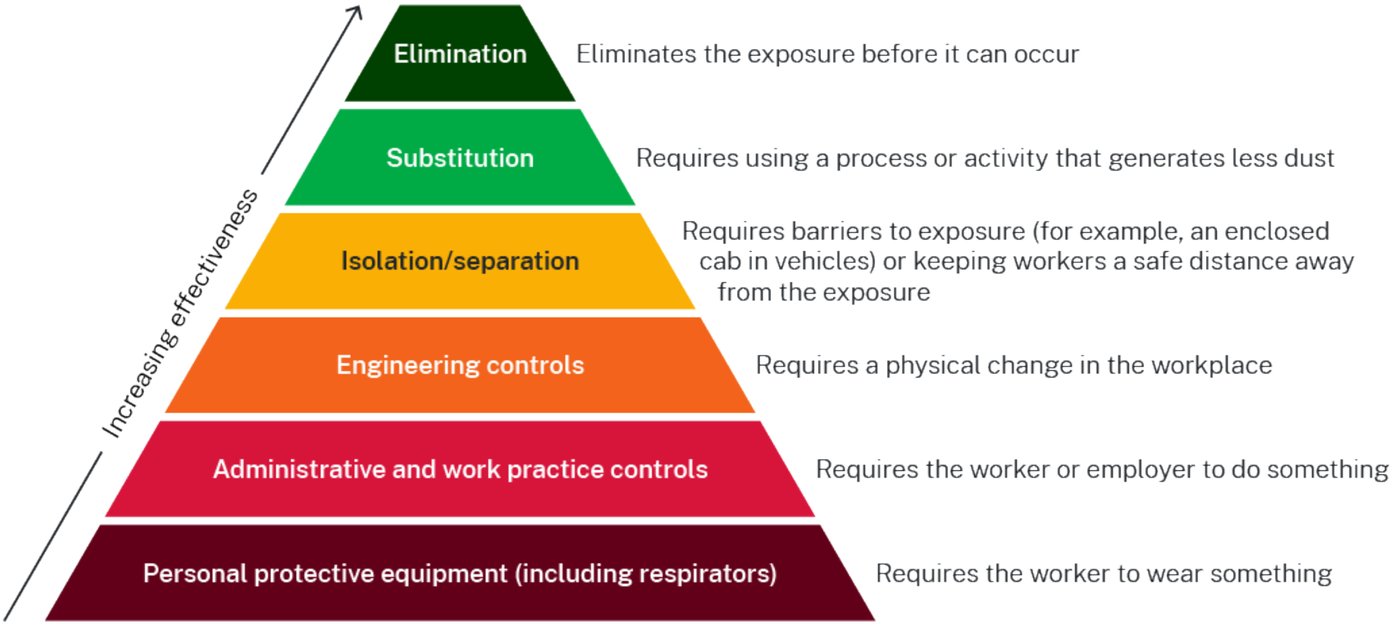
[10] ICMM Critical control management: good practice and implementation guide.

functioning to their designed specification

- incorporate dust control measures into shift and daily routines that are documented and adequately resourced in short-term and long-term planning processes
- systematically review the effectiveness of controls
- have appropriately trained and competent personnel inspect, maintain, and monitor controls and equipment.

3.1.2.1. Hierarchy of controls

Figure 4: Hierarchy of controls



The mine operator must follow the hierarchy of controls, with higher order control measures considered first.

Examples of applying the hierarchy of controls for effective risk management of dust generation and exposure include:

- elimination — using systems which eliminates dust at the point of its generation, or eliminates the need for workers to be in dusty areas, e.g. autonomous mining
- substitution — using methods that generate less dust e.g., replacing dry sweeping with wet cleaning methods
- isolation/separation — using curtains, enclosures, containment and remote controls
- engineering — using dust suppression sprays, extraction systems, filtration systems, suppressant additives etc.
- administration — task rotation and use of procedures to limit exposure, including operator positioning
- personal protective equipment — using properly fitted and maintained respiratory protective equipment.

3.1.3. Dust control trigger action response plans (TARPs)

The mine operator must minimise the exposure of workers to airborne dust as far as reasonably practicable and ensure workers are not exposed to concentrations of airborne dust which are greater than acceptable limits (i.e., WES, or legislated exposure concentrations as per section 41 WHS (MPS) Regulation). Actions should be implemented whenever there is a deficiency in dust controls causing an elevated exposure risk to workers. A TARP should be developed which identifies the actions required to be taken in these circumstances.

The TARP should include:

- key triggers that indicate when controls are not working to their designed specification
- the escalation process to ensure that any increase in the level of risk is considered with appropriate actions to mitigate the effects of the exposure
- clear definitions, responsibilities, and names/positions of those required to implement these actions.

The mine operator's TARP should include key matters with metrics to determine their effectiveness, for example:

- the number of defective sprays
- water flow and pressure requirements
- filtration pressure
- real-time dust concentrations
- automation functionality

The TARP should also consider the use of short-term alternative action responses if key controls are deficient. These actions are designed to limit exposure to workers until the control system is returned to its original operational state, including:

- task rotation
- real-time monitoring until control effectiveness returns to the designed parameters
- decreasing operation / production rates to reduce dust generation.

3.2. Mine dust control strategies

3.2.1. Mining sequence and method

The mining sequences and equipment, in conjunction with environmental conditions, should be designed to minimise operator exposure to dust. Priority should be given to higher order controls (e.g., engineering design).

Any changes to the sequence or equipment which results in potential deficiencies in dust control (including dust suppression or maintenance issues) need to consider interim controls such as those outlined in a TARP. The mine operator should consider how to minimise worker dust exposure when determining mining / cutting sequences and method. This includes interaction between method, dust generation sources, and air quantity. Some examples include:

- the impact of different mining methods on personnel positioning

- how production rates influence dust generation
- the ability of dust controls to remain effective
- the ability to maintain visibility
- operator positioning outside high dust exposure areas.

3.2.2. Automation in underground mines

Automation can provide benefits in reducing dust exposure and should be considered when conditions allow.

3.2.2.1. Automation in underground coal mines

There are a number of processes that can be automated in underground longwall coal mining. Automation of shearer cutting, and shield advance removes the necessity to have an operator inside the higher dust generation areas on the longwall face. When full automation is not practical or possible, shields should be advanced using adjacent control. Operators should also remain on the intake side of the shearer and shield advance. The TARP should also include failures in automation and defined actions that can be implemented in response.

When continuous miners are fitted with extraction manifolds (whales mouth ducting), automation timing of cutting cycles can be used. This minimises operator exposure to higher dust levels generated by the trapdoor operation during the cycle. The mine operator must consider how continuous cutting and bolting cycles and manual bolting operations increase the risk profile.

3.2.2.2. Automation in other mines

Examples of automation in non-coal mines includes the use of autonomous drilling, blasting, loading and hauling machinery and equipment. In addition, the operation of machinery can also be undertaken by workers from a remote location, for example remote operation drilling, and ore-extraction using remote control load haul dump (LHD) machines.

3.2.3. Ventilation in underground mines

The mine operator should assess ventilation design in underground mines to ensure ventilation velocities do not have substantial influences on the generation of dust.

The mine operator should consider the following to manage ventilation in underground operations:

- ventilation will affect dust dilution capability and spray efficiency, so appropriate quantities need to be configured at the right locations and with consideration of the inherent mining system requirements
- displacement ventilation can be used to push dust laden air out of the mine
- in an underground coal mine outbye work in any given ventilation circuit that may increase dust levels for inbye work groups must be considered
- in non-coal underground mines ensure the air velocity in the intake roadway is not sufficient to raise dust, and dust suppression sprays are installed, ensure high dust exposure areas (refuelling and services facilities, crusher stations, conveyor transfers, ore passes etc.) are ventilated direct to the return airway.

3.2.4. Underground roadway dust suppression

The mine operator should consider dust suppression as part of the airborne contaminants PHMP that includes:

- grading
- salting
- watering / suppression sprays
- chemical additives.

3.2.5. Dust control zones

The mine operator should consider developing dust control zones to ensure operators remain outside of high dust exposure areas where practicable (e.g., crushing and screening plants, drilling areas, loading or tipping areas). The mine operator should develop safe work procedures when workers are required to enter designated dust control zones.

3.2.6. Surface mine roads

Designers of surface mine roads should consider:

- early planning to identify the location of mine infrastructure that may generate dust, mobile plant to be used and other dust generating activities
- the geographical location of the road in relation to surface mine facilities and infrastructure
- selecting road surface material that minimises dust generation
- the frequency of use and travelling speeds
- sealing of mine road surfaces where dust may impact sensitive areas (offices, workshops etc.)

To maintain surface mine roads, the mine operator should consider:

- the location, availability, and accessibility of water stations (fill points)
- the flow capacity of water stations (reduce fill time)
- the number, capability, and availability of water trucks (including contingencies for breakdowns)
- the use of fixed sprinkler systems, especially near infrastructure such as workshops and coal/ore processing plants.

The mine operator should consider:

- safety implications when selecting watering methods (uncontrolled movement of equipment verse dust generation)
- using additives which may improve the suppression of dust or sealing of roads.

The mine operator should continually monitor dust generation from mine roads.

3.2.7. Local exhaust ventilation and extraction systems

3.2.7.1. Local exhaust ventilation

The most effective way of reducing the airborne dust concentration is to remove the dust at its generation source. One way of doing this is by using a well-designed and maintained local exhaust ventilation (LEV) or extraction system. These systems may be fixed (e.g., around milling machines) or flexible systems (e.g., around grinding, welding, maintenance and cleaning applications).

When selecting an LEV or extraction system, the mine operator should consider the system's design and factors such as:

- the shape (area) of the capture hood
- proximity of the capture hood to the dust generating source
- cross-drafts and eddies
- the power of the fan
- the angle of joins in the associated ductwork
- the material the duct work is constructed from
- the length of the associated duct work
- the access for cleaning and the removal of captured contaminants
- the availability of test points to carry out checks / inspections.

These factors may have a significant impact on the system's efficiency and ability to achieve and maintain an appropriate capture velocity.

When designing, selecting and installing LEV and extraction systems, the mine operator should use a competent person. Dust captured by the system must not be vented or recirculated into the environment as it may become a secondary source of exposure to other mine workers.

Identifying the correct capture velocity is essential for the type of contaminant (e.g., dust, fume or gas) and method in which the contaminant is being generated. It is important to regularly maintain the LEV system to ensure it continues to operate at the designed capture velocity. This will include regular inspection, cleaning and assessment of the capture velocity. The capture velocity should be qualitatively checked routinely (e.g., smoke tubes) and quantitatively checked at periodic intervals (e.g., measured using a hot wire anemometer, or differential pressure gauges). The mine operator should prevent secondary dust exposure when maintaining the system including replacement and cleaning of filters.

The mine operator can find further practical guidance at:

- American Conference of Governmental Industrial Hygienists (2013) *Industrial Ventilation: A manual of recommended practice for design, 31st Edition*, ACGIH®, Cincinnati
- NIOSH Dust Control Handbook for Industrial Minerals Mining and Processing
- HSE Local Exhaust Ventilation.

3.2.7.2. Filters for dust collection

The mine operator may use filters for entrapment and dust collection in devices such as vacuums and local exhaust ventilation systems (LEV). Filters may also be components of heating, ventilating and air conditioning (HVAC) systems.

Filters are classified by the efficiency of the filter media in trapping and containing particulates of certain sizes. There are also filters available to trap toxic particulates.

H-Class (High Risk) particulates include those with a WES of <0.1mg/m^3 H Class filters must be able to trap and contain 99.995% of dust at 0.3µm. Respirable Crystalline Silica is classified as a H-Class particulate.

A H-Class Certified extraction unit must display the appropriate warning label as described in AS/NZS 60335.2.69.

M-Class Filters capture at least 99.9% of dust particles that are 0.3 microns in diameter and are suitable for medium hazard dusts such as wood dust, concrete dust, and other materials that pose a moderate risk to health.

The extraction unit should undergo annual testing to ensure it maintains H-Class or M-Class certification. All H-and M-Class extraction units must be maintained on a register to ensure compliance to annual servicing and testing conducted by an approved certified third party.

Further guidance for mine operators can be obtained from:

- British Standard BSEN 1822-1 (2019). High efficiency air filters (EPA, HEPA, and ULTA), Part 1: Classification, performance, testing, marking
- Australian Standard AS/NZS 60335.2.69 (2021) household and similar electrical appliances – Safety, Part 2: Particular requirements for wet and dry vacuum cleaners, including power brush, for commercial use”
- Australian Standard AS 4260-(1997) High efficiency particulate air (HEPA) filters — Classification, construction and performance.

3.2.7.3. Bag filters and dust collectors

Dust collection facilities including bag filters fitted to drills, engine air intake filters, and particulate filters have the potential to generate airborne dust during filter replacement or maintenance.

The mine operator should consider using exchange filters to allow old filters to be bagged/sealed then cleaned in a controlled environment. Filter elements (engine intake, external dust filters for cabins) should not be “tapped” clean as this could potentially expose workers to airborne dust. The mine operator should consider using exchange filters to allow old filters to be bag/sealed then cleaned in a controlled environment. The mine operator should have suitable controls to protect workers when replacing filter elements.

3.2.8. Use of compressed air

Mine operators have widely used compressed air for cleaning down enclosures during maintenance activities. This activity generates excessive airborne dust and should therefore be replaced by other cleaning methods wherever possible.

The mine operator should consider controls which negate the use of compressed air for cleaning, for example:

- prevent/limit dust from entering enclosures through design, pressurisation of enclosures and sealing
- use alternate cleaning methods (vacuum instead of blow)
- schedule more frequent cleaning to limit the duration of blow outs
- consider a minimum of powered air purifying respiratory protection (PAPR) for these tasks until suitable engineering controls are in place
- consider use of real time monitoring devices during implementation of controls to understand the effectiveness.

If compressed air is used for cleaning as there is no alternative, the mine operator should:

- identify all tasks that involve the use of compressed air to clean out/blow down settled dust
- establish and maintain a register of these tasks
- review current dust control measures during these activities to ensure exposures are kept within acceptable levels
- conduct personal exposure monitoring of workers conducting any of the registered tasks to ensure controls are effective and do not exceed workplace exposure limits
- review the type and level of RPE used for these tasks to ensure it is appropriate.

3.2.9. Plant selection

The mine operator should use competent people to carry out a risk assessment for plant selection. When selecting plant, the mine operator should refer to the hierarchy of controls, and equipment specifications for the control of dust generation at the source and ingress of dust (e.g., dust sprays, and cabin design are the correct engineering specification for the planned application). Plant includes:

- fixed plant installations (e.g., conveyors, dump hoppers, crushers, transfer points)
- fixed plant control rooms (e.g., crushing plant control rooms)
- mobile plant equipment (e.g., heavy earth moving equipment, drill rigs, water carts, agitator trucks etc.)
- transportable and relocatable equipment (e.g., mobile crib rooms).

3.2.9.1. Fixed and mobile cabin design

Conventional HVAC systems are not designed to filter airborne particulates from entering the system. It is also likely that standard cabin filters cannot sufficiently protect plant operators from airborne dust.

Fit for purpose cabins on mobile and fixed plant can provide a means for thermal comfort and dust control. For cabins that are used in potentially high concentrations of airborne dust, these systems should be used as a control measure and designed to prevent respirable airborne dust from entering or recirculating in the system.

When selecting equipment or undertaking major overhauls on existing mobile plant, mine operators should consider the following:

- the ability to supply pre-cleaned and filtered air to the cabin that passes through a high efficiency particulate air (HEPA) filter
- the ability to pressurise the cabin to sufficient levels to prevent inward ingress of dust. A pressure range of between 50 Pa and 200 Pa is recommended in ISO 10263-4:2009 when the machine is in use
- the ability to continuously monitor cabin pressure with a system that alarms when the pressure is not adequate
- the ability to remove dust that has been brought into the cabin on boots and clothing or when doors are opened (e.g., through a return air filtration system, or a mounted in-cabin bagless vacuum system that exhausts out of the cabin)
- selection of materials, structural rigidity, seal selection and accuracy of fitment to ensure good cabin sealing to assist in pressurisation of the air space
- the design of the cabin should be such that it minimises the need for the operator to get in/out of the cabin for operational reasons (i.e., adequate visibility)
- a means of ensuring cabin doors remain closed, such as self-closing cabin doors
- covering seats in mobile plant with less porous materials to minimise the harbouring of dust
- design the cabin to minimise potential for dust accumulations. Position blowers / vents / outlets such that dust is not blown around the cabin (e.g., from the floor/foot well)
- shrouding to minimize latent dust build up above cabin doors.

Further guidance on the performance requirements and test methods for fixed and mobile cabins in the mining industry can be obtained from AS/NZS ISO 23875:2023 *Mining - Air quality control systems for operator enclosures - Performance requirements and test methods*, and ISO 10263-4:2009 *Earth-moving machinery - Operator enclosure environment - Part 4: Heating, ventilating and air conditioning (HVAC) test method and performance.*

The mine operator should always follow the manufacturer's maintenance requirements. This ensures the effectiveness and adequacy to prevent airborne dust entering an operator's cabin or other enclosed workplace including control rooms and office buildings.

Operational conditions and systems should be monitored for their effectiveness and adequacy and conduct control verification checks at pre-start inspections and during maintenance. (e.g., seal condition, crack/penetrations to windows or cabin surfaces, damage to doors resulting in bending, bungs are in place, filter housing is sound).

The mine operator should have a TARP in place for circumstances when one or more of the dust controls are not functioning properly.

3.2.9.2. Conveyors

When designing conveyor systems, designers should consider the following:

- the location of the conveyor system in relation to proposed or existing infrastructure including locations of offices

- environmental conditions, including prevailing wind
- medium being conveyed (e.g., light friable material that may be affected by high winds)
- roof covered conveyor systems
- enclosed conveyor systems where sensitive receptors may be present
- transfer points
- sizing or crushing locations
- drive heads etc.
- cleaning practices.

Designers and mine operators should control identified dust generation points. Dust controls may include:

- water suppression - dust suppression sprays work best when the dust particles and atomised water droplets are of equivalent sizing.
- enclosure or partial enclosure of conveyors and transfer points (e.g., dust curtains at head/tail ends, skirting of loading chutes)
- belt scrapers and belt wash to reduce carryback on the belt
- coffin seals at underground ventilation control devices
- dust extraction/exhaust systems to dust collectors and filters.

Mine operators should conduct chemical analysis on the mined product and any waste products (coal rejects, flyash, tailings, waste rock) to be transported to understand the contaminants it contains which may constitute an exposure risk to persons during haulage and transport (e.g., analysis to determine mineral/metal content – asbestos, cadmium, mercury, arsenic, lead, silica etc).

Designers and mine operators should consider the following to control dust emissions during haulage and transport:

- the predominant wind direction and potential interaction with other workings when selecting the travel route
- whether the product is moisture conditioned before being transported
- having operators remain inside the mobile equipment pressurised cabins during the loading, transporting and dumping of product
- reducing load volumes to prevent spillage on the roads. Product spillage rapidly dries and will then generate airborne dust
- using sprinkler systems on stockpiles or exposed cells to keep the surface area moist
- using covers placed on top of trailers preventing dust from being emitted
- applying a water based veneering solution to the surface layer of product in trailers to minimise dust emissions
- selecting travel routes that have minimal interaction with towns and communities
- speed restrictions

- washing trucks prior to travelling on public roads
- using shakers (e.g., a grid to shake dust from the exterior of trucks).

3.2.9.3. Transport of product by rail

The mine operator should consider rail wagon dust management practices at preparation and processing plants that include the veneering process. Veneering is designed to minimise and control dust emissions during transportation along rail corridors. This involves applying a water-based solution to the surface layer of product on each wagon as it passes underneath the spray bar. The solution dries to form a flexible 'crust' over the product and prevents dust from being released from the wagons.

3.2.9.4. Mobile crushing and screening

Mobile crushing plants and screens are used to crush and screen materials for road construction, sheeting of roads, ballast and other purposes. Mine operators should reduce the amount of airborne dust generated when using mobile crushing plants and screens. The mine operator should consider dust control capability when selecting, operating and maintaining mobile crushing plants.

The mine operator should use an equipment selection and introduction to site process that considers dust controls that includes the following:

- ability for water to be plumbed to the crushing plant and installation of water sprays
- the type and location of the sprays including (belts, inside crushers, screens, bins and transfer points)
- the availability of water on site to feed the plant
- the use of shrouding at transfer points, hoppers etc.
- access for the inspection and maintenance of spray systems.

The mine operator during the operation of the crushing plant should consider reducing dust generation and preventing exposure to plant operators by:

- ensuring all dust controls are inspected and operating effectively prior to commencing crushing or screening operations
- ensuring mobile plant feeding crusher, stockpiling and loading trucks are fitted with fit for purpose cabins that prevent dust ingress
- wetting down product prior to crushing.

The mine operator should also consider managing dust generated from stockpiles, road traffic and loading operations. This may be achieved by using water trucks or yard sprays.

3.2.9.5. Processing plant dust management

The mine operator should consider potential dust generating activities, including (but not limited to):

- product loading and unloading practices
- product transfer / movement on conveyors
- creating and reclaiming stockpiles including relocation of product from one stockpile to another

- lift-off from stockpiles in high wind conditions
- spillage, and accumulations of fines and dust.

The mine operator should keep the generation and presence of dust in all processing/preparation plant areas as low as reasonably achievable.

The mine operator should consider the following as means of minimising the generation and presence of dust:

- effective housekeeping standards, including (but not limited to):
  - routine hosing down areas where materials containing dust build up
  - sumps and drains are emptied and cleaned as necessary
  - dust suppression on roadways is maintained by either water carts, sprinkler systems or foam
  - clean up of spillage
  - create a cleaning program that allows the operators to hose the plant from top to bottom removing dust that might be collected on beams and rails.
- design considerations, including (but not limited to):
  - minimising accumulations of fines and dust, such as inverting structural members
  - cleaning and maintenance activities
  - installing concrete aprons below and around product preparation and handing facilities that can be hosed down
  - on-belt sensors that activate dust suppression
  - variable dust suppression (depending on loading rates)
  - conveyor washing systems / belt turnovers
  - wash down facilities under conveyors
  - dust extractor systems in enclosed areas
  - enclosed bins, transfer points and loading points, fitted with dust extraction systems and or water (curtain) sprays
  - belt scrapers
  - variable belt speed
  - controlling and minimising air velocity around materials
  - spray systems – including liquids (e.g., water) with or without surfactants or liquid foams
  - enclosed galleries, wind guards
  - conveyor transfer design to minimise breakage and degradation
  - weather conditions and controls needed to be implemented
  - spillage points
- keeping chute access doors closed when not in use to prevent airborne dust escaping

- ensuring control belt surfaces do not run dry or too wet
- maintenance of water sprays
- maintenance of belt cleaners, skirts and liners is adequate.

3.2.10. Electrical equipment enclosures

When designing enclosures for electrical equipment designers should consider prevention of dust entering enclosures. This includes the following methods for preventing dust ingress:

- misting systems for air intake systems
- positive air pressure monitoring systems for enclosures
- automatic cleaning filtration system (air scrubbers).

The mine operator should develop procedures to remove dust from cabinets and enclosures such as:

- provision for mounting portable local extraction ventilation
- provision for setting up shrouds (tent) / containment screens for maintenance days
- remote controlled blow out systems
- wiping out the enclosure to remove the bulk of the dust before using other techniques and in a way that stops the dust from becoming airborne.
- removal of dust by not allowing the dust to become airborne via use of vacuum systems (long lance and shrouding of the nozzle should be considered), also consider:
  - the use of carbon dioxide (CO_2) cleaning methods as an alternative to using compressed air
  - removal of dust by allowing it to become airborne (blowing out) in the enclosure and extracted by exhaust fans. This technique requires that the airborne dust cannot exit the cabinet or enclosure other than through the exhaust system. These systems can incorporate:
    - shielded vacuum nozzles or longer lances
    - portable extraction systems
    - portable air curtains
    - portable vacuum units
    - containment screens and provision for mounting portable local exhaust ventilation (LEV)
    - pressurization of I/O cabinets which may include air coolers coupled with a water trap and filtration to remove oil and moisture. This reduces dust ingress into the enclosure
    - Using extended air lances with venturi tip designs combined with blower fans to move dust away from workers.

3.2.11. Onsite mine laboratories

Minimising airborne dust generation should be considered when designing, installing, operating, cleaning and maintaining laboratories and associated equipment. Mine operators should consider using local exhaust ventilation (LEV) systems to remove dust at all dust generation points. This will include any on site laboratories where dust can be generated by means such as crushing or transferring from one bin to another drum or bucket. Ideally the system should be fully enclosed with access to allow for cleaning of spillage and routine maintenance.

Laboratory workers should not use compressed air for cleaning and blowing down of components to remove dust. Alternative cleaning methods such as using a H-or M Class vacuums should be used. If there is no alternative to using compressed air, see section 3.2.8 of this TRG for guidance.

3.2.12. Overburden waste dumps

The mine operator should consider how it will eliminate or minimise dust generation from overburden and waste dumps. For example:

- considering the predominant wind direction when selecting a location for spoil and waste dumps
- minimising the footprint area of spoil and waste dumps, avoid dumping over large surface areas
- rehabilitating exposed spoil and waste dump areas
- using sprinkler systems to suppress the dust
- ensuring workers remain inside the mobile equipment pressurised cabins during the loading, transporting and dumping of overburden product.

3.2.13. Water application and sprays

Designers should ensure they use correct dust capture and spray design (including droplet size and interactions with dust particle size) to effectively manage airborne dust. This may require specialist advice.

Airborne dust suppression system designers should consider:

- environmental factors
- size of focus area
- wind velocities
- water consumption / availability
- sufficient flow and pressure
- water quality suitable to prevent blockages
- ability to contain and manage the water generated
- physical barriers
- hazards (such as machine or equipment movements and flying rock)
- dust properties, including particle size distribution (PSD)

  Note: Dust suppression sprays work best when dust particles and atomized water droplets are of equivalent sizing.
- concentration levels
- velocity (e.g., air and particle movement, belt speed)
- nozzles selection and position such as:
  - positioned for maximum coverage, maintenance access, and free of any interference issues that could cause damage

  - selection for maximum capture efficiency
- use of surfactants and/or liquid foams.

3.2.14. Underground drilling

The mine operator should be aware that drilling activities can generate excessive dust. This dust has the potential to cause secondary exposures to post drilling activities.

Mine operators should consider dust suppression options during underground drilling processes, which may include the following:

- using wet drilling processes during inseam drilling, diamond core drilling, face drilling and jumbo drilling
- dry dust collection systems, deck shroud enclosures, shrouds on collector dump discharges and maintaining appropriate collector-to-bailing airflow ratios during downhole drilling
- use of booster fans to improve local ventilation.

3.2.15. Surface drilling

- removing the dust collection systems. These systems are known to deposit fine dust particles on the bench in the path of traffic during the loading process
- using water and dust binding agents during the drill process to bind and coat cutting piles
- under deck spray bars to apply extra dust suppression to cutting piles (without affecting the drilling process)
- drill deck skirting to restrict dust from spreading out across a larger than required surface area
- ensuring the drill bit and drill rods size match to allow adequate annulus (clearance between the side of the drill pipe and the wall of the drill hole). This will allow the cuttings to be ejected from the hole without being subjected to extra grinding and size reduction.

3.2.16. Surface exploration drilling

The mine operator should consider the following when drilling with compressed air:

- drill rigs should be fitted with fixed diverters (engineered T piece) and pressed into the ground over the borehole casing
- a blooie line should be coupled to the diverter that removes the dust from the immediate work area
- drill site setup should ensure T-Piece is angled away from people and equipment
- drill site setup should include restricted areas around T piece diverter and blooie lines
- drill site inductions should include adequate familiarisation of drill site work area including restricted areas
- dust suppression via water injection should be applied while spudding in holes by incorporating water misting sprays into the engineered T-piece
- exploration drill site inspections should include checks for dust generation.

3.2.17. Blasting activities

The mine operator should construct surfaces around magazine and explosive reload compounds using low dust generation materials (e.g., concrete, bitumen or gravel). The mine operator should undertake general care and maintenance (e.g., watering, cleaning and resurfacing when required).

The design of underground production shots should consider the following in the ventilation plan:

- minimum air volumes to adequately ventilate and maintain air velocities to remove post blast dust
- operation of main fans in exhaust mode
- use of stoppings in key locations to direct and control airflow
- use of booster fans to improve local ventilation.

The design of surface blast areas should consider:

- material type and geological properties. Geological structures containing high levels of crystalline silica will require additional diligence throughout the process. The elevated risks from this should be highlighted to drillers and blast crews
- powder factors designed to achieve desired outcomes and correct material size for extraction should be used. Excessively high powder factors will lead to high dust generation throughout the muckpile and may contribute to general mine dust issues during the excavation phase of the mining process
- stemming heights incorporated in the design. Shorter stemming heights will cause a higher level of dust to be released into the air during initiation of the shot. (Scale depth of burial equations are useful in determining the reaction of the shot surface during initiation)
- decking of blasts with longer delay periods between the lower explosive decks, which can lead to a reduction in dust liberation from the shot during the initiation
- general mine dust control methods that should also be considered around the blast bench including road design and maintenance, mine layout, the use of water carts and dust suppression agents
- reduction of dust generation by limiting interaction between neighbouring activities during the design and scheduling process
- the drill pattern surface may be watered or coated with a dust suppression agent prior to on bench activities commencing
- when the dust cannot be effectively managed, work should be suspended. Work should not resume until effective controls are implemented for the current conditions (e.g., relocation of adjacent activities, or additional provision of dust suppression).

The mine operator should consider the following when loading and stemming blast holes:

- the blast bench traffic management plan should consider the wind direction and how this will influence potential dust being generated from the moving vehicles and the impact on personnel
- steady movement of the explosive truck and other traffic across the bench will reduce surface dust being created. All equipment movement should avoid contacting drill cuttings
- manufacturers of explosives trucks should consider the impacts on ground personnel from the air flow and dust generation during the loading process. Skirting or ducting may be able to direct dust away from personnel positioned at the point of loading. Downlines should be attached to a securing device to prevent loss during the stemming process. This will eliminate the need for the ground personnel to be close to the collar of the hole during the stemming process. Stemming material should have fines removed through screening.

When selecting machines for the stemming process, the mine operator, should consider the following:

- machines with large carrying capacities will assist in limiting equipment movement across the bench reducing the amount of dust generated from the movement
- operator seating positions, machines with low mounted cabins may incur a higher dust exposure than machines with high mounted cabins
- stemming machines should be fitted with air conditioners and sealed cabins that prevent dust ingress
- stemming equipment should be able to deliver stemming accurately in through the collar of the hole as this will reduce wastage and the material required to stem the hole. These may include stemming trucks or specially designed stemming buckets.

Stemming material may be wet down or coated with a dust suppression agent to reduce dust. Some stemming trucks can spray the material while being delivered.

The mine operator during firing of the shot should formulate a dust path and include it in the blast exclusion zone.

Mine operators should consider the following factors when determining the dust path:

- weather conditions (e.g., wind speed, wind direction, wind gusts, inversion layers, boundary heights, temperature and atmospheric moisture)
- bench surface area being disturbed, this should include any free faces which may create dust during the blast
- surface and strata moisture levels
- topography and the likely influences
- estimated time the dust will be airborne
- distance and down wind direction of dust cloud.

The mine operator may consider the use of fog cannons in some sensitive locations to suppress dust from the initiation of the shot.

The shotfirer or blast controller should view the blast from a vantage point if possible. They should indicate to the blast guards the direction, size and speed of the dust cloud from the blast. The shotfirer or blast controller should also communicate the actions required to maintain a safe zone away from the dust cloud.

The shotfirer or blast controller should only carry out post blast inspections when dust has cleared from the shot area.

3.2.18. Stockpiles

The mine operator should minimise dust generation when stockpiles are created and consider incorporating effective dust control strategies such as:

- **Design** – where applicable, the design of the stockpile should remain static to enable the application of permanent dust suppression systems. Consider including engineering controls such as water sprays, delivery socks, use of anemometers etc.
- **Location** - consider the location of stockpiles relative to the processing plant or any area with high pedestrian traffic and prevailing wind direction
- **Operation** - review all material handling processes to identify areas of improvement to reduce the level of airborne dust creation whilst minimising exposure to workers
- **Review** - regularly monitor and review the airborne dust control methods to address any areas of WES exceedance.

3.2.19. Task rotation

Mine operators may consider task rotation after implementing engineering controls as part of the management of dust exposures. Task rotation is an administrative (lower order) control that requires monitoring and review and does not control dust generation. If task rotation is used as part of a TARP, workers carrying out high exposure tasks should be rotated to lower exposure tasks during the shift when exposure cannot be adequately controlled by other means.

> **Note:** meal breaks are not considered as task rotation.

3.2.20. Tyre fitting activities

Mine operators should consider the potential for tyre fitting activities to generate airborne dust.

The following activities have the potential to expose workers to airborne dust:

- the release of pressurised air
- using compressed air to clean components
- buffing and dressing of components.

The mine operator should consider alternative work methods and / or suitable controls that minimise the generation of airborne dust during tyre fitting activities.

3.2.21. Equipment maintenance

The mine operator should verify that a maintenance program for all installed dust control equipment is implemented. The program should be based on the original equipment manufacturers' recommendations and be optimised based on site experience and knowledge. It should also incorporate planned maintenance for all dust controls.

The mine operator's maintenance program should include components dealing with:

- establishing housekeeping standards designed to minimise accumulations of dust
- acceptable wear limits
- accidental damage
- routine and condition-based maintenance schedules
- maintenance of water quantity/quality
- spray nozzle maintenance - including how to deal with erosion and wear, corrosion, clogging and caking
- filter/scrubber replacement and cleaning standards
- dust leakage from shrouds, collector disposal points and dust hoods
- conveyor belt scraper maintenance
- improper reassembly
- post-maintenance commissioning checks, including performance testing of equipment.

3.2.22. Groundskeeping, domestic and industrial cleaning

The mine operator should consider the potential for intermittent high intensity exposures during groundskeeping, domestic and industrial cleaning activities. Domestic cleaning refers to activities which include general domestic cleaning of site buildings such as crib rooms, bathhouses, restrooms, office spaces and meeting rooms. Industrial cleaning refers to activities including cleaning of industrial plant and equipment.

It is important that the mine operator consider the hierarchy of controls when undertaking these activities. Examples include:

- **Engineering controls** – undertake groundskeeping (lawn mowing etc) in equipment with pressurised, filtered cabins
- **Substitutio**n – replace dry sweeping with wet cleaning methods
- **Administration** – Plan activities to coincide with favourable environmental conditions. Set up exclusion zones
- **RPE –** Where RPE is required, ensure it is used as part of a respiratory protective equipment program.

3.2.23. Respiratory protective equipment program

The mine operator should only use respiratory protective equipment (RPE) as a control strategy when all other higher order engineering controls in the hierarchy of controls have been considered. RPE should never be the primary means for exposure control in situations when other higher order controls are available, practicable and effective.

Where RPE is used as a control measure, the mine operator should develop a respiratory protective program which contains the following components:

- risk assessment and reports indicating exposure levels for airborne contaminants

- medical evaluation to ensure the worker is physiologically and psychologically suited to wear RPE
- respirator selection – information used to select respirators, as per AS/NZS 1715:2009, Selection, use and maintenance of respiratory protective equipment, and AS/NZS 1716:2012, Respiratory protective devices.
- fit testing to determine facial fit – conducted by a competent in-house person, manufacturer, supplier or consultant. Information regarding accredited training providers or consultants is available on the RESP-FIT website.
- fit checking procedures
- procedures for proper use in routine and emergency situations
- respirator cleaning
- maintenance
- storage requirements
- filter changes when required
- training in the correct use, storage and maintenance of RPE.

Note: AS/NZS 1715:2009 does not permit the use of tight-fitting respirators by workers with facial hair that lies along the sealing surface of the respirator; and stipulates the requirement for fit testing of all tight-fitting respirators to be carried out on workers who are clean shaven or have no hair between their face and the fitting surfaces of the respirator face piece.

It is recognised that RPE will always form part of the mine's overall airborne contaminants PHMP. In these situations, using RPE will provide additional protection to mine workers if worn correctly and for the full duration of the task.

RPE will form part of the overall control strategy in situations such as:

- supplementing higher order controls for mine workers operating in high dust-generating tasks
- completing non-routine or short duration tasks with the potential for intermittent high intensity exposure
- an interim mitigation measure if additional engineering controls are being developed, implemented, and evaluated — if RPE is being used as an interim control, it should be linked to an action plan that clearly specifies the stages for implementation of higher order controls.

3.2.24. Education and training on dust

The mine operator's airborne contaminants PHMP must include an education component to ensure workers understand the airborne contaminant/dust health impacts and control measures at the mining operation.

Workers should be trained in the key dust control strategies operating at the site. Relevant components of the education should include:

- installed controls and their design capability
- prestart and inspection procedures, and reporting of dust and maintenance issues
- operator positioning

- health and hygiene monitoring programs, standard operating procedures, and TARP requirements
- general requirements for dust control and monitoring
- respiratory protection standards and requirements
- high risk dust exposure zones.

In addition, mine operators are required to provide training of workers in the risks and controls implemented at the site in respect to respirable crystalline silica, as per the training requirements outlined in section 529CD of the WHS Regulations (2017).

3.2.25. Inspection and validation of controls

The mine operator should develop and maintain a process to monitor the effectiveness of dust controls in all areas of the mining operation. The mine operator should have a documented process for inspections on commencement of each shift and a process for in-shift validation of controls. When inspections identify variances or failed controls, the actions undertaken will be in accordance with the TARP. The inspections should be conducted by personnel with direct responsibility for operations in each work area, and personnel with direct responsibility for all operations on shift.

Start of shift inspections should be conducted prior to commencement of any production activities or dust-generating processes on every shift. Other hazards that may present a significant increase in risk to mine workers should be considered before undertaking these inspections.

The mine operator should ensure the inspection process covers all relevant dust controls including:

- all dust suppression sprays
- all ventilation control devices (fixed or temporary)
- all dust scrubbing or filtering devices
- all dust wetting agent systems.

3.3. Audit and review processes

The mine operator should develop and maintain an audit and review program to verify the effective implementation of dust control measures. The program should include the use of internal and external audits to verify that they address all matters relating to dust risk control. These audits should be conducted at the commencement of new installations and at frequencies appropriate to the level of risk identified from review of all work personal dust exposure monitoring results. Section 22(1)(b) of the WHS (MPS) Regulation requires a review of the site safety management system at least once every three years.

3.3.1. Periodic review of dust controls

The mine operator should carry out a periodic review of the effectiveness of controls in each area of the mining operation. This review should be based on dust monitoring results and all relevant hazard, geological, maintenance and incident reports. The mine operator should review dust control measures in the event of:

- any significant changes in mining operations or conditions
- any changes in the equipment being used in mining operations
- any increase in worker personal exposure monitoring results for a similar exposure group that increases the risk profile of that SEG.

The mine operator's review should be conducted by a relevant cross-section of the affected workers involved in carrying out the tasks. This ensures that dust generation areas are identified, controlled and incorporated in the mining operation's airborne contaminants PHMP and SMS updates.

3.3.2. Review of dust control effectiveness and routine validation of controls

A competent person with relevant experience and skills should carry out the validation of controls process. They should document the outcomes of the validation process and keep records.

The mine operator should develop a process to review the effectiveness of dust controls introduced at the mining operation, including a process for routine validation of dust control functionality. One way of validating the effectiveness of controls is to monitor dust concentrations before and after the control has been introduced. This can be achieved by using gravimetric or real-time dust monitoring. The advantage of real-time dust monitoring is that it only requires a short sampling period and provides quick feedback.

The mine operator should develop and maintain an audit and review program to ensure the effectiveness of the airborne contaminants PHMP. Audits should be conducted at the commencement of new installations and at frequencies appropriate to the level of risk identified from reviews of all dust monitoring results.

The mine operator should ensure dust controls continue to work to the design parameters. In addition to dust monitoring, this can also be achieved by taking other measurements such as pressure (for example, measuring the pressure inside an operator's cabin) or air velocity (measuring the air velocity at the capture point on a local exhaust ventilation system).

The mine operator should document actions to be taken where the maintenance program is found to be ineffective in managing the operating performance of dust control systems. This will ensure the required changes have been implemented to rectify the inefficiency.

The mine operator should audit and review the effectiveness and implementation of the SMS to ensure dust exposure risk to persons is as low as reasonably practical.

Appendix A – NSW similar exposure groups

Mines other than coal mines

Non-Coal Surface Processing SEGs	SEG Name	Non-Coal Surface Processing SEG Descriptions	Non-Coal: Processing SEG Code
Processing	Laboratory / Core Shed / Sample Collection	Employees and contractors taking sample collection, preparation and processing at a surface operation, or analysing samples in laboratory.	P001
Processing	Surface Crushing / Milling	Employees and contractors involved in surface crushing/milling operations, crusher plant control room operations, clearing blockages, shovelling, general maintenance, loading out/bagging of product, and stockpile dozer operations.	P002
Processing	Smelting / Gold Room	Employees and contractors undertaking smelting or gold room operations.	P003
Processing	Processing Other	Employees and contractors undertaking surface processing tasks not otherwise classified.	P004
Processing	Surface Processing Plant	Employees and contractors involved in surface processing operations and inspection of screening or classification (wet or dry) processes, including size selection, solvent extraction, electro-winning, floatation, leaching, dewatering)	P005

Non-Coal Surface SEGs	SEG Name	Non-Coal Surface SEG Descriptions	Non-Coal: Surface SEG Code
Surface	Shift Supervisor / Managers	Employees and contractors performing inspection and monitoring tasks in the mining and excavation areas (e.g., manager and shift supervisors).	S001
Surface	Control Room / Weighbridge	Employees and contractors involved in control room or weighbridge operations.	S002
Surface	Mobile Plant Operators	Employees and contractors working in surface areas of a mine operating mobile equipment (e.g., haul trucks, loaders, dozers, graders, excavators, digger/shovel and water cart).	S003
Surface	Workshop Maintenance	Employees and contractors undertaking electrical and mechanical maintenance in the workshop. Includes servicing/maintaining vehicles in surface workshop.	S004
Surface	Mobile Maintenance	Employees and contractors undertaking electrical and mechanical maintenance activities on mobile plant equipment. Includes supplying fuel, grease and oil to mobile plant throughout the mine; and performing tyre handling, tyre fitting and tyre repair duties.	S005
Surface	Fixed Plant Maintenance	Employees and contractors undertaking electrical and mechanical maintenance activities on fixed plant. Includes supplying fuel, grease and oil to fixed plant.	S006

Non-Coal Surface SEGs	SEG Name	Non-Coal Surface SEG Descriptions	Non-Coal: Surface SEG Code
Surface	Boilermakers	Employees and contractors involved in steel fabricating, welding, oxy cutting, air gouging on surface or surface workshop.	S007
Surface	Conveyor Belts	Employees and contractors performing conveyor belt maintenance, splicing and commissioning.	S008
Surface	Drilling and Blasting	Employees and contractors undertaking blast hole drilling and blasting, including drill operators, charge up, firing the shot, blast clearance, exclusion zone management.	S009
Surface	Exploration Drilling	Employees and contractors undertaking exploration drilling operations (reverse circulation or diamond drilling).	S010
Surface	Stores / Warehouse	Employees and contractors undertaking store/warehousing activities, including forklift operation.	S011
Surface	Surface Other	Employees and contractors routinely performing any non-production tasks on a surface mine that are not adequately represented by any other SEG.	S012
Surface	Domestic Cleaners	Employees and contractors involved in the general domestic cleaning of internal and external buildings and structures (e.g. crib rooms, bathhouses, restrooms, office spaces and meeting rooms).	S013
Surface	Industrial Cleaners	Employees and contractors involved with heavy and light industrial cleaning of plant and equipment.	S014
Surface	Tech Services	Employees and contractors performing mine planning and design (includes surveyors, geotechnical engineers, hygienists, observers conducting tasks at surface operations).	S015
Surface	Groundskeeping	Employees and contractors maintaining grounds (e.g., gardens, lawns).	S016
Surface	Laundry	Employees and contractors operating an on-site laundry of work clothes, including handling and consignment of clothes to off-site laundry.	S017

Non-Coal Underground SEGs	SEG Name	Non-Coal Underground SEG Descriptions	Non-Coal: Underground SEG Code
Underground	UG Supervisor / Managers	Employees and contractors performing inspection and monitoring tasks in the underground mining and excavation areas (e.g., manager and shift supervisors).	U001
Underground	UG Mobile Plant Operators	Employees and contractors working in an underground mine operating mobile equipment (e.g., haul trucks, loaders/bogger, refuel/water carts, grader) for product movement and road maintenance.	U002
Underground	UG Workshop Maintenance	Employees and contractors undertaking electrical and mechanical maintenance and services predominantly in the underground workshop.	U003
Underground	UG Mobile Maintenance	Employees and contractors performing electrical and mechanical maintenance services underground including mechanical repairs and vehicle servicing underground.	U004

Non-Coal Underground SEGs	SEG Name	Non-Coal Underground SEG Descriptions	Non-Coal: Underground SEG Code
Underground	UG Fixed Plant Maintenance	Employees and contractors undertaking electrical and mechanical maintenance activities underground on fixed plant. Including supplying fuel, grease and oil to underground fixed plant throughout the mine.	U005
Underground	UG Drilling (Production & Exploration)	Employees and contractors performing production long hole, box hole or shaft sinking activities using rock machine drills; and exploration activities using diamond drilling.	U006
Underground	UG Charge Up	Employees and contractors undertaking charge up, firing shot and post blast clearance activities.	U007
Underground	UG Development Drilling	Employees and contractors, including nippers, involved in underground development face (Jumbo) drilling including blast pattern drilling, meshing and cable bolting.	U008
Underground	UG Conveyor Belts	Employees and contractors performing underground belt maintenance, splicing and commissioning.	U009
Underground	UG Boilermakers	Employees and contractors involved in steel fabricating, welding, oxy cutting air gouging in underground areas/underground workshop.	U010
Underground	UG Strata Stabilisation	Employees and contractors involved in strata stabilsation using cable bolting or injection.	U011
Underground	UG Service Installation	Employees and contractors performing installation or repair of underground services, including air and water lines, ventilation (ducting or secondary vent fans)	U012
Underground	UG Shotcreters	Employees and contractors performing shotcreting or fibrecreting underground. Includes agitator operator and spray mesh operator.	U013
Underground	UG Crushing / Milling / Processing	Employees and contractors involved in underground processing/crushing operations, including control room operations, clearing blockages, shovelling etc.	U014
Underground	UG Other	Employees and contractors routinely performing tasks in an underground mine that are not adequately represented by any other SEG.	U015
Underground	Paste Fill / Backfill	Employees and contractors routinely performing back fill of surface and underground voids and paste production.	U016

Coal mines

Coal - CHPP SEGs	SEG Name	Coal CHPP SEG Descriptions	Coal: CHPP SEG Code
CHPP	CHPP Production	Employees and contractors involved in control room operations, hosing, clearing blockages, shoveling, bobcat, general maintenance, and train loading out and stockpile dozer operators.	CP01

Coal - CHPP SEGs	SEG Name	Coal CHPP SEG Descriptions	Coal: CHPP SEG Code
CHPP	CHPP Maintenance	Employees and contractors undertaking electrical and mechanical maintenance throughout the plant and in the workshop.	CP02
CHPP	CHPP Laboratory	Employees and contractors taking samples and processing samples in CHPP laboratory.	CP03
CHPP	CHPP HME	Employees and contractors operating heavy mobile equipment (HME) such as stockpile dozer, loader, dump truck	CP04
CHPP	Conveyor Belts	Employees and contractors performing belt maintenance, splicing, and commissioning.	CP05
CHPP	CHPP Other	Employees and contractors performing any other tasks at the CHPP that are not adequately represented by any other SEG	CP06
CHPP	ROM HME	Employees and contractors operating heavy mobile equipment (HME) such as loaders / dozers around ROM not otherwise covered under CHPP activities. This may include loading and carting rejects	CP07
CHPP	CHPP Shutdown Maintenance	Employees and contractors involved in maintenance activities during major shutdowns of the CHPP	CP08

Coal - Open Cut SEGs	SEG Name	Coal Open Cut SEG Descriptions	Coal: Open Cut SEG Code
Open cut	Pre-strip and overburden removal	Employees and contractors working in pre-strip areas of the mine and operating equipment (e.g., haul trucks, loaders, dozers, graders and excavators).	CS01
Open cut	Coal Removal	Employees and contractors involved in the removal of product coal (e.g., digger/shovel, dump trucks).	CS02
Open cut	Open Cut Inspection Services	Employees and contractors performing inspection and monitoring tasks in the mining and excavation areas (e.g., OCE and shift supervisors).	CS03
Open cut	Road Maintenance	Employees and contractors involved in road maintenance operations, including grader and water truck.	CS04
Open cut	Boilermaker	Employees and contractors involved in steel fabricating, welding, oxy cutting air gouging — surface workshop and CHPP workshop.	CS05
Open cut	Field Maintenance	Employees and contractors undertaking electrical and mechanical maintenance activities predominantly in the mining areas other than a fixed workshop.	CS06
Open cut	Blast Crew	Employees and contractors undertaking blasting and shot firing duties.	CS07
Open cut	Tech Services	Employees and contractors performing mine planning and design (includes surveyors, geotechnical engineers).	CS08

Coal - Open Cut SEGs	SEG Name	Coal Open Cut SEG Descriptions	Coal: Open Cut SEG Code
Open cut	Exploration Drillers	Employees and contractors undertaking exploration drilling operations, including exploration geologists.	CS09
Open cut	Blast Hole Drillers	Employees and contractors undertaking blast hole drilling operations.	CS10
Open cut	Conveyor Belts	Employees and contractors performing belt maintenance, splicing, and commissioning.	CS11
Open cut	Warehousing	Employees and contractors undertaking stores/warehousing activities, including forklift operation.	CS12
Open cut	Administration	Employees and contractors performing administration officer duties, management, and security.	CS13
Open cut	Workshop	Employees and contractors undertaking electrical and mechanical maintenance and services predominantly in the workshop.	CS14
Open cut	Service Crew	Employees and contractors supplying fuel, grease, and oil to mobile plant throughout the mine.	CS15
Open cut	Tyre Fitters	Employees and contractors performing tyre handling, tyre fitting and tyre repair duties.	CS16
Open cut	Dragline	Employees and contractors operating or supporting dragline operations.	CS17
Open cut	Dozer Push	Employees and contractors operating in production dozing operations.	CS18
Open cut	Emergency Response Personnel	Employees and/or contractors whose principle responsible is supplying emergency response capability.	CS19
Open cut	Open Cut Other	Employees and contractors performing any other tasks at an open cut mine that are not adequately represented by any other SEG.	CS20
Open cut	Control Room Operator	Employees and contractors involved in control room operations. This includes those workers remotely operating automated equipment from within an enclosed control room environment	CS21
Open cut	Pump Crew	Employees and contractors performing pump crew activities such as polywelding, pump checks, operating backhoe, and other mobile equipment	CS22
Open cut	Highwall / Auger	Employees and contractors conducting highwall / auger mining operations such as operator, deckhand, and loader operations.	CS23
Open cut	Quarrying / Stone Crushing	Employees and contractors conducting crusher activities associated with an onsite quarry or as a by-product of coal mining activities such as non-coal mobile crusher activities	CS24
Open cut	Mobile / Bypass Crushing (Coal)	Employees and contractors conducting coal crushing activities using fixed and mobile crushers. This includes operation of loaders, dozers, and excavator within this area	CS25
Open cut	Civil Construction	Employees and contractors conducting civil construction projects such as concreting, road construction, earthworks, and surface infrastructure.	CS26
Open cut	Coal Haulage	Employees and contractors hauling coal from processing plants to load out facilities.	CS27

Coal - Open Cut SEGs	SEG Name	Coal Open Cut SEG Descriptions	Coal: Open Cut SEG Code
Open cut	Rehabilitation	Employees and contractors operating heavy mobile equipment for mine environmental rehabilitation and remediation	CS28
Open cut	Surface Coating / Preparation	Employees and contractors involved in surface preparation, abrasive blasting, surface coating / painting.	CS29
Open cut	Domestic Cleaners	Employees and contractors involved in the general domestic cleaning of internal and external buildings and structures (e.g., crib rooms, bathhouses, restrooms, office spaces and meeting rooms).	CS30
Open cut	Industrial Cleaners	Employees and contractors involved with heavy and light industrial cleaning of plant and equipment.	CS31
Open cut	Groundskeeping	Employees and contractors maintaining grounds (e.g., gardens, lawns).	CS32
Open cut	Shutdown Maintenance	Employees and contractors involved in maintenance activities during major shutdowns of plant.	CS33

Coal - Underground SEGs	SEG Name	Coal Underground SEG Descriptions	Coal: Underground SEG Code
Underground	Longwall production (Uni-di)	Employees and contractors who operate or rotate through the following tasks: operating shearer (tailgate or maingate); operating maingate drive; operating chocks / shields and performing inspections and statutory duties.	CU01.1
Underground	Longwall production (Bi-di)	Employees and contractors who operate or rotate through the following tasks: operating shearer (tailgate or maingate); operating maingate drive; operating chocks / shields and performing inspections and statutory duties.	CU01.2
Underground	Development production (Cont. Mining and Bolting)	Employees and contractors operating as a continuous miner, operating a shuttle car or ram car, undertaking roof and rib bolting, hanging hoses, handling cables, hanging vent tubes, performing belt extensions, hanging brattice and performing inspections and statutory duties.	CU02.1
Underground	Development production (Place Change)	Employees and contractors operating as a continuous miner, operating a shuttle car or ram car, undertaking roof and rib bolting, hanging hoses, handling cables, hanging vent tubes, performing belt extensions, hanging brattice and performing inspections and statutory duties.	CU02.2
Underground	Development production (Pillar Extraction)	Employees and contractors operating as a continuous miner, operating a shuttle car or ram car, undertaking roof and rib bolting, hanging hoses, handling cables, hanging vent tubes, performing belt extensions, hanging brattice and performing inspections and statutory duties.	CU02.3

Coal - Underground SEGs	SEG Name	Coal Underground SEG Descriptions	Coal: Underground SEG Code
Underground	Underground Maintenance	Employees and contractors performing mechanical maintenance services underground; performing electrical maintenance underground; undertaking mechanical repairs and vehicle servicing underground.	CU03
Underground	Outbye Supplies	Employees and contractors delivering supplies to underground locations on LHDs, juggernauts and personnel transporters. This includes waste management activities.	CU04
Underground	Longwall Move	Employees and contractors operating dozers, LHDs, driftrunners performing face retraction and installation, or involved in the face retraction/installation including fitters, electricians, and mine technicians.	CU05
Underground	Outbye Construction / Infrastructure	Employees and contractors performing roadwork construction and maintenance underground; installing/removing infrastructure underground including hoses, cables, lights, and pipe work; shotcreting and concreting underground.	CU06
Underground	VCD Installer	Employees and contractors spraying stoppings, and using jackhammer, and conducting VCD removal tasks.	CU07
Underground	ERZ Controller	Employees and contractors performing inspections and statutory duties in returns and outbye locations.	CU08
Underground	Belt Splicers	Employees and contractors performing belt maintenance, splicing, and commissioning.	CU11
Underground	Resin Worker	Employees and contractors undertaking resin injection and void filling activities throughout the underground workings. This includes the use of polyurethane resins (PUR) and phenolic resins.	CU14
Underground	Stone Drivage	Employees and contractors involved in mining through stone, faults and intrusions (e.g., for mine expansion or drift construction). Does not include development or longwall workers who encounter small areas of faulted ground or stone banding.	CU15
Underground	Secondary Support	Employees and contractors undertaking secondary support tasks including bolting; building cogs; standing cans; building bulkheads; injecting cementitious products (grout).	CU16
Underground	Gas Drainage	Employees and contractors undertaking gas drainage tasks underground.	CU17
Underground	Shift Co-ordinator / Management	Shift or section coordinators and under managers who undertake inspections and supervisory tasks. This includes a mixture of underground and surface activities.	CU18
Underground	Production Support /	Employees and contractors undertaking longwall support and development support activities. This may include some	CU19

Coal - Underground SEGs	SEG Name	Coal Underground SEG Descriptions	Coal: Underground SEG Code
	Bullgang	minimal coal winning activities within their work period (e.g., straightening shear, bolting unsupported ground etc).	
Underground	Returns	Employees and contractors routinely undertaking maintenance, construction, service recovery, secondary support, stone dusting and services extension/retractions activities in return airways.	CU20
Underground	Underground Other	Employees and contractors routinely performing any underground non-production tasks underground that are not adequately represented by any other SEG.	CU22
Underground	Industrial Cleaners	Employees and contractors involved with heavy and light industrial cleaning of plant and equipment	CU28
Underground	Remote Mining Operations	Employees and contractors involved in the continuous remote method of mining of consecutive unsupported plunge cuts extending from pre-developed gate roads under controlled conditions. This includes remote guidance, horizon control, gas monitoring and incorporating a high level of automation functionality	CU29

Coal - Underground (Surface) SEGs	SEG Name	Coal Underground (Surface) SEG Descriptions	Coal Underground (Surface) SEG Code
Underground (Surface)	Surface Maintenance	Employees and contractors undertaking electrical and mechanical maintenance and services predominantly in the workshop.	CU09
Underground (Surface)	Control Room Operator	Employees and contractors involved in control room operations. This includes those workers remotely operating equipment from within an enclosed control room environment.	CU10
Underground (Surface)	Boilermaker	Employees and contractors involved in steel fabricating, welding, oxy cutting, air gouging — surface workshop and CHPP workshop.	CU12
Underground (Surface)	Administration	Employees and contractors undertaking administration and security activities on the surface, who are not directly involved in mining related activities	CU13
Underground (Surface)	Surface Other	Employees and contractors performing any other tasks on the surface of an underground mine that are not adequately represented by any other SEG.	CU21
Underground (Surface)	Gas Drainage Surface	Employees and contractors undertaking gas drainage tasks on the surface	CU23

Coal - Underground (Surface) SEGs	SEG Name	Coal Underground (Surface) SEG Descriptions	Coal Underground (Surface) SEG Code
Underground (Surface)	Drilling Other	Employees and contractors undertaking surface to seam drilling operations at an underground coal mine for the purpose of boreholes, shafts, and services.	CU24
Underground (Surface)	Warehousing	Employees and contractors undertaking surface warehousing activities including forklift operation.	CU25
Underground (Surface)	Tech Services	Employees and contractors performing mine planning and design (includes surveyors, geotechnical engineers, ventilation officers, hygienists, observers conducting tasks underground).	CU26
Underground (Surface)	Domestic Cleaners	Employees and contractors involved in the general domestic cleaning of internal and external surface buildings and structures (e.g., crib rooms, bathhouses, restrooms, office spaces and meeting rooms).	CU27

Appendix B – Definitions and Acronyms

Definitions

Acceptable SEG exposure	**Exposure monitoring results for a Similar Exposure Group (SEG), are shown to conform to the Workplace Exposure Limit.**
Airborne contaminant Principal Hazard Management Plan	A safety management system document that sets out how the mine operator will manage risks associated with airborne contaminants at the mine and provide for compliance with requirements of the WHS laws that relate to airborne contaminants. The document contains the control measures, exposure monitoring, health monitoring and review requirements used to manage the risks of air quality and dust.
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 the front of the face and measured from the mid-point of a line joining the ears
Competent person	A competent person is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.
Critical controls	A control that is crucial to preventing the event or mitigating the consequences of the event, and/or a control that prevents more than one unwanted event or mitigates more than one consequence (ICMM).
Dust control zones	Areas within a mine designated as requiring higher order dust controls due to the risk of high dust exposure.
High dust exposure areas	Those areas within a mine that have actual or probable exposure to dust generation above workplace exposure limits
High dust-generating tasks	Refers to tasks performed at a mine that have been found to have high exposure to dust, which have been identified through monitoring results at the site or other means
Higher order controls	Refers to control measures that are higher on the hierarchy of controls, such as elimination, substitution, or engineering; administrative and personal protective equipment are considered the lowest forms of control
Interim control	Refers to the use of a control measure designed to temporarily reduce exposure to dust. Often a lower order control such as personal protective equipment or administrative controls (e.g., task rotation)
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
May	The use of the word "may" indicate that an action is undertaken or not undertaken at discretion

Acceptable SEG exposure	**Exposure monitoring results for a Similar Exposure Group (SEG), are shown to conform to the Workplace Exposure Limit.**
Must	The use of the word "must" directs a regulatory action to be undertaken
Respirable Crystalline Silica (RCS)	The terms respirable crystalline silica and crystalline silica are used interchangeably and represents the very fine particles generated when the solid form of crystalline silica is processed through cutting, sanding, drilling or other activities which create a fine dust.
Respirable dust	Dust particles that are less than 10 microns in size and, when inhaled, are retained in the gas exchange region of the lungs
Risk assessment	The overall process of risk analysis and risk evaluation as determined in accordance with AS ISO 31000:2018, *Risk management—guidelines*
Should	The use of the work "should" is a recommended action that is undertaken or not undertaken at discretion
Unacceptable SEG Exposure	Exposure monitoring results for a Similar Exposure Group (SEG), are not shown to conform to the Workplace Exposure Limit.
WEL	Workplace Exposure Limit (replaces Workplace Exposure Standard). 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
WHS Regulation	Work Health and Safety Regulation 2017
WHS (MPS) Regulation	Work Health and Safety (Mines and Petroleum Sites) regulation 2022

Acronyms

ACGIH	**American Conference of Governmental Industrial Hygienists**
AIOH	Australian Institute of Occupational Hygienists
CHPP	Coal Handling & Processing Plant
COH	Certified Occupational Hygienists
GSD	Geometric standard deviation
HVAC	Heating, Ventilation, and Air Conditioning

ACGIH	**American Conference of Governmental Industrial Hygienists**
HEPA	High Efficiency Particulate Air (filter)
LEV	Local Exhaust Ventilation
LOR	Limit of Reporting
LOQ	Limit of Quantification
NIOSH	National Institute of Occupational Safety and Health
MAIOH	Member Australian Institute of Occupational Hygienists
MU	Measurement Uncertainty
PAPR	Powered Air Purifying Respirator
PSD	Particle Size Distribution
RPE	Respiratory Protective Equipment
SEG	Similar Exposure Group
SMS	Safety Management System
UCL	Upper Confidence Limit
WEL	Workplace Exposure Limit (replacing the current Workplace Exposure Standard from December 2026 – used to represent both in this document)
TARP	Trigger Action Response Plan
TRG	Technical Reference Guide

Appendix C – Standards and references

Standards

AS 2985:2009 - Workplace Atmospheres—Method for sampling and gravimetric determination of respirable dust

AS 3640:2009 - Workplace Atmospheres—Method for sampling and gravimetric determination of inhalable dust

AS 4260:1997 - High efficiency particulate air (HEPA) filters — Classification, construction and performance

AS ISO 31000:2018 - Risk management - guidelines

AS ISO/IEC 17025:2018 - General requirements for the competence of testing and calibration laboratories

AS/NZS 1715:2009 - Selection, use and maintenance of respiratory protective equipment

AS/NZS 1716:2012 - Respiratory protective devices

AS/NZS 60335.2.69:2017 - Household and similar electrical appliances – Safety, Part 2.69: Particular requirements for wet and dry vacuum cleaners, including power brush, for commercial use

AS/NZS ISO 23875:2023 - Mining - Air quality control systems for operator enclosures - Performance requirements and test methods,

BSEN 1822-1:2019 - High efficiency air filters (EPA, HEPA, and ULTA), Part 1: Classification, performance, testing, marking

EN689:2018 Workplace exposure - Measurement of exposure by inhalation to chemical agents - Strategy for testing compliance with occupational exposure limit values

ISO 10263-4:2009 - Earth-moving machinery - Operator enclosure environment - Part 4: Heating, ventilating and air conditioning (HVAC) test method and performance.

ISO 16258-1:2015 - Workplace Air – Analysis of respirable crystalline silica by X-ray diffraction. Part 1: Direct-on-filter method.

Resources Regulator

Code of practice – Safety management systems in mines (2015)

Guide - Preparing a principal hazard management plan (September 2022)

Guide – Airborne contaminants principal hazard management plan (July 2018)

Guide - Managing risks in mining and petroleum operations (2022)

Guide - Health control plan (2024)

Guide - Contractors and other businesses at mines and petroleum sites (2024)

Position Paper – Preventing worker exposure to respirable crystalline silica

SafeWork Australia

Guidance on the interpretation of workplace exposure limits for airborne contaminants (2024)

SafeWork NSW

NSW Code of practice: Work health and safety consultation, cooperation and coordination (2022)

Queensland Department of Natural Resources – Resources Safety and Health

Recognised Standard 14 - Monitoring respirable dust in coal mines (2021)

Recognised Standard 15 – Underground respirable dust control (2017)

Recognised Standard 20 – Dust control in surface mines (2019)

QGL02 – Guideline for management of respirable dust in Queensland mineral mines and quarries (2021)

Australian Institute of Occupational Hygienists (AIOH)

AIOH - Occupational Hygiene Monitoring and Compliance Strategies (2019)

AIOH - Simplified Occupational Hygiene Risk Management Strategies (AIOH, 2020)

American Conference of Governmental Industrial Hygienists (ACGIH)

American Conference of Governmental Industrial Hygienists (2013) *Industrial Ventilation: A manual of recommended practice for design, 31st Edition*, ACGIH®, Cincinnati.

American Industrial Hygiene Association (AIHA)

AIHA - A strategy for assessing and managing occupational exposures 4th edn. (2006)

British Occupational Hygiene Society (BOHS)

BOHS NVvA - Testing Compliance with Occupational Exposure Limits for Airborne Substances (2022)

National Health and Medical Research Council (NHMRC)

National Health and Medical Research Council (NHMRC) Methods for measurement of quartz in respirable airborne dust by infrared spectroscopy and x-ray diffractometry (1984).

National Institute of Occupational Safety and Health (NIOSH)

NIOSH Occupational Exposure Sampling Strategy Manual (1977)

NIOSH Dust Control Handbook for Industrial Minerals Mining and Processing (2019)

NIOSH Method 7602 Silica, respirable crystalline by infrared (IR) (KBr pellet) (2017)

NIOSH Method 7603 Quartz in coal mine dust, by IR (redeposition) (2017)

NIOSH Best Practices for Dust Control in Coal Mining (2021)

UK Health and Safety Executive (HSE)

HSE 2015 - Crystalline Silica in Respirable Airborne Dust: Direct-on-Filter Analyses by Infrared Spectroscopy or X-Ray (MDHS101/2).

HSE Local Exhaust Ventilation

HSE Measurement Method – Exposure Measurement: Air Sampling, COSHH Essentials General Guidance G409 (2022).

Occupational Hygiene organisations

American Conference of Governmental Industrial Hygienists (ACGIH)

American Industrial Hygiene Association (AIHA)

Australian Institute of Occupational Hygienists (AIOH)

Coal Services

NSW Standing Dust Committee – Dust Control References and Resources

Other Information:

International Council on Mining and Metals (ICMM) Good Practice Guide on Occupational Health Risk Assessment (2016)