NSW Resources
Resources Regulator

Guide

Airborne contaminants principal hazard management plan

Guidance for the NSW mining and petroleum industries

September 2024

Published by the Department of Primary Industries and Regional Development

Title: Airborne contaminants principal hazard management plan

First published: July 2018

Department reference number: MEG/DOC18/430148

More information

Authorised by: Chief Compliance Officer – Resources Regulator

Amendment schedule		
Date	Version	Amendment
31 July 2018	1	First published
9 September 2022	2	Revision
September 2024	3	Full review and template update

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1. Introduction

Airborne contaminant means a contaminant in the form of a fume, mist, gas, vapour or dust and includes microorganisms. An airborne contaminant of this type is a potentially harmful substance that is either not naturally in the air, or is present in an unnaturally high concentration, and to which workers may be exposed in their working environment[1].

The most common airborne contaminants are dusts that can be generated through mining activities such as extraction, drilling, crushing, hauling and stockpiling of coal and other rock containing minerals. In coal mining, coal dust appears in both inhalable and respirable fractions. Crystalline silica dust can also occur at both an inhalable and respirable fraction at operations in all sectors.

Normally dust of the larger inhalable fraction is considered an irritant as it is deposited in the upper respiratory tract. At the smaller respirable fraction (< 5 microns diameter), these dust contaminants can represent a serious health risk to those exposed.

The smaller sized particles can penetrate the lower regions of the lung where gas exchange takes place. Respirable dust such as coal and silica dusts can cause pneumoconiosis (in the case of coal) or silicosis (in the case of crystalline silica). Both conditions are disabling and can lead to early death.[2]

Other airborne contaminants such as diesel exhaust emissions and welding fumes are also present in mining and can cause lung disease.

A principal hazard management plan (PHMP) is an important tool for establishing a systematic way to manage the risk of airborne contaminants as part of the overall safety management system for the mine.

1.1. What is an airborne contaminants principal hazard management plan?

A principal hazard management plan (PHMP) forms part of the safety management system (SMS) for a mine. Airborne contaminants are identified as a principal hazard in Schedule 1 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHSMPS Regulation). The PHMP is a document that sets out how the mine operator will manage risks associated with airborne contaminants at the mine.

WHSMPS Regulation 2022

s 28 - Preparation of principal hazard management plan

The operator of a mine or petroleum site must prepare a principal hazard management plan for each principal hazard associated with mining operations or petroleum operations at the mine or petroleum site in accordance with this clause and Schedule 1.

Schedule 1 Part 2 s 8 - Air quality or dust or other airborne contaminants

[1] Workplace Exposure Standards for Airborne Contaminants. – SafeWork Australia – 2018 (WESFAC) (www.safeworkaustralia.gov.au/doc/workplace-exposure-standards-airborne-contaminants)

[2] The National Institute of Occupational Safety and Health (NIOSH) Respirable dust. - www.cdc.gov/niosh/mining/topics/RespirableDust.html

The following matters must be considered in developing the control measures to manage the risks of air quality or dust or other airborne contaminants:

(a) the types of dust and other chemical and biological contaminants likely to be in the air from both natural sources, including naturally occurring asbestos, and introduced sources,

(b) the levels of oxygen, dust and other contaminants in the natural or supplied air of a mine,

(c) the temperature and humidity of the air,[3]

(d) the length of exposure, having regard to extended shifts and reduced recovery periods.

1.2. Who has duties in relation to the PHMP?

Under the *Work Health and Safety Act 2011* (WHS Act), a person conducting a business or undertaking has the primary duty to ensure, so far as is reasonably practicable, workers and other people are not exposed to health and safety risks arising from the business or undertaking. This duty includes eliminating exposure to airborne contaminants, so far as is reasonably practicable, for example, better engineering solutions that eliminate airborne contaminants.

The operator of a mine must prepare a PHMP if airborne contaminants are a risk at the mine.

1.3. What needs to be included in the PHMP?

The PHMP must set out how the mine operator will manage the risks associated with airborne contaminants at the site. In so doing, it should provide for compliance with any requirements of the WHS laws that relate to airborne contaminants.

The matters that must be addressed in the PHMP are set out in Schedule 1 of the WHSMPS Regulation. The plan must include the following:

- types of contaminants in the air (dusts, fumes, gas, mist)
- workers' shift length
- personal airborne contaminant exposure monitoring (baseline data and ongoing monitoring as necessary)
- control and suppression of airborne contaminants
- periodic review and revision
- auditing and program review.

The operator needs to produce the PHMP in the context of the safety management system (SMS) so that it relates to other PHMPs and principal control plans (PCPs), or processes and procedures, that rely on the PHMP as a control. This helps to prevent gaps and identify overlaps in processes and information where it relates to air quality, or where air quality may impact on other PHMPs and PCPs.

The PHMP must include the risk assessment for air quality. This provides the framework for initial and ongoing assessment of workers' exposure to airborne contaminants.

Further information on what to consider for inclusion in the PHMP is at Appendix 8.3.

[3] Temperature and humidity will not be covered specifically in this document. There are occupational exposure standards for temperature and humidity.

1.3.1. Monitoring

Schedule 2, 1(c) WHSMPS Regulation, requires health control plans to include "monitoring of the existence of the health hazards associated with mining operations…"

Schedule 2, 1(c) WHSMPS Regulation also goes on to require monitoring of "..the exposure of workers to those hazards".

1.3.2. Personal exposure sampling or monitoring

Personal airborne contaminant monitoring measures the level of airborne contaminant exposure on a particular working day (such as inhalable dust, respirable dust, respirable crystalline silica, diesel exhaust emissions, welding fume etc). It involves workers being fitted with sampling equipment and monitored while they carry out their usual duties.

The sampling takes place over a full shift, or a representative sample thereof, and can determine the levels of exposure to airborne contaminants in a worker's breathing zone (within 30cm radius of workers nose and mouth). As exposure standards are based on an eight-hour shift, adjustments for extended working hours will be required.

Personal exposure monitoring provides information to assist in determining whether workers are being exposed to harmful levels of contaminants, or if the measures in place to control exposure to that hazard are working effectively. This provides useful information in terms of assessing exposure levels associated with particular jobs on site.

Monitoring does not replace the need for implementing controls that reduce airborne contaminant exposure in the workplace or other measures designed to reduce risk.

A prescribed exposure standard represents the airborne concentration of a particular substance or mixture that must not be exceeded.

To find out if a substance has a prescribed exposure standard, you can search the Safe Work Australia Hazardous Chemical Information System (HCIS) or consult the Workplace Exposure Standards for Airborne Contaminants document on the Safe Work Australia website. This document provides a list of exposure standards.

Under clause 50 of the Work Health and Safety Regulation 2017 (WHS Regulation), a PCBU at a workplace must ensure that air monitoring is carried out to determine the airborne concentration of a substance or mixture in the workplace to which an exposure standard applies if:

(a) the person is not certain on reasonable grounds whether or not the airborne concentration of the substance or mixture at the workplace exceeds the relevant exposure standard, or

(b) monitoring is necessary to determine whether there is a risk to health.

1.3.3. Static dust sampling or monitoring

Involves sampling units being strategically placed around the workplace, particularly in areas of concern (high contaminant concentration). This method of sampling or monitoring can be:

- useful in determining levels in less frequented areas where contaminants may be of concern
- used to assess effectiveness of introduced controls.

Refer to Appendix 8.4 for commonly accepted sampling methods.

1.3.4. Health monitoring

Health monitoring is a way to check if the health of workers is being harmed from exposure to hazards while carrying out work and aims to detect early signs of ill-health or disease.

Health monitoring is used to ensure that the controls in place are effective, and that airborne contaminants are not causing an adverse effect on the health of workers (WHS Reg, Division 6).

Health monitoring does not replace the need for control measures to minimise or prevent exposure.

A review of controls is needed if health monitoring indicates that the controls are not effective.

Under the WHS Regulation (cl 368) a PCBU must ensure that health monitoring is provided to a worker carrying out work for the business or undertaking if:

(a) the worker is carrying out ongoing work at a workplace using, handling, generating or storing hazardous chemicals and there is a significant risk to the worker's health because of exposure to a hazardous chemical referred to in Schedule 14, Table 14.1, Column 2, or

(b) the person identifies that because of ongoing work carried out by a worker using, handling, generating or storing hazardous chemicals there is a significant risk that the worker will be exposed to a hazardous chemical (other than a hazardous chemical referred to in Schedule 14, Table 14.1) and either:

  (i) valid techniques are available to detect the effect on the worker's health, or

  (ii) a valid way of determining biological exposure to the hazardous chemical is available and it is uncertain, on reasonable grounds, whether the exposure to the hazardous chemical has resulted in the biological exposure standard being exceeded.

Health monitoring must be carried out, or supervised by, a registered health practitioner who has sufficient knowledge, skills and experience in the appropriate techniques and procedures, including interpretation of result (WHS Regulation cl 371).

Safe Work Australia (SWA) has a range of guidance materials in relation to health monitoring, which can be found on the SWA website (www.safeworkaustralia.gov.au).

1.3.5. Common airborne contaminants and their effects

The table below shows common airborne contaminants and their effects. It is provided to assist operators with assessing risks arising from air quality. The list is not exhaustive.

Exposure can be categorised into two types:

- acute exposure - is short-term exposure to a hazard that affects worker health. Acute health effects happen quickly, are usually identified easily and can be serious in nature.
- chronic exposure - is long-term exposure, usually over several years, which can cause serious long-term health effects.

Airborne contaminants	Health effects	Exposure
Asbestos	Health effects associated with asbestos exposure include respiratory diseases, such as asbestosis (lung fibrosis), lung cancer and mesothelioma (cancer of the mesothelium).	Chronic

Airborne contaminants	Health effects	Exposure
	Asbestos can be found in building materials, pipe and boiler lagging. It might be in insulation materials, gaskets and friction materials including clutch and brake linings. Any activity that breaks up or disturbs geological material can also disturb and release naturally occurring asbestos if it is present. The WHS Regulation (Chapter 8) specify how to manage asbestos and associated risks. PCBUs must make sure that exposure to airborne asbestos (including naturally occurring asbestos) is eliminated so far as is reasonably practicable. If it is not reasonably practicable, they must minimise exposure so far as is reasonably practicable.	
Blasting fumes	Exposure to the fumes in a blast plume is usually very brief – seconds to minutes. For most people, any health effects from exposure to a blast plume are short lived. Symptoms from high levels of exposure might include: • eye, nose and throat irritation and coughing • dizziness and headache • shortness of breath • wheezing or exacerbation of asthma. Serious lung inflammation has been known to develop several hours after exposure to very high levels of nitrogen dioxide.	Acute
Coal dust	Inhalation of respirable coal dust can lead to serious respiratory disease including coal mine workers' pneumoconiosis and progressive fibrosis. These diseases can take many years to develop, but in the shorter term a reduction in lung function can also occur due to chronic obstructive pulmonary disease (COPD).	Chronic
Diesel exhaust emissions	Short-term acute symptoms include headaches, dizziness, light-headedness, nausea, coughing, difficult or laboured breathing, tightness of chest and irritation of the eyes, nose and throat. Long-term exposures can lead to chronic, more serious health problems such as cardiovascular disease, cardiopulmonary disease, and lung cancer. Diesel exhaust emissions have been classified as a human carcinogen.	Acute Chronic
Gases	Contaminant gases can present an acute or chronic health risk, or both. Acute health effects can include irritation and asphyxiation. Irritation can be mild to severe (e.g. mild irritation of the eyes, nose and throat, to severe damage to the lungs). Asphyxiation can occur either by the displacement of oxygen from the air (called simple asphyxiants such as carbon dioxide and nitrogen), or by interference with the body's ability to transport oxygen (called chemical asphyxiants, such as carbon monoxide and hydrogen cyanide). Chronic health effects from exposure to gases and vapours can include target organ effects (e.g. cardiac and central nervous system effects). Due to the radioactive properties of radon gas, it can have long term health effects on people after exposure. They release alpha radiation, or alpha particles, into the atmosphere. When radon decay	Acute Chronic

Airborne contaminants	Health effects	Exposure
	products are inhaled, they can damage the lungs, and lead to lung cancer.	
Legionella	Inhalation of mists containing the bacteria can cause Legionnaires disease, a potentially fatal respiratory disease, or the less severe Pontiac fever. In mining, the main risk areas for the growth of and exposure to Legionella bacteria are cooling towers or water treatment plants.	Acute
Man-made vitreous fibres (MMVFs)	Health effects from working with MMVFs include skin, eye and upper respiratory tract irritation. Ceramic fibres can possibly cause cancer however, glass fibre, rock wool and slag wool are not classified as carcinogenic to humans.	Acute Chronic
Metal dust	Different metals give rise to different health effects, but can include: lung disease, such as pneumoconiosis (e.g. siderosis from iron exposure); chronic obstructive pulmonary disease; occupational asthma; cancer; target organ toxic effects (e.g. on the liver or kidney); or adverse skin effects (e.g. allergic contact dermatitis from skin contact with nickel metal).	Chronic
Respirable crystalline silica (RCS)	Short term acute symptoms include: • respiratory irritation, • shortness of breath, and • asthma like symptoms. Prolonged exposure to respirable crystalline silica can cause the serious and disabling respiratory disease, known as silicosis (a condition due to scarring of the lung). Exposure to RCS has also been linked to: • chronic obstructive pulmonary disease (COPD), also known as chronic bronchitis or emphysema • lung cancer • kidney disease. A health condition caused by exposure might have no symptoms at the outset. The acute symptoms listed above may indicate early signs of a more serious health issue. These symptoms worsen over time and can develop into a serious respiratory disease.	Acute Chronic (could be as short as 5 years if high exposure)
Vapours and mists	Health effects of vapours vary depending on the substance. Organic solvents are associated with central nervous system effects, some of which can target specific organs. • Mercury poisoning can result from both acute and chronic exposures. High mercury vapour concentrations can cause upper respiratory tract irritation and severe lung damage. At low vapour concentrations over a long time, neurological disturbances, memory problems, skin rash, and kidney abnormalities can occur.	Acute Chronic

Airborne contaminants	Health effects	Exposure
	• Xanthates can liberate carbon disulphide, which is flammable and can cause peripheral and central nervous system effects, and inflammation of the optic nerve. • Di-isocyanates, such as TDI, MDI and HDI, are potent respiratory sensitisers causing occupational asthma and reduced lung function. → Some vapours and mists can also cause adverse skin reactions due to irritation, corrosion or allergy. Safety data sheets should be consulted for information on health risks. Read product safety data sheets for information on health risks.	
Welding fumes	The health effects of welding fumes and gases depend on their composition. They can include metal fume fever (a short-term painful ailment with symptoms of fever and chills), chronic obstructive lung disease, pneumoconiosis (lung disease due to accumulation of mineral or metallic particles), occupational asthma, and irritation of the eyes and respiratory tract. Welding fumes have been classified as a human carcinogen.	Acute Chronic

1.4. Interaction with other plans

All mining operations must have a documented SMS. A PHMP is an essential part of the SMS.

The SMS must:

- develop, document, implement and maintain the SMS
- interact with other PHMP and PCPs
- make sure the SMS is easily understood and used by all workers
- engage with workers when preparing and reviewing the SMS.

Figure 1: Safety management system elements.

1.5. Does the PHMP need to be documented?

The PHMP must be documented and expressed in a way that can be readily understood by the people who use it. This may require technical content for certain workers and non-technical content for others. Section 28 of the WHSMPS Regulation provides for matters to be considered in the preparation of the PHMP.

PHMP documentation should be version controlled. The document may be kept in an electronic or paper form, or combination of both, however the most up to date version must be easily accessible to all workers.

In accordance with section 106(3) of the WHSMPS Regulation, the PHMP, as with all PHMPs, must be readily accessible to all workers at the mine.

1.6. Exclusions

Explosive gases, such as methane, should be addressed through the fire and explosion principal hazard management plan.

2. Preparing the PHMP

Before writing the PHMP, the mine operator should consider how the PHMP is to be prepared, implemented and integrated with other plans. The operator must ensure the development and review of the PHMP be undertaken by, or under the supervision of, a competent person. The preparation and review must also involve consultation with relevant workers.

Before a PHMP is prepared, the mine operator should consider the matters below:

- relevant information
- nature and complexity of operation
- intended audience
- identification of airborne contaminants
- existing plans or procedures and generic documentation
- any legacy monitoring data.

A PCBU must eliminate risks to health and safety, so far as reasonably practicable. There needs to be systems in place to:

- identify hazards (appraise risks) at the mining operation
- assess the risks of injury or ill-health to workers from the hazards
- identify the controls required to manage that risk.

The risk appraisal might identify principal hazards. These are hazards that can create a risk of multiple fatalities in a single accident, or a series of recurring accidents, at the mining operation.

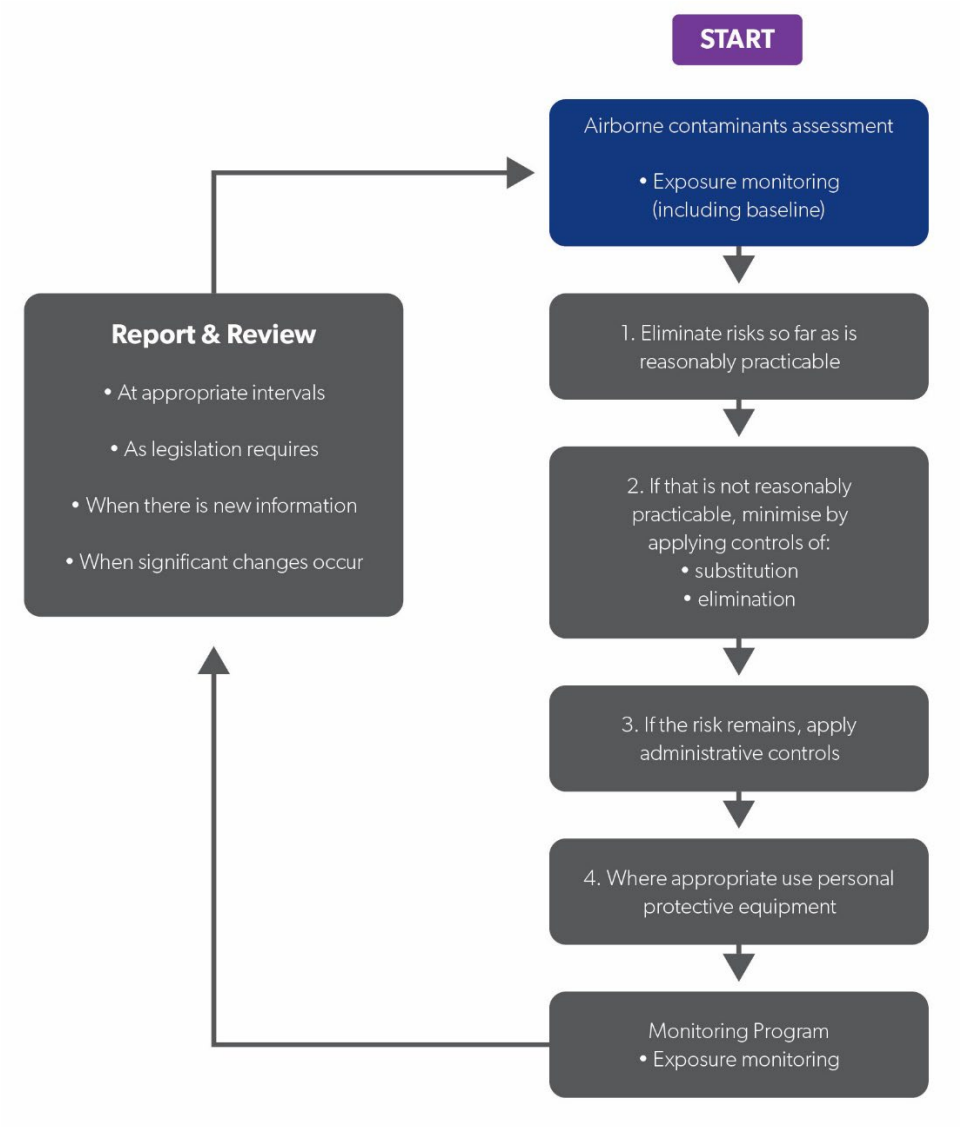
Unless hazards are identified and risks assessed properly, no amount of risk management will ensure a safe place and system of work. Unidentified hazards and risks can lead to serious consequences.

The operator must, as far as is reasonably practicable, consult with workers on matters that relate to work, health and safety that are or likely to be directly affected (section 47 WHS Act), which includes the preparation, review and amendment of a PHMP. This requirement includes consultation with health and safety representatives and/or health and safety committees where applicable.

In the case of a coal mine, the site safety and health representative (SSHR) and the industry safety and health representative (ISHR) must be consulted.

General guidance on the duty to consult under the WHS Act can be found in the NSW Code of Practice: Work health and safety consultation, cooperation and coordination (SafeWork Australia) and for mines specifically the NSW code of practice: Safety management systems in mines (Resources Regulator).

Figure 2: Health and safety management system overview



The operator must ensure that the initial baseline data matches actual conditions once the mining or activities commence, and that no additional contaminants are present. This should be done by maintenance or campaign monitoring or benchmark studies of the operation.

Consideration should be given to the impact of weather conditions on air quality. Temperature, wind speed and direction, and air pressure can all affect the movement of air and contaminants.

If the initial risk appraisal identifies air quality as a hazard or principal hazard, operators need to carry out an air quality risk assessment.

3. Assessment sampling and monitoring

3.1. Identifying hazards

The PHMP must set out how the mine operator will manage the risks associated with airborne contaminants at the mine in accordance with section 14 of the WHSMPS Regulation.

Operators need to ensure there are processes in place for the timely collection of appropriate information to identify risks arising from air quality at the mining operation. Involvement by a competent person, such as a suitably qualified occupational hygienist, when identifying risks arising from air quality is needed. Risk identification and assessment should also involve a team of workers with a range of expertise and experience, including health and safety representatives.

It should be noted that likely contaminants and their effects vary depending on the:

- size and type of operation
- activities carried out
- controls in place.

Mine operations need to identify potential sources of airborne contaminants as early as possible, normally during the design and development process, as well as on an ongoing basis.

Mine operators should proactively identify sources of airborne contaminants using:

- exploration drilling
- soil and rock sampling to determine the minerology
- information about mining methodologies and equipment used
- information about ore processing and equipment used.

The table below shows common mining activities and associated airborne contaminants. It is not an exhaustive list, additional activities specific to the individual mine site should also be considered.

Mine activity or feature	Potential airborne contaminant
The excavation, processing or transportation of natural resources including sand, rock, coal and metals, including: • excavating • drilling • blasting • crushing or transporting broken up material • conveying • screening • storage (i.e. wind picking up dust) • load-out	These activities can also disturb and release: • respirable crystalline silica • naturally occuring asbestos • gases • inhalable and respirable dust • dust sulphides • dust containing heavy metals. These activities can also use hazardous chemicals: • diisocyanates (from roof bolting)

Mine activity or feature	Potential airborne contaminant
• sanding and/or sandblasting	• trichloroethylene and toluene are both inhalable and absorbed through the skin (from conveyor repairs)
Blasting in shafts and on the surface	Explosive fumes containing hazardous gases including: • carbon monoxide • oxides of nitrogen, including nitric oxide and nitrogen dioxide • hydrogen sulphide • sulphur dioxide • ammonia. The amount of gases produced depends on: • the type of explosives used • confinement and age of explosives • contamination of explosives with water or drill cuttings.
Coal mining	Coal mining produces coal dust when coal is broken from a seam, and crushed, screened, conveyed, stored and transported. It contains a range of elements and their sulphides, the composition varies from seam to seam.
Cooling towers, water treatment plants, water cart mist sprays, and dust suppressing sprays	Growth of, and exposure to, Legionella bacteria, thermal tolerant coliforms, E Coli, etc
Metal processing plants	Chemical extraction methods can produce a range of vapours, gas and dust depending on the process used and rock type, including: • mercury • nitric acid fumes • inorganic lead concentrates • arsenic • reagents such as methyl isobutyl carbinol and xanthates, used in flotation • hydrogen cyanide, from the accidental mixing of cyanide salts and acids. • corrosive materials such as hydrated lime. Sulphur dioxide can be generated from the use of sodium metabisulphite.

Mine activity or feature	Potential airborne contaminant
Natural gases	**Methane** Methane occurs naturally in coal mines. Increases in coal extraction rates often result in increased methane emissions. Methane can make up 0% to 100% of coal seam gas, with lower proportions of other gases, including carbon dioxide and nitrogen. Methane is lighter than air, explosive at a range of concentrations (generally 5-15%) and displaces oxygen in the air. (Explosive atmospheres are dealt with through spontaneous combustion and fire and explosion PHMP). **Hydrogen sulphide** A colourless and tasteless gas with a powerful odour of rotten eggs at low concentrations. It occurs naturally in coal seams with high sulphur content. It also accumulates around stagnant water. It can be released as the coal is mined, when coal is heated and by the action of acid waters on easily decomposed sulphide ores. Gases can enter a working area: • during removal of overburden • when breaking into abandoned shafts • when opening in-seam gas pockets • from historical workings. **Radon** A radioactive gas that can be released from rock, coal or water. Radioactive decay of radon produces fine solid particles called radon progeny. Reactions between groundwater and minerals in the rock can produce carbon dioxide, sulphur dioxide and hydrogen sulphide.
Other structures (e.g. buildings)	Man-made vitreous fibres (also known as synthetic mineral fibres or man-made mineral fibres), for example slag, rock and glass wool, refractory fibres and continuous filament glass fibres. Asbestos in building materials, pipe and boiler lagging. Ammonia from: • reactions between alkaline whitewash and fire-retardant salts in timber • some types of cement-based cavity fillers

Mine activity or feature	Potential airborne contaminant
	• ANFO and water. If synthetic materials (e.g. PVC belting or refrigerants) melt they can release chlorine, hydrogen chloride, hydrogen cyanide or phosgene.
Naturally occurring asbestos (NOA)	Asbestos is found as a naturally occurring mineral in many areas of NSW and may occur in veins within rock formations. Naturally occurring asbestos is generally found when building roads, working on constructions sites and undertaking excavation activities. Clauses 431-434 of the WHS Regulation provides that the person with management or control of the workplace must manage the risks associated with NOA at the workplace[4]. Any naturally occurring asbestos identified, or assumed to be present at a workplace, must be included in an asbestos management plan and readily available asbestos register. An asbestos management plan should be prepared by the person with management or control of the workplace.
Oxygen deficient atmospheres	Oxygen-deficient atmospheres in underground mines can be caused by: • emission of another gas (e.g. methane displacing oxygen) • consumption of oxygen (e.g. oxidation of coal or organic material, metal rusting) • oxidation of reactive sulphides, timber, or solution and evaporation in stagnant or flowing water.
Spontaneous combustion	Spontaneous combustion of coal produces gases such as methane, hydrogen, carbon monoxide and hydrogen sulphide. Other flammable gases that act as indicators of fire might be present in small amounts, such as ethane, ethylene and acetylene.
Underground mining operations	Contaminants or lack of fresh air from: • poor or inadequate ventilation • contaminated intake air.
Use and maintenance of	1. Diesel exhaust emissions including:

[4] Naturally occurring asbestos factsheet (SafeWork)

Mine activity or feature	Potential airborne contaminant
plant, including fixed and mobile plant	• carbon monoxide • oxides of nitrogen (nitric oxide and nitrogen dioxide) • diesel particulate matter • sulphur dioxide. Diesel exhaust emissions are particularly hazardous in places without enough ventilation to dilute them (e.g. in workshops or underground). Emissions can also accumulate in surface operations if there is not enough natural airflow to disperse them (i.e. in the pit). 2. Vapour from fuels, fuel additives and oils. 3. Man-made vitreous fibres (also known as synthetic mineral fibres or man-made mineral fibres), for example, slag, rock and glass wool, refractory fibres and continuous filament glass fibres. These fibres are present in gaskets, tapes and packings. 4. Asbestos might be in insulation materials, gaskets and friction materials including clutch and brake linings.
Use and storage of substances	Vapours might be released from substances including: • solvents (e.g. used for extraction, electrowinning, degreasing and painting) • liquid polymers (e.g. sludge treatment) • degreasers • paints • polymeric chemicals (e.g. phenolic resins, for strata stabilisation and sealing) • polyurethane foams (can liberate isocyanate vapour and mists, as well as other solvent vapours). Reactions between arsenic-containing substances and hydrogen in water or acids can produce arsine gas. This highly toxic gas is colourless, non-irritating and flammable.
Welding & Grinding	Welding fumes and gases, including carbon monoxide. Metal dust from grinding activities.

Mine activity or feature	Potential airborne contaminant
Supplied air respirator systems	Oil mist from poor air compressor maintenance.

3.2. Air quality risk assessment

The air quality hazards identified in the risk appraisal need to be assessed to determine their risk of causing injury or ill health. This is the risk assessment, or air quality risk assessment.

The air quality risk assessment needs to be produced by a competent person (refer to section 3.5 for more information). It determines air quality in the mining operation, its likely impacts on worker health and identifies controls. It should include the:

- level of oxygen in natural or supplied air
- temperature and humidity of the air
- types and levels of dust and other airborne contaminants likely to be in the air
- length of exposure of workers to dust and contaminants, considering extended shifts
- recovery periods between shifts.

3.3. Assessing workers' exposure

Operators need to ensure that workers' exposure to airborne dust and other contaminants is assessed.

Exposure assessment must be carried out or supervised by a competent person such as a qualified occupational technician, occupational hygienist or person who has a recognised competency as a certified occupational hygienist (COH).

The design of the assessment strategy depends on the size and type of mining operation, and the activities carried out. A good assessment requires:

- a robust sampling strategy
- appropriate measuring and monitoring
- appropriate interpretation of results.

Exposure needs to be compared against workplace exposure standards and biological exposure indices.

Results of exposure monitoring should be made available to workers.

Schedule 6 of the WHSMPS Regulation outlines the minimum requirements for exposure monitoring for airborne dusts in coal and non-coal mines. Sampling to satisfy these requirements requires a licence under section 89 of the WHSMPS Regulation

3.3.1. Sampling strategy

The sampling strategy will usually include identifying groups of workers for whom risk, and exposure profiles are similar. These groups are called SEGs (similar exposure groups).

The sampling strategy needs to be developed and overseen by a competent person such as an occupational hygienist or person who has a recognised competency as a certified occupational hygienist (COH), in consultation with relevant management groups and workers.

Further guidance on monitoring worker exposure is provided in the Technical Reference Guide: Monitoring and control of worker exposure to airborne contaminants.

The frequency of worker exposure monitoring will depend on the objectives and outcomes of the risk identification and analysis.

3.3.2. Statistical analysis of sampling results

Following the collection of sufficient samples, a competent person should generate inferential statistics to summarise the dataset and estimate the exposure profile of the SEG.

The application of appropriate statistical analysis to sampling results can be valuable in:

- assessing confidence that the results represent the 'true' exposure profile (the profile you would see if you were to measure the exposure every shift, and you were to measure all workers in the SEG)
- interpreting whether exposure standards are complied with
- managing uncertainties in exposure assessment and health risk assessment.

Application of appropriate statistical analysis to sampling results is important to assess how closely the results represent the 'true' exposure profile and can be used to assess compliance with the exposure limit and assess risk.

Guidance on estimating SEG exposure using statistical analysis is provided in the Technical Reference Guide: Monitoring and control of worker exposure to airborne contaminants.

3.4. Workplace exposure standards

Workplace exposure standards are limits and/or a concentration of a substance at which nearly all workers can be repeatedly exposed day after day without coming to harm.

Exposure standards relate to the amount of a substance that a person is exposed to during their workday. Section 41 of the WHSMPS Regulation provides that a PCBU must ensure exposure standards for substances and mixtures are not exceeded.

3.5. Competence of exposure assessors

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

Analysis of exposure monitoring results must be carried out by an organisation that is accredited with the National Association of Testing Authorities, Australia (NATA).

Clause 89 of the WHSMPS Regulation requires mine operators to ensure any sampling and analysis of airborne dust undertaken at the mine is done by a licenced provider. An independent person not employed by the mine and who holds a Resources Regulator-issued licence should carry out the sampling and analysis.

A list of providers who currently hold a licence to carry out sampling, analysing or reporting of airborne dust is on the Resources Regulator's website.

3.6. Reporting of exceedances

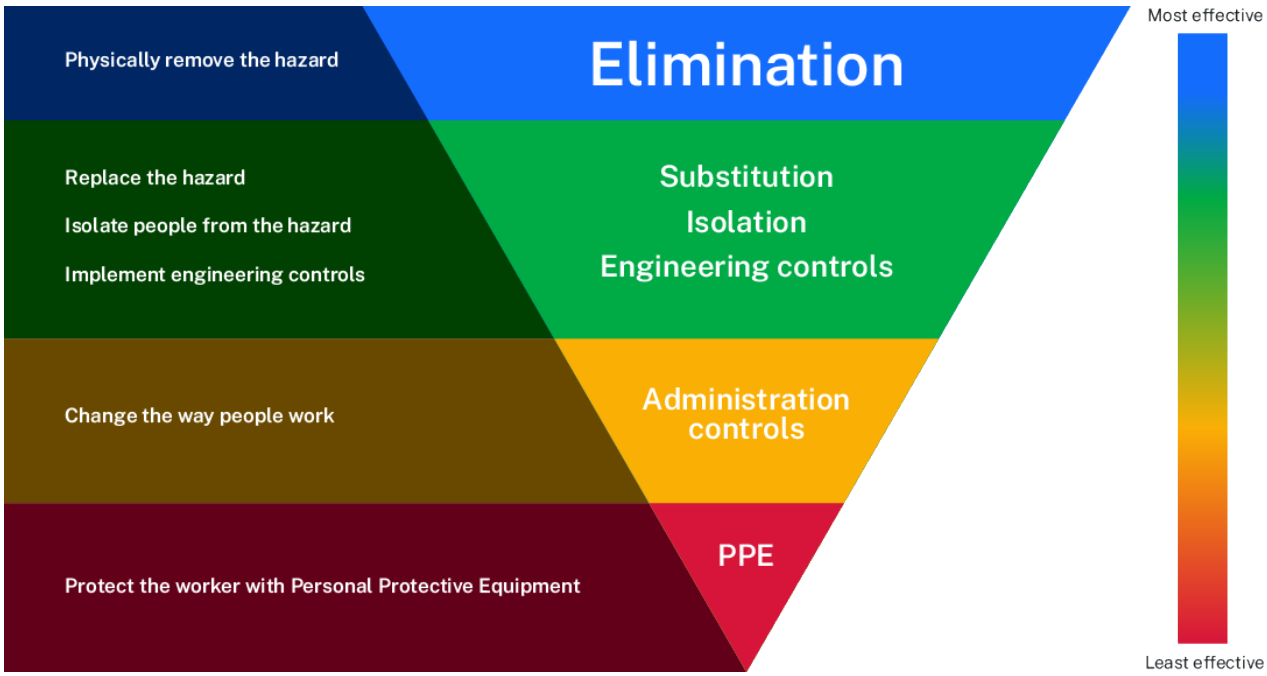
Exceedances to exposure standards for respirable coal and crystalline silica dust must be notified to the Regulator in accordance with clause 124 of the WHSMPS Regulation.

4. Control measures

4.1. Hierarchy of controls

Operators or PCBUs need to apply the hierarchy of controls set out in the WHS laws. They must try to eliminate risks so far as is reasonably practicable. If elimination is not reasonably practicable, the risk must be minimised, so far as is reasonably practicable. The hierarchy is shown in Figure 3.

Figure 3 – Hierarchy of risk controls.



Operators and other PCBUs should identify which control is critical to preventing health incidents relating to airborne contaminants at their operation. A critical control (CC) is one which is crucial to preventing an unwanted event or mitigating the consequences of that event. The absence or failure of a CC would significantly increase the risk despite the existence of the other controls.

Where reasonably practicable, the more effective control measures should be used first. More than one type of control measure at a time can be used. The control measures used should be proportionate to the risk. Control measures include equipment, processes, procedures or behaviour to minimise risk.

If elimination is not reasonably practicable, PCBUs must minimise risks so far as is reasonably practicable.

4.2. Controls for dust and airborne contaminants

The controls used for airborne contaminants depend on the type, size and nature of the operation.

This section provides examples of the types of controls that can be adopted to control airborne contaminants within your operations. When selecting the appropriate controls, it is important that

the controls specifically address the airborne contaminant generating source you are seeking to manage. More than one control may be needed to eliminate or reduce the risk so far as reasonably practicable.

The table below shows an example hierarchy of controls.

Hierarchy level	Control
Elimination	• electric powered plant rather than diesel • sealed roads
Substitution	• welding methods that generate less, or less harmful, fumes
Isolation	• enclosed positive pressure cabins with filtered air conditioning units • remotely operatored machinery (e.g. longwall shearer)
Engineering	• procdurement of appropirate equipment • ventilation and filtration systems (e.g. specific exhaust or return air system) • local exhaust ventilation • wet suppression systems (considering droplet size and dust particle size) for stockpiles, roads, machinery and cutting equipment • covers on conveyors and loads • dust control substances
Administrative	• regular plant maintenance and housekeeping • operator positioning and task rotation • provision of training and information to workers • modification of activities to suit weather conditions
PPE	• respiratory protective equipment (including training in use and maintenance)

4.2.1. Roadway dust

Operators should eliminate road dust generation, so far as is reasonably practicable and minimise roadway dust if it is not reasonably practicable to eliminate it. Apply water to roadways, including haul roads and underground mine roadways, to control dust generation. Water can be applied using a mobile tanker with sprays or fixed water sprays, as shown in Figure 4. Reapply water as the road surface dries out.

Figure 4: Dust suppression using a mobile tanker.

The time between reapplication can be extended by treating the road surface with:

- salts
- surfactants (such as soaps and detergents)
- soil cements
- bitumen / sealed surfaces
- polymer films.

Vehicles operating on haul roads should have enclosed cabs and be equipped with air conditioning. Make sure doors and windows are always closed when the vehicle is operational. Check cab filters on a shift basis and replace and clean them as required.

Use longer distances between vehicles to reduce driver dust exposure. A 40-60 second gap between vehicles reduces dust concentrations in the air by more than 300% compared to a 0-20 second gap[5].

4.2.2. Drilling

Operators should reduce dust generation at the source when drilling, and use enclosed cabs on drilling rigs, so far as is reasonably practicable.

There are two main types of dust suppression for drilling operations:

- wet dust suppression
- dry dust collection.

[5] National Institute for Occupational Safety and Health (2010). *Best Practices for Dust Control in Coal Mining*. Retrieved from: www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2010-110.pdf

Figure 5: Surface drilling.

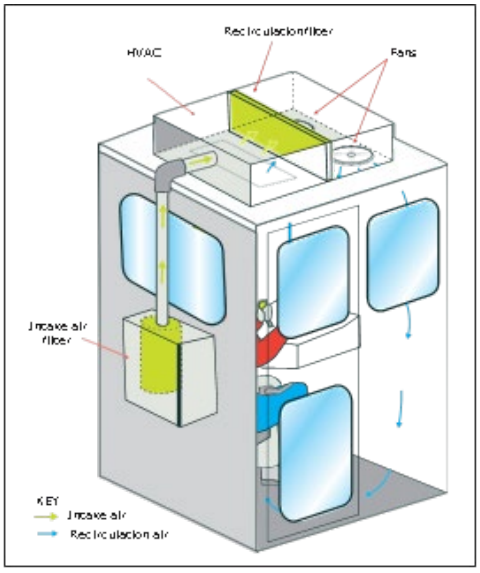
4.2.3. Enclosed cabs

Operators should use modern drill rigs with enclosed positive pressure cabs and filtration systems, so far as is reasonably practicable. Fit enclosed cabs to older drill rigs, so far as is reasonably practicable.

Operators need to ensure:

- there are no leaks and door seals are maintained
- high efficiency dust filters for intake and recirculation are used and replaced as required
- dust carried into cabs by operators is removed
- doors and windows are closed during drilling and tramming
- filters and ventilation are regularly checked and maintained
- air conditioning filters are suited to the dust particle size.

Figure 6: Filtration system for an enclosed cab.



4.2.4. Other sources of dust

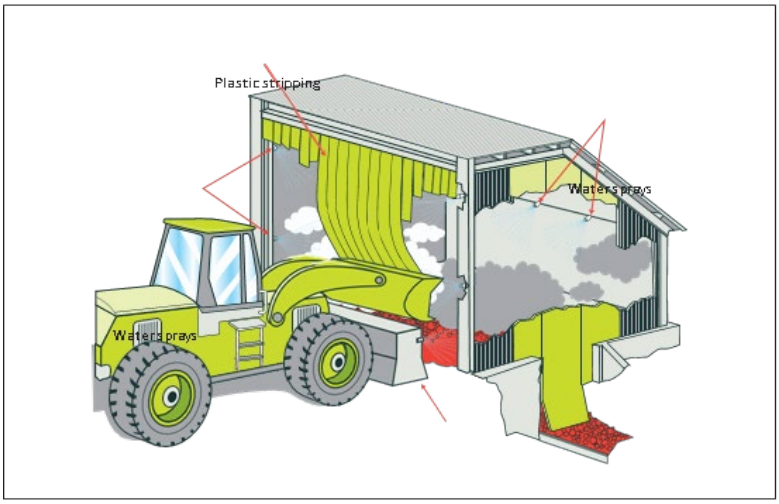
Dust can be generated when loading trucks and trailers for product haulage, and at:

- crusher dump hoppers
- crushers and screening plants
- stockpiles.

Dust is to be controlled wherever it is generated. Make sure the PHMP covers all likely sources of dust. Water sprays and enclosures are the most effective methods of dust control. Use water sprays and curtains to control dust at hoppers and transfer points. These need to use water at approximately 1% of the weight of material being moved or processed.

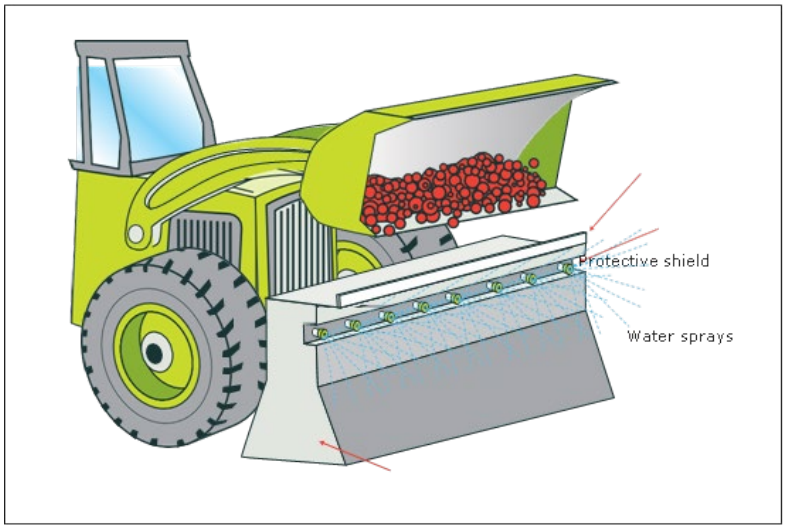
Stockpiles need to be wetted regularly to control dust. Fogging systems can be very effective at controlling dust at stockpiles. Refer to Figure 7 for an example of how fogging systems in an enclosure help reduce the generation of airborne dust.

Figure 7: Example of enclosed hopper.



Use a spray bar that is incorporated into the tyre stop at stockpiles and hoppers. This will also reduce carry back on loader or truck tyres, see Figure 8 below as example.

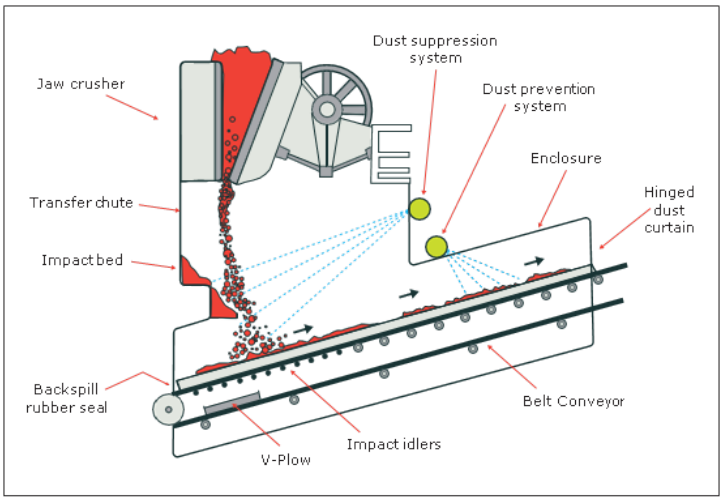
Figure 8: Example of spray bar in a concrete tyre stop.



At crushing and screening plants:

- enclose transfer areas
- use sprays on screens and where material is placed into stockpiles
- use sprays on conveyors and screens, when material is dropped.

Figure 9: Example of enclosed discharge from jaw crusher with water sprays.



If the use of water is a problem for the material, or is not reasonably practicable to provide, then the use of dust extractors, cyclones, filters and load out hoppers/bins can be an effective way to control and remove dust and then deposit the collected dust back into the product stream prior to loadout.

4.3. Control for diesel engine emissions

Operators should prevent diesel emissions being generated (elimination), so far as is reasonably practicable, and control them so far as is reasonably practicable if they cannot be prevented.

Controls for diesel emissions vary depending on the type and nature of the operation and the type of plant and engines used. Several controls are normally required to be used in combination. Use substitution, isolation and engineering controls first, administrative controls second, and PPE as a last resort. Further information can be found in the Technical Reference Guide: Management of diesel engine pollutants in underground environments.

Examples of controls may include:

- engine design
- fuel type
- filtration systems (eg diesel particulate filter systems, disposable diesel exhaust filters, active diesel particulate filtration system)
- water scrubbers
- operator training such as idling times
- maintenance.

4.4. Welding fumes

Welding fumes can either be controlled by using a safer working method which produces less (or less harmful) airborne contaminants or providing ventilation (i.e. local exhaust ventilation). Safer working methods need to be applied in preference to ventilation.

SafeWork NSW has published guidance on the necessary controls for different welding situations. These controls should be applied as relevant. Powered air purifying respirator (PAPR) welding helmets should be used if RPE is needed while welding. For more detailed control methods refer to SafeWork NSW – Welding Process – Code of Practice.

4.5. Hazardous substances

Many substances and fuels used in extractive operations pose a risk to workers and are controlled under the WHS laws. The steps used to control exposure to a number of gases, mists and vapours that are the result of hazardous substances are detailed in the relevant safety data sheet (SDS) for the substance (see the references section of this document for further details). SDS are documents that provide critical information about hazardous chemicals. Apply the controls specified in the applicable SDS.

4.6. Training

Training on the applicable controls must be completed by all workers involved in any activity that might have an effect on the air quality. They are to have an understanding of the:

- airborne contaminants that they might be exposed to or generated through their activities
- controls in place to eliminate or minimise the effects of airborne contaminants
- correct operation of equipment and mobile plant affecting airborne contaminants
- correct use of any PPE required to be worn during these activities
- monitoring arrangements and testing procedures (as appropriate)
- the effects of contaminants.

Standard operating procedures are to be readily available to all workers so they are fully knowledgeable about the type(s) of airborne contaminants that can be generated and the controls in place.

Workers must be provided with appropriate supervision based on their experience and qualifications.

Additional training should be provided where there are changes to air quality. Refresher training should be provided to workers as needed. Records of training should be kept.

4.7. Respiratory protection equipment (RPE)

Respiratory protective equipment (RPE) is a form of personal protective equipment (PPE).

RPE is the lowest order control in the hierarchy of controls and relies heavily on worker compliance and enforcement by supervision to be effective. Failure to wear suitable, correctly fitted RPE when required can result in a worker being directly exposed to hazardous airborne contaminants.

Further guidance about the selection, use and maintenance of respiratory protection is provided in AS/NZS 1715 - Selection, use and maintenance of respiratory protective equipment, and

AS/NZS 1716 - Respiratory protective devices.

PCBUs should ensure that workers are trained in the use and maintenance of their respirable protection to ensure that it is effective.

Required minimum protection factor	Suitable RPE
Up to 10	P1, P2 or P3 filter half face P1 or P2 disposable facepiece
Between 10-15	P2 filter in full facepiece PAPR with P2 or P3 filter
50-100	P3 filter in full facepiece Full facepiece with air hose
100+	PAPR – P3 filter in full facepiece

5. Implementation

Once airborne hazards have been identified and the means to accurately gauge the risks to workers have been agreed upon, the risks need to be controlled.

Control measures need to eliminate or reduce (so far as reasonably practical) these risks. Selected controls need to be implemented and their effectiveness monitored and maintained. Part of this includes the evaluation incidents, non-conformances and static monitoring, personal exposure monitoring and health monitoring results against performance standards (legislative and corporate).

For a more in-depth explanation of the implementation requirements for a SMS (of which a PHMP is part of), see NSW Code of practice on safety management systems in mines (section 4.5).

6. Performance standards and audit

As part of the SMS, a PHMP needs to continue to be effective, relevant and compliant to the legislation. The WHSMPS Regulation sets out the requirements for the establishment, implementation, monitoring and review of the SMS in sections 18-22.

Performance standards and audit requirements include:

(a) performance standards for measuring the effectiveness of all aspects of the safety management system that;

  (i) are sufficiently detailed to show how the operator will ensure the effectiveness of the safety management system, and

  (ii) include steps to be taken to continually improve the safety management system,

(b) the way in which the performance standards are to be met,

(c) a system for auditing the effectiveness of the safety management system for the mine or petroleum site against the performance standards, including the methods, frequency and results of the audit process.

6.1. Performance standards

Performance standards provide a reference comparison designed to enable mine operators to determine how effectively the planning, execution and implementation of the mine's PHMP risk management approach is and continues to be. Airborne contaminants covered in the PHMP must be controlled to as low as reasonably practicable and where there is an exposure standard it must not be exceeded. These are essentially a performance standard which pertain to personal exposure monitoring and health monitoring of workers.

Mine operators are also able to choose a performance standard more stringent should they wish. For example, an operator may choose to have their triggered action response level at 50% of the workplace exposure standard (WES).

6.2. Use of trigger action response plans

Trigger action response plans (TARPs) summarise the overall monitoring arrangements and include planned actions ready to implement when certain trigger points are detected by monitoring. However, TARPs should be put in place only after a risk assessment has verified the selection of the most effective control measures.

Use TARPs to specify the actions to be taken when changes in air quality happen, including but not limited to, when:

- variations from normal occur
- results of gas or dust monitoring indicate concentration changes
- engine exhaust sampling is outside of the expected levels
- weather events create excessive dust.

For example, if real-time particulate monitoring detects a sudden rise in the level of respirable particulate matter over a specified level, the TARP requires evacuation.

6.3. Auditing the PHMP

Audits of the PHMP should be undertaken by competent people on a regular basis. Operators should consider both internal and external audit programs.

Audits need to examine the adequacy, implementation and compliance with the PHMP. The areas that may be audited include:

- hazard identification and risk assessment for airborne contaminant generation at the operations
- compliance with workplace exposure limits and biological monitoring indices
- results of personal exposure monitoring
- results of health monitoring

The final audit report needs to include the findings of the audit, recommendations and the actions that will be taken to correct the issues raised. The person(s) responsible for implementing the corrections should be stated in the audit report.

Records of the audit of the PHMP must be kept in accordance with the safety management system.

Records should be made available to the Regulator and worker representatives.

7. Review

7.1. Reviewing the PHMP

The operator must review the PHMP at least once every three years (section 22 of the WHSMPS Regulation) or after an incident or other circumstance as outlined in section 15 of the WHSMPS Regulation. The review determines whether the controls continue to be suitable, consistent with current best practice and effective in managing the risks associated with air quality.

The PHMP must also be reviewed, and as necessary, revised after:

- an incident involving air quality at the mining operation
- the occurrence of any event specified in the PHMP as requiring a review of the PHMP
- each audit, if any non-conformances are identified
- if exposure monitoring indicates that the controls are not effective
- if there is a significant change to mining methodology
- exceedance of exposure standards for respirable coal and crystalline silica dust (section 15 and 124 WHSMPS Regulation
- if requested by a health and safety representative for workers at the workplace if they believe it affects or may affect the health and safety of a member of the work group (clause 38(4) of the WHS Regulation).

When reviewing the PHMP the risk assessment used and referred to within it must also be reviewed. There could be new risks for which controls are needed, or existing risks that have changed meaning controls may need changing.

During the review, the operator needs to consider any other relevant information gathered during:

- routine risk appraisals and assessments
- monitoring and results of inspections by the mine operator or the Resources Regulator
- review of TARPs
- incidents or near misses
- feedback from workers, industry health and safety representatives or other health and safety representatives.

The PHMP and supporting documents might need to be revised and re-issued after the review. Make sure that workers are informed about any updated documents and train or re-train them where required. New employees will need to be inducted and trained in the risks and controls implemented by the operator.

The mine operator must keep records relating to the review and revision of the PHMP for the last seven years (section 61 WHSMPS Regulation). Records about the review must be provided, on request, to an inspector or a health and safety representative.

8. Appendices

Appendix 8.1 Definition of terms

Term	Definition
aftercooling	Cooling intake air prior to induction into the combustion chamber to increase power and reduce the emission of oxides of nitrogen.
after-treatment devices	Devices such as filters that remove constituents of diesel exhaust as they leave the equipment.
ANFO	An explosive material consisting of ammonium nitrate and fuel oil.
BEI (biological exposure index)	Guidance values for assessing biological monitoring results. It indicates a concentration below which nearly all workers should not experience adverse health effects from exposure to a particular substance.
competent person	A person who has the knowledge, relevant experience and skill to carry out a particular task. Skills and knowledge may be acquired through training, qualification, or experience, or a combination of these.
diamond drilling	Cutting rock by means of a rotary hollow drill with diamond tips that is used to obtain core samples of the rock/ ore.
diesel particulate matter (DPM)	Diesel particulate matter (DPM) is a component of diesel exhaust emissions that includes soot particles made up primarily of carbon, ash, metallic abrasion particles, sulfates and silicates. Diesel soot particles have a solid core consisting of elemental carbon, with other substances attached to the surface, including organic carbon compounds known as aromatic hydrocarbons.
operator	A PCBU nominated under the Work Health and Safety (Mines and Petroleum Sites) Act 2013 to be the operator of the mine or petroleum site. Operators include coal mines, metal mines, quarries and petroleum sites.
elemental carbon	Elemental carbon is sometimes used as a surrogate measure for DPM. It is composed of graphitic carbon, as opposed to organic carbon, and usually accounts for 40 to 60 percent of the DPM by mass.
exhaust back pressure	Buildup of pressure against the engine created by the resistance of the exhaust flow passing through the exhaust system components.
fuel-to-air ratio	The ratio of the amount of fuel to the amount of air introduced into the diesel combustion chamber.
health and safety representative (HSR)	A health and safety representative (HSR) in relation to a worker, means the health and safety representative elected under Part 5 for the work group of which the worker is a member (WHS Act).
HVAC system	Heating, ventilation and air conditioning system.
mesothelium	A membrane that forms the lining of several body cavities.

Term	Definition
mining operation	Has the meaning given in WHS (M&P) Act 2013, Part 1, Clause 7
mine operator	Has the meaning given in WHS (M&P) Act 2013, Part 1, Clause 7A
NOx	Oxides of nitrogen. Generated as a fume from blasting activities. Also generated by diesel exhaust fumes.
OEM	Original equipment manufacturer.
ore	A mineral deposit that is mined in metalliferous mining operations.
organic carbon	Non-graphitic soluble organic carbon material associated with DPM.
oxygenates	Fuel additives which contain a substantial fraction of oxygen by weight (e.g. ethanol, methanol, and methyl soyate).
person conducting a business or undertaking (PCBU)	A person conducting a business or undertaking. This is a broad term used in the work health and safety laws for individuals, businesses or organisations that are conducting business or not for profit entities involved in work.
principal control plan (PCP)	A plan required under WHSMPS Regulation section 30 to control hazards.
principal hazard	Any activity, process, procedure, plant, structure, substance, situation or other circumstance relating to the carrying out of: (a) mining operations that have a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents in relation to any of the following: (i) ground or strata failure (ii) inundation or inrush of any substance (iii) mine shafts and winding systems (iv) gas outbursts (v) spontaneous combustion (vi) subsidence (vii) roads or other vehicle operating areas (viii) air quality or dust or other airborne contaminants (ix) fire or explosion (x) a hazard identified by the mine operator under clause 34 of the WHS Regulations, or (b) petroleum operations that have a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents in relation to any of the following: (i) roads or other vehicle operating areas (ii) air quality or dust or other airborne contaminants (iii) fire or explosion (iv) a hazard identified by the petroleum site operator under clause 34 of the WHS Regulations (WHSMPS Regulation cl 5).
principal hazard management plan (PHMP)	A plan required under WHSMPS Regulation section 28 to manage a principal hazard.
regeneration	Process of oxidizing DPM collected on a diesel exhaust particulate filter to remove it. This process cleans the filter and reduces back pressure to acceptable limits.

Term	Definition
rib	The sides of a roadway typically associated with underground coal mines.
roadways	The formed underground excavations, that once supported provide access for people, equipment or services through them. Roadways can be a simple excavation forming one roadway or multiple excavations forming a network of roadways in an underground environment.
standard operating procedures (SOPs)	Documented standard operating procedures for installation, maintenance, removal and quality control.
TARPs	TARPs specify the actions to be taken when changes occur. For example, if a gas monitor detects a sudden rise in the level of carbon monoxide over a specified level, the TARP requires evacuation.
tramming	Travelling
top hammer drilling	Drilling of rock by means of percussion and rotation provided by a drill passing percussive action down the drill steel.
total carbon	Refers to the sum of the elemental and organic carbon associated with the diesel particulate matter and accounts for about 80-85 percent of the DPM mass.
tri-cone drilling bit	A rotary cutting bit usually associated with hole diameters larger than 150 mm.
turbocharge	Process of increasing the mass of intake air by pressurisation to the engine which allows more fuel to be burned and results in increasing the engine's power output.
volatility	Measure of the ability of a fuel to vaporise.
welding fumes	Metal and fluxing fumes made up of toxic gases and very fine particles, produced from welding and hot cutting.
workplace exposure standard	Workplace exposure standards for airborne contaminants are a value that refers to the airborne concentration of substances, at which it is believed that nearly all workers can be repeatedly exposed to day after day without coming to harm. (See appendix 8.4 of this document for an excerpt from Safe Work Australia's list of exposure standards).

Appendix 8.2 Acronyms

AS	Australian Standard (produced by Standards Australia)
AS/NZS	Australian and New Zealand Standard
ISO	International Standard (produced by International Organisation for Standardisation)
NOA	Naturally occurring asbestos
OEM	Original equipment manufacturer
PCBU	Person conducting a business or undertaking
PCP	Principal control plan
PHMP	Principal hazard management plan
PPE	Personal protective equipment
RPE	Respiratory protective equipment
SEG	Similar exposure group
SMS	Safety management system
TARP	Trigger action response plan

Appendix 8.3 Information to consider for inclusion in the PHMP

Information	Examples
Site characterisation	• material being mined • extraction rates • background air quality
Mining methods	• blasting • drilling
Weather conditions and changes	• wind speed and direction • rain • temperature • pressure
Equipment used	• mobile plant • light vehicles • fixed plant, including • crushers • screens • conveyors • drills • compressors
Hours of operation	• shift lengths and time weighted average exposure limits
Mine design	• ventilation systems • roads and other vehicle operation areas • location and size of stockpiles
Air quality monitoring	• frequency of measurements • instrumentation used
Worker exposure	• regulatory standards and exposure limits, as well as site-specific criteria
Controls	• effectiveness of existing controls • new controls
Number of workers exposed	• worker duration • worker activity [similar exposure groups (SEGs)] • number of workers exposed

Appendix 8.4 Sampling methods

A person carrying out air sampling and analysis of airborne contaminants is to use the appropriate method. Some accepted examples are outlined below.

Airborne contaminant	Sampling method	Reference
Respirable dusts including coal dust and crystalline silica	AS 2985	AS 2985 Workplace atmospheres – Method for sampling and gravimetric determination of respirable dust.
Inhalable dusts including (most) metals	AS 3640	AS 3640 Workplace atmospheres – Method for sampling and gravimetric determination of inhalable dust.
Diesel particulate matter	NIOSH 5040	US National Institute of Occupational Safety and Health Manual of Analytical Methods 4th Edition Method 5040.
Asbestos	Safe Work Australia NOHSC:3003(2005)	Guidance note on the membrane filter method for estimating airborne asbestos fibres 2nd edition [nohsc:3003(2005)].
Synthetic mineral fibres	Use the methods set out in AS 3640 to measure the inhalable fraction. Suitable methods for measuring the respirable fraction are set out in the Australian SMF membrane filter method (NOHSC 1989b), or the asbestos methods in NOHSC 3003 and NIOSH 7400.	Guidance note on the membrane filter method for estimating airborne asbestos fibres 2nd edition [nohsc:3003(2005)].
Gases, vapours, mists	Apply AS/NZS 60079 and BS EN 45544-4 as appropriate. Direct-reading gas meters (e.g. electrochemical cells), or tubes and filter samples requiring laboratory analysis can be used to measure levels of gases, vapours and mists. Direct reading instruments are not available or practical to use for some gases, vapours and mists. Use appropriate standards to measure these, such as NIOSH, OSHA and HSE sampling and	AS/NZS 60079 Explosive atmospheres – Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen. BS EN 45544-4 Workplace atmosphere: Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours. Guide for selection, installation, use and maintenance.

Airborne contaminant	Sampling method	Reference
	analytical methods.	
Welding fumes and gases	Apply AS 3853.1 and AS 3853.2 as appropriate.	AS 3853.1 Health and Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operator's breathing zone – sampling of airborne particles. AS 3853.2 Health and Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operator's breathing zone – sampling of gases. ISO 10882-1 Health and safety in welding and allied processes – Sampling of airborne particles and gases in the operator's breathing zone – Sampling of airborne particles. ISO 10882-2 Health and safety in welding and allied processes – Sampling of airborne particles and gases in the operator's breathing zone – Sampling of gases.
Isocyantes	Follow the OSHA method 42/47 for di-isocyanates or MDHS method 25/4 for organic isocyanates in air.	United States Department of Labour. Sampling and analytical methods number 42 – Diisocyanates. Health and Safety Executive. MDHS 25/4 Organic Isocyanates in Air method.

9. References

STANDARDS

Intertek Inform – Australian Standards

Reference number	Title
AS 2985	Workplace atmospheres - Method for sampling and gravimetric determination of respirable dust.
AS 3640	Workplace atmospheres - Method for sampling and gravimetric determination of inhalable dust.
AS 3853.1	Health and Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operator's breathing zone – sampling of airborne particles.
AS 3853.2	Health and Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operator's breathing zone – sampling of gases.
AS 4024.1201	Safety of machinery General principles for design - Risk assessment and risk reduction
AS 4024.1302	Safety of machinery Risk assessment - Reduction of risks to health from hazardous substances emitted by machinery - Principles and specifications for machinery manufacturers
AS/NZS1715	Selection, use and maintenance of respiratory protective equipment
AS/NZS1716	Respiratory protective devices
AS/NZS 60079	Explosive atmospheres – Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen
EN 45544-4	Workplace Atmospheres - Electrical Apparatus Used for the Direct Detection and Direct Concentration Measurement of Toxic Gases and Vapours - Part 4 - Guide for Selection, Installation, Use and Maintenance
ISO 10882-1	Health and safety in welding and allied processes – Sampling of airborne particles and gases in the operator's breathing zone – Sampling of airborne particles
ISO 10882-2	Health and safety in welding and allied processes – Sampling of airborne particles and gases in the operator's breathing zone – Sampling of gases.
ISO/IEC 17025:20017	General requirements for the competence of testing and calibration laboratories
SA/SNZ-HB 89	Risk management - Guidelines on risk assessment techniques

WHS LAWS

Title
Work Health and Safety Act 2011
Work Health and Safety (Mines and Petroleum Sites) Act 2013
Work Health and Safety Regulation 2017
Work Health and Safety (Mines and Petroleum Sites) Regulation 2022

RESOURCES REGULATOR

Type	Title
Code of practice	Safety management systems in mines
TRG	TRG 29 – Guideline for the management of diesel engine pollutants in underground environments
Guidance	Dust safety in the metals and extractives industries 3rd edition

SAFE WORK AUSTRALIA

Type	Title
Exposure Standards	Workplace Exposure Standards for Airborne Contaminants
Guidance	Hazardous chemicals requiring health monitoring
Guidance	Health monitoring for persons conducting a business or undertaking guide
Guidance	Health monitoring for exposure to hazardous chemicals – guide for persons conducting a business or undertaking
Guidance	Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants

SAFEWORK NSW

Type	Title
Code of practice	Welding process
Code of practice	How to manage and control asbestos in the workplace.
Code of practice	Work health and safety consultation co-operation and coordination

GUIDANCE DOCUMENTS

The following documents were used and adapted in the formulation of this document through the Mine Safety Advisory Council's sub committee, the Health Management Advisory Committee.:

- Safe Work New Zealand Approved code of practice: Air Quality in the Extractives Industry (2016)
- Queensland Department of Natural Resources and Mining: Recognised Standard 14: Monitoring Respirable dust in coal mines (2017)
- Queensland Department of Natural Resources and Mining: QGL02 Guidelines for management of respirable crystalline silica in Queensland's mineral mines and quarries
- Australian Institute of Occupational Hygienists (AIOH) Adjustment of workplace exposure standards for extended work shifts position paper 2016

FURTHER INFORMATION

Name	Details
Coal Services	Fact sheet - Prevention of pneumoconiosis in NSW (Coal Services)
	Booklet - Protecting against airborne dust exposure in coal mines (Coal Services)
AIOH	Australian Institute of Occupational Hygienists
	Position Paper: Dusts not otherwise specified (dust NOS) and occupational health issues
NIOSH	National Institute of Occupational Safety and Health
	Best Practices for Dust Control in Coal Mining
	Best Practices for Dust Control in Mining
QLD Government	Controlling the risk of dust exposure to workers in mines
WA Government	Guidance - Dust and other airborne contaminants