**Guidance about underground air quality and ventilation**

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**Why is ventilation important in underground workplaces?**

**Aim of ventilation**

Ventilation in an underground mine is of critical importance to the occupational health and safety of underground employees.

The atmosphere underground is limited and confined, and is thus readily reduced to a sub-standard (or even dangerous) condition if contaminants (e.g. gases, dusts, fumes) produced in the course of operations are not controlled, safely extracted or diluted to acceptable levels. Ventilation is used to extract and dilute contaminants.

**Sources of toxic, explosive and asphyxiant gases**

Gases in mines may be naturally occurring, the products of combustion, or fumes from vehicle exhaust emissions or activities such as blasting. They include methane and other hydrocarbons, carbon dioxide, carbon monoxide, oxides of nitrogen, sulphur dioxide, hydrogen sulphide, ammonia and radon.

Methane and other hydrocarbons encountered during drilling are a potential explosive risk and can displace oxygen.

Blast fumes contain large quantities of oxides of nitrogen and carbon monoxide. Oxygen levels can also be depleted. Adequate ventilation to remove contaminants and air testing is required before workers can return to the workplace.

The most common mining occurrences of spontaneous combustion are in coal mines. However, spontaneous combustion of sulphide ores can produce high levels of sulphur dioxide and carbon monoxide.

Underground fires caused by vehicles can be a significant source of fumes.

Ammonium nitrate?fuel oil explosive (ANFO) is a powerful oxidising agent and spills of ANFO prill can promote fire in contact with combustibles. Ammonia may be generated where ammonium nitrate comes in contact with cement used in grouting, strengthening stope filling or in shotcreting.

Rarely, hydrogen cyanide may be generated where tailings are used in stope fill.

For more on mobile equipment and tyre fires, see [Guidance about addressing some common fire hazards](http://www.dmp.wa.gov.au/Safety/Guidance-about-addressing-some-6398.aspx)

For more details on gas outbursts, see [Guidance about explosion hazards](http://www.dmp.wa.gov.au/Safety/Guidance-about-explosion-hazards-6439.aspx)

**Diesel emissions**

The potential health effects from exposure to diesel exhaust are well documented and underground mines are required to monitor and control diesel emissions. In 2012, the International Agency for Research on Cancer (IARC) classified diesel exhaust emissions as carcinogenic to humans (Group 1).

Diesel exhaust particulates consist of elemental and organic carbon components as well as unburnt hydrocarbons and other solid material.

Gaseous components include carbon monoxide, carbon monoxide, oxides of nitrogen, sulphur dioxide and organic compounds.

Enclosed cabins can be an effective means of reducing exposures to diesel emissions, although their use will not be practical for all activities in an underground mine. Cabins should be air-conditioned and positively pressurised (using HEPA filters) to ensure operators are both comfortable and protected from exposure to diesel emissions.

A HEPA or high-efficiency particulate arrestance air filter removes at least 99.97% of airborne particles with diameters of 0.3 micrometers or larger.

The operator is only protected while in the cabin and if the cabin seals and air conditioner filters are well maintained. This includes checking seals, leak testing and maintaining filters.

[Management of diesel emissions in Western Australian mining operations - guideline](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_DieselEmissions.pdf) - 2 Mb

Management of diesel emissions in Western Australian mining operations - guideline: This guideline should be used by anyone planning or conducting underground mining where diesel engines are likely or are being used.

[Diesel emission management planning (2015)](http://www.dmp.wa.gov.au/Documents/Safety/MSH_TB_DieselEmissionMgmtPlanning.pptx) - 4 Mb

This toolbox presentation contains information about diesel emission management plans. These include using a 10-point checklist and the status of particulates in underground mines.

There are specific requirements under r. 10.52 of the [Mines Safety and Inspection Regulations 1995](http://www.slp.wa.gov.au/pco/prod/FileStore.nsf/Documents/MRDocument:26524P/$FILE/Mines%20Safety%20and%20Inspection%20Regulations%201995%20-%20%5b06-a0-00%5d.pdf?OpenElement) relating to ventilating air requirements for diesel unit operations.

**Dusts**

Where practicable, wet drilling should be used to minimise dust generation. Otherwise drilling machines are to be fitted with effective collection devices.

Sulphide minerals oxidise rapidly when broken and fresh surfaces are exposed to air. When dispersed as dust, sparks or heat flash from blasting can initiate an explosion. Disulphides that contain iron (e.g. chalcopyrite, pyrite) are the most susceptible to 'flash' initiation and explosive propagation.

[Safety management of underground combustible sulpide dust - guideline](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_SafeManagementOfUGCombustibleSulphideDust.pdf) - 277 Kb

Safety management of underground combustible sulpide dust - guideline: This guideline assists in identifying hazards and developing preventative strategies and training action plans to deal with safe management of underground combustible sulphide dust.

For details on sulphide dust ignition, see [Guidance about explosion hazards](http://www.dmp.wa.gov.au/Safety/Guidance-about-explosion-hazards-6439.aspx)

**What is primary ventilation?**

The basis of effective ventilation of underground mines is the adequacy of the primary ventilation system. This is the total mine air volume flow generally through the major underground workings, normally involving splits into parallel circuits.

Factors that determine the total primary volume capacity (and pressure) requirements include:

* extent and depth of the mine
* complexity of workings, including stoping and extraction systems
* size of development openings
* equipment used.

Many deep and extensive underground mines tend to use series ventilation circuits. The main problem with series or parallel-series circuits is progressive contamination of the air by recirculation from secondary ventilation system returns. There is also an increased fire risk, with the fumes and smoke from any fire in the intake or any upstream section of the mine being carried into working sections downstream.

[Underground ventilation (metalliferrous mines) - guideline](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_UGVentilation.pdf) - 199 Kb

Underground ventilation (metalliferrous mines) - guideline: This guideline is issued to assist in the understanding of underground ventilation in metalliferrous mines and provide guidance on essential design aspects and operating practice.

**What is secondary ventilation?**

Secondary ventilation refers to the provision of ventilation to development ends, stopes and services facilities that constitute secondary circuits tapped off the primary circuit or main through flow of air. These headings are typically ‘dead end’ configurations, and may have multiple parallel headings where flow-through of air is not available.

The use of secondary ventilation fans and ducting is normally required, most commonly in a ‘forced air’ configuration, but pressure or exhaust overlap or total exhaust may also be used.

[Underground ventilation (metalliferrous mines) - guideline](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_UGVentilation.pdf) - 199 Kb

Underground ventilation (metalliferrous mines) - guideline: This guideline is issued to assist in the understanding of underground ventilation in metalliferrous mines and provide guidance on essential design aspects and operating practice.

**What is required for the effective ventilation of underground mines?**

**Ventilation plans for underground mines**

The manager of an underground mine must ensure that a plan of the ventilation system at the mine is kept at the mine that shows the direction, course and volume of air currents, and the position of all air doors, stoppings, fans, regulators and ventilating devices, in the mine.

It is important to understand the influence of following factors in determining the effectiveness of the ventilation planning process:

* the mine plan and schedule
* mine design and method
* modelling of airflow
* development of ventilation plans and schedules
* diesel equipment
* contaminants – both naturally occurring and man-made.

**Air sources**

The manager of a mine must ensure that:

* the supply of air for any ventilating equipment used underground is obtained from the purest source available
* the recirculation of air within any secondary ventilation circuit is maintained at the minimum level that is practicable
* where practicable, contaminated return air from any secondary ventilation circuit is exhausted directly to the primary return air exhaust system.

Refer to Part 9 of the [Mines Safety and Inspection Regulations 1995](http://www.slp.wa.gov.au/pco/prod/FileStore.nsf/Documents/MRDocument:26524P/$FILE/Mines%20Safety%20and%20Inspection%20Regulations%201995%20-%20%5b06-a0-00%5d.pdf?OpenElement) for requirements relating to the ventilation and control of dust and atmospheric contaminants.

[Underground ventilation (metalliferrous mines) - guideline](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_UGVentilation.pdf) - 199 Kb

Underground ventilation (metalliferrous mines) - guideline: This guideline is issued to assist in the understanding of underground ventilation in metalliferrous mines and provide guidance on essential design aspects and operating practice.

[MSB No. 095: Ventilation standards in underground mines](http://www.dmp.wa.gov.au/Documents/Safety/MSH_SB_095.pdf) - 58 Kb

Mines Safety Bulletin No. 095: Ventilation standards in underground mines (14 February 2011)

**Audit**

Please refer to the following documents:

[Underground ventilation management – audit guide](http://www.dmp.wa.gov.au/Documents/Safety/MSH_AuditGuide_UndergroundVentilationManagement.pdf) - 631 Kb

This audit guide provides information on the underground ventilation management audit

**Risk-based hygiene management plan**

Mine sites are required to carry out a structured risk assessment of their occupational health hazards, and develop a risk-based hygiene management plan (RBHMP).

[Risk-based hygiene management planning and health & hygiene system - procedure](http://www.dmp.wa.gov.au/Documents/Safety/MSH_G_RiskbasedHygieneMgmtPlanning.pdf) - 1 Mb

This procedure defines and details roles and responsibilities, how to conduct a health and hygiene risk assessment, how to prepare a sampling quota and how to report sampling results.

[What are the duties of the ventilation officer?](http://www.dmp.wa.gov.au/Safety/What-are-the-duties-of-a-9674.aspx)

[What are the health assessment and monitoring requirements for mining operations](http://www.dmp.wa.gov.au/Safety/What-are-the-health-assessment-9667.aspx)