



5 Costly Mine Ventilation Mistakes (and how to avoid them)

A field guide for underground mining engineers, ventilation officers, safety professionals and mine managers.

*Developed in partnership with J. Daniel Stinnette, PE | Founder,
Ventilation Innovation*

For full details visit www.ausimm.com/courses



WHY THIS MATTERS

Mine ventilation is not a background system. It is life support. When it fails even partially the consequences are measured not in downtime or repair costs, but in lives. Yet across mines on every continent, the same critical mistakes are made, again and again. Not because engineers are careless. But because ventilation is a discipline that demands specialised knowledge that is rarely taught well, if at all, at the undergraduate level.

In a landmark assessment of ventilation education, it was found that fewer than half of those teaching ventilation at the undergraduate level have significant, practical experience in the field. The result is a generation of engineers who are often asked to perform the function of a ventilation officer without the practical knowledge to do so safely. This guide distills the most costly and preventable mistakes identified across decades of ventilation surveys, system designs, and incident analyses so that you and your team can recognise and avoid them.

150+ mines

across **6 continents** surveyed and assessed
by course facilitator J. Daniel Stinnette, PE



MISTAKE 1

Ignoring gas accumulation until it's too late

Of all the hazards present in underground mining, gases are among the most lethal and the most frequently underestimated. Carbon monoxide (CO), methane (CH₄), hydrogen sulphide (H₂S) and nitrogen dioxide (NO₂) are colourless, often odourless, and can reach deadly concentrations before any visible sign of a problem appears.

The mistake is not always a failure of monitoring equipment. More often, it is a failure of system thinking: ventilation circuits that create dead-end zones, inadequate dilution rates for diesel-powered equipment, and a lack of real-time awareness of where contaminant plumes are moving.

Disaster case: Sunshine mine fire, USA 1972

Ninety-one miners lost their lives when a fire broke out in the Sunshine silver mine in Idaho. The primary cause of death was not the fire itself; it was carbon monoxide poisoning. The ventilation system, rather than containing and directing the gas away from workers, spread carbon monoxide throughout multiple levels of the mine. Many miners who were far from the fire's origin had no warning before they were overcome. The disaster led to sweeping reforms in US mine safety law and remains one of the defining case studies in the failure of ventilation system design to account for emergency gas distribution.

The consequences:

When **gas accumulation** is not actively managed through deliberate ventilation design:

1. CO from diesel equipment or fires can accumulate to incapacitating levels in minutes.
2. Methane in coal mines can reach explosive concentrations between 5% and 15%, the so-called 'explosive range', swiftly if not mitigated appropriately.
3. H₂S, heavier than air, pools silently in low-lying areas and can cause rapid incapacitation at just 100 ppm.
4. NO₂ from blasting operations, if not flushed correctly, causes delayed pulmonary injury. Miners may feel fine initially, then deteriorate hours later.

How to avoid it?

1. Design ventilation circuits with gas dilution as a primary engineering criterion, not as an afterthought.
2. Model worst-case gas dispersion scenarios, including fire, during the design phase using network simulation software.
3. Ensure real-time multi-gas monitoring is integrated with your ventilation control system, not operating in isolation.
4. Establish clear re-entry protocols after blasting that are based on measured gas concentrations, not fixed time intervals.
5. Train all personnel, not just ventilation officers, to recognise early warning signs of gas exposure.



MISTAKE 2

Designing for today, not for the mine's future

One of the most common and costly errors in mine ventilation is designing a system around the current mine layout and production requirements without building in the capacity for the mine to grow, deepen, or change.

Ventilation networks are not static. As a mine advances, airways extend, resistance increases, heat loads grow, and the number of personnel and diesel equipment underground multiplies. A system that performs adequately at year 1 may be critically inadequate by year 3.

The financial consequences are severe: retrofitting a ventilation system in an operating mine, adding raises, re-positioning main fans, or installing secondary fans is orders of magnitude more expensive than designing correctly from the outset. The safety consequences can be worse.

Disaster case: Westray mine explosion, Canada 1992

Twenty-six miners died when methane and coal dust ignited at the Westray coal mine in Nova Scotia. Investigations found that ventilation airflow was chronically inadequate for the production levels being undertaken; a direct consequence of ventilation design failing to keep pace with operational demands. Methane accumulations in development headings were well-documented in the weeks and months before the explosion. Adequate airflow was the single most critical variable that could have prevented the disaster, and it was absent.

The consequences

1. Insufficient airflow to dilute diesel exhaust in deeper, more active headings.
2. Heat stress incidents as geothermal heat loads increase with depth and infrastructure cannot keep up.
3. Fan operating points moving off their design curves, reducing efficiency, increasing energy cost, and risking stall conditions.
4. Regulatory non-compliance as airflow falls below minimum legal requirements.

How to avoid it?

1. Commission ventilation network models at the pre-feasibility stage and update them at each stage gate.
2. Plan fan infrastructure fan chambers, raises, and ducting to accommodate at least two future expansion stages.
3. Build airflow quantity contingency into your design: a minimum 20-30% buffer above current requirements is a reasonable starting point.
4. Schedule periodic ventilation surveys (at least annually) to detect when actual airflows are diverging from design intent.



MISTAKE 3

Underestimating diesel particulate matter (DPM)

Diesel-powered equipment is the backbone of most underground hard rock operations. It is also one of the most significant sources of airborne contamination in underground environments and one of the most consistently mismanaged.

Diesel particulate matter (DPM) is a complex mixture of fine particles and gases produced by diesel combustion. It is classified as a group 1 carcinogen by the International Agency for Research on Cancer. Chronic exposure significantly elevates the risk of lung cancer.

The mistake typically manifests in one of three ways: insufficient dilution airflow for the diesel fleet in operation; failure to account for fleet changes (adding more or larger machines without recalculating ventilation requirements); or reliance on outdated monitoring that does not capture elemental carbon, the primary metric for DPM.

Operational reality

In many jurisdictions, the dilution airflow requirement for diesel equipment is calculated based on engine kilowatt rating. A single 300 kw underground loader may require as much as 18 m³/sec or more of fresh air for dilution alone. In a busy development heading with multiple diesel units operating simultaneously, the required airflow quantities are substantial. When ventilation design does not account for the full diesel fleet, DPM exposure routinely exceeds regulatory limits without triggering immediate visible symptoms, making it one of the most insidious occupational health hazards in underground mining.

The consequences

1. Long-term elevated cancer risk for underground workers: a liability that extends years beyond a miner's time underground.
2. Regulatory penalties and potential mine closure orders in jurisdictions with strict DPM exposure limits.
3. Significant remediation costs if systems must be redesigned to accommodate unplanned diesel fleet expansion.

How to avoid it?

1. Calculate dilution airflow requirements against your entire diesel fleet, including peak simultaneous operation scenarios.
2. Use elemental carbon monitoring rather than relying solely on CO or opacity as DPM proxies.
3. Establish a formal change management process: any new diesel equipment introduced underground must trigger a ventilation review.
4. Consider lower-emission diesel technology and transition pathways as part of long-term ventilation planning.



MISTAKE 4

Failing to model before you build

Ventilation network simulation is not a luxury reserved for large, complex mines. It is a fundamental engineering tool that should be used at every stage of mine development from pre-feasibility through to operational optimisation.

The mistake is proceeding with ventilation infrastructure decisions (fan selection, raise placement, regulator design) based on simplified hand calculations or, worse, intuition and precedent. Underground airflow networks are non-linear systems. Small changes in one part of the network can produce significant, counterintuitive effects elsewhere.

Without simulation, engineers cannot predict how airflow will redistribute when a new heading is opened, how a fan failure will propagate through the network, or whether a proposed expansion will result in airflow reversals in critical areas.

Disaster case: Pike River mine, New Zealand 2010

Twenty-nine miners were killed in a series of methane explosions at the Pike River coal mine. Subsequent investigation found that ventilation design was fundamentally inadequate for the mine as built and operated – a single fan in a gassy coal mine with no secondary means of ingress or egress for fresh air. Network modelling would have revealed the catastrophic vulnerability of this configuration. Instead, decisions about ventilation infrastructure were made without the benefit of robust simulation, and the mine opened with a system that could not safely manage the methane loads generated by coal extraction.

The consequences

1. Infrastructure decisions that are expensive or impossible to reverse once construction has commenced.
2. Fan selection errors – oversized or undersized fans that operate inefficiently or fail to deliver required airflow quantities.
3. Airflow reversal events in emergencies, where smoke or contaminated air is directed towards refuge chambers or egress routes.
4. Inability to demonstrate regulatory compliance through engineering evidence.

How to avoid it?

1. Build and maintain a calibrated ventilation network model from the earliest stages of mine development.
2. Update the model whenever significant changes are made to the mine layout, production schedule, or diesel fleet.
3. Use simulation to test emergency scenarios including fire and fan failure before they occur underground.
4. Engage a qualified ventilation engineer to interpret model outputs and translate them into practical design decisions.



MISTAKE 5

Treating ventilation as a cost centre, not a safety system

Ventilation is typically the single largest operational energy cost in an underground mine, often accounting for 30–50% of total electricity consumption. This creates a persistent pressure, at both the site and corporate level, to optimise ventilation for cost rather than for safety. The mistake manifests in decisions such as: reducing fan speeds; deferring the installation of additional ventilation infrastructure to control costs; or allowing the diesel fleet to grow without a corresponding investment in ventilation capacity.

These decisions are often made by people who are not ventilation specialists – mine managers, financial controllers, and operational leaders who see ventilation as purely a cost rather than as the primary means of keeping underground workers alive. And they are often made incrementally, each individual decision appearing reasonable, until the cumulative effect creates a system that is critically compromised.

Disaster case: Upper Big Branch mine disaster, USA 2010

Twenty-nine miners died in a methane explosion at the performance coal company's Upper Big Branch Mine in West Virginia. Investigations identified chronic ventilation inadequacies that had been documented but not remediated. The economic pressures of coal production had repeatedly taken precedence over ventilation investment. The disaster is one of the worst in recent US coal mining history and resulted in over US\$10 million in penalties and more than US\$200 million in criminal liabilities. Multiple ventilation system failures spawned by a corporate culture that prioritised production and cost over safety were identified as contributing causes to the initial methane explosion and the more powerful coal-dust explosion that followed.

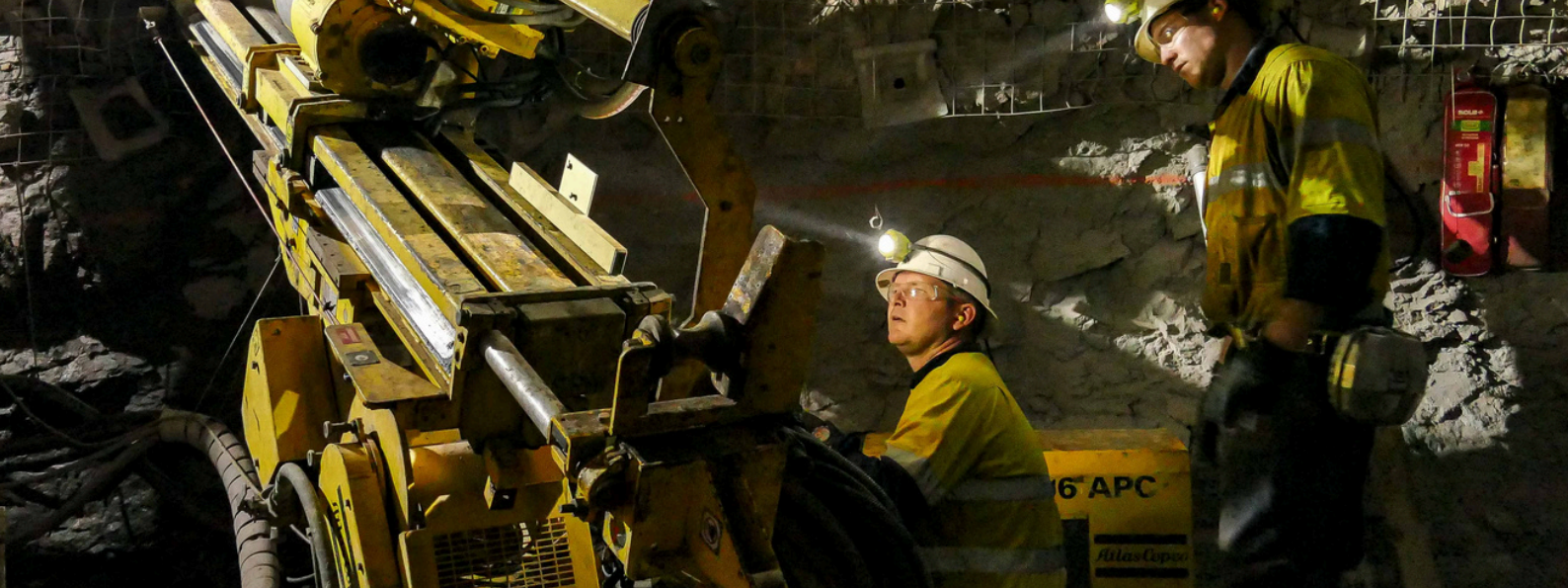
The consequences

1. Catastrophic single-event failures when accumulated ventilation deficiencies encounter an ignition source or emergency.
2. Regulatory penalties and mine suspensions that far exceed the cost of the ventilation investment that was deferred.
3. Chronic health effects and acute safety impacts that generate long-tail legal and civil compensation liability.
4. Loss of the social licence to operate, particularly as community and regulatory scrutiny of mining operations intensifies.

How to avoid it?

1. Treat ventilation investment decisions through a risk-adjusted lens: quantify the cost of a ventilation failure, not just the cost of the system.
2. Implement ventilation on demand (VOD) systems to optimise energy use intelligently without compromising safety.
3. Ensure ventilation professionals have a direct line of reporting to senior management and are included in production planning discussions.
4. Conduct regular ventilation audits and present findings to mine leadership as a risk management function, not a technical housekeeping exercise.





PROFESSIONAL CERTIFICATE

What's next for you?

If any of the mistakes in this guide are present in your operation or in the operations you advise, the most powerful step you can take is to build a deeper, more practical foundation in mine ventilation.

The **AusIMM Professional Certificate in Mine Ventilation** is a globally applicable, 100% online program developed and delivered by experts, including J. Daniel Stinnette – the same expert whose field experience underpins this guide.

Across six modules, you will develop the technical capability to design, assess, model, and optimise underground ventilation systems, and to avoid precisely the kinds of errors documented here.

Note: *Completion of this course alone does not meet statutory requirements or qualify participants for Ventilation Officer appointment under any jurisdiction.*

Course Details

- 6 modules delivered over 8 weeks
- 100% online | 40 PD hours
- Globally applicable to coal & hard rock



ENROL NOW