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# Technical reference guide

## Windblast management in underground coal mines

**(MDG 1003)**

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# Table of Contents

# 1. Introduction

This technical reference guide (TRG) replaces previous editions of MDG1003 Windblast guideline for underground coal mines.

This TRG guides underground coal mine operators in developing and documenting a windblast management plan. A windblast management plan (WMP) forms part of the mine's principal hazard management plan (PHMP) for ground or strata failure in underground mining operations. This document is intended for underground coal mines. It also provides further reference material for factors that mine operators need to consider when developing predictive models.

This document should be read in conjunction with:

- NSW WHS Acts and Regulations[1]
- NSW codes of practice:
  - Work health and safety consultation, cooperation, and coordination (NSW State Government, Safe Work NSW. August 2019b)
  - How to manage work health and safety risks (NSW State Government, Safe Work NSW. August 2019a)
  - Safety management systems in mines (NSW State Government, Feb 2015a)
  - Strata control in underground coal mines (NSW State Government Feb 2015b)
- NSW Resource Regulator's guidance material, for example:
  - Guide - Preparing a principal hazard management plan (NSW State Government, Sep 2022b)
- Australian and International Standards in related fields, for example:
  - AS ISO 31000: 2018 Risk Management — Guidelines
  - AS/NZ ISO 45001: 2018 Occupational Health and Safety Management Systems – Requirements with guidance for use.

# 2. Complying with the legislative and regulatory requirements

## 2.1. Legislative and regulatory requirements

Windblast poses significant risk to worker health and safety. Accordingly, PHMP's for ground or strata failure[2] should contain separate WMPs where windblast risk is identified. WMPs should include comprehensive and systematic investigation and analysis of all aspects of windblast risk. Rates of extraction in an underground coal mine can contribute to windblast risk. Consequently,

[1] The NSW WHS laws are:

*Work Health and Safety Act 2011* (WHS Act)

Work Health and Safety Regulation 2017 (WHS Regulation)

*Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHS(MPS) Act)

Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHS(MPS) Regulation)

[2] Schedule 1, section 1(k) WHS (MPS) Regulation 2022

mine operators should assess and regularly update their management plans to account for any changes in projected production.

Mine operators must involve competent workers in windblast risk assessments to ensure the appropriate assessment of all risks and controls[3]. Developing a WMP also requires active workforce participation.

## 2.2. Interaction with the safety management system

A ground and strata control PHMP forms part of the safety management system (SMS) for a mine. For more information about SMSs, see the Safety management systems in mines - code of practice.

The WMP within the ground and strata control PHMP must:

- describe the context in which the hazard exists at the mine
- describe how the implementation of measures under the PHMP – ground or strata failure for the area will be coordinated with other PHMPs and principal control plans.

When developing a WMP the mine operator must consider its relationship with other plans. The WMP will cross reference the following plans:

- Ventilation control plan
- Fire or explosion PHMP
- Emergency plan
- Inrush and inundation PHMP
- Pillar design and extraction plan.

## 2.3. Consultation

When managing risks, the mine operator must consult with workers and other duty holders at the mine[4] on windblast risk. This includes other workers conducting a business or undertaking (PCBUs) such as contractors. Details are found in the Guide – Preparing a principal hazard management plan (NSW State Government, Sep 2022b). The following links provide further guidance on consultation, cooperation and coordination:

- NSW Code of practice: Work health and safety consultation, cooperation, and coordination
- Consulting workers fact sheet.

# 3. Risk Management

## 3.1. Hazard identification

Windblast is an event resulting in sudden mass air movement that has the potential to cause injury to workers, damage the mine and mining equipment or seriously disrupt the mine's ventilation system. Windblast is one of the most serious events that can occur in an underground coal mine. This can be whether the mine utilises various 'wall' type extraction methods, or other full or partial secondary extraction techniques. Windblasts are violent, uncontrolled, and unpredictable.

There is a windblast risk where there is:

1. a void/goaf; and

[3] Section 14 WHS (MPS) Regulation 2022

[4] Section 19 WHS (MPS) Regulation 2022

2. a source of potential energy (typically an unsupported rock mass); and
3. an opening from the void into the mine workings.

The effects of a windblast include:

- large displacements of atmosphere from mined out areas into the working place
- a shock wave associated with increased air pressures
- abnormal pressure differentials
- high velocity (hurricane force) winds

The risks associated with windblast include:

- objects (ranging from particle size to in some instances hundreds of kilograms in weight) becoming projectiles
- violent displacement of people including the possibility of being drawn back into the goaf
- flammable, noxious and/or irrespirable gases that have accumulated in the goaf inundating the workplace
- water that has accumulated in the goaf inundating the workplace
- dust being raised into suspension, including coal dust which can become explosive
- massive roof, containing quartz, generating incendive sparks hot enough to provide ignition sources
- damage to electrical apparatus during the windblast providing ignition sources.

The most severe consequence of windblast is a gas and/or coal dust explosion. Gas or coal dust explosions require fuel and an ignition source. Windblasts provide both.

Ignition sources may be either manufactured or natural. The incendive nature of roof strata is critical to the risk of explosion from windblast. Electrical apparatus in the workplace is an example of a manufactured ignition source that might be classified as that with the highest probability of producing ignition energy. It must be remembered that the damage caused by a windblast can bypass the best electrical protection in use. In the event of a windblast, pressure transducers commonly used to disconnect power may not operate quickly enough to eliminate an ignition source (although they are still useful to control secondary hazards).

It is unlikely that all ignition sources will be controlled in the event of a windblast. Positive ventilation of the goaf should therefore form a major part of any risk minimisation strategy. This will prevent the accumulation of gas that is flammable or likely to become flammable. This also applies to minimising risk associated with noxious and irrespirable gases.

The likelihood or advent of spontaneous combustion adds complexity to windblast management. Goaf ventilation controls necessary to eliminate seam gases are opposite to those associated with spontaneous combustion control. Selection of a suitable ventilation regime becomes more difficult when the risk of both is present. As a guide, mine operators could resolve this dilemma by ranking the presence of methane gas as the greatest hazard. This is because of its known continuous presence, the immediacy of its danger and relative ease with which it can be measured and controlled.

In the situation where a goaf already contains a coal heating, mine operators must also consider the possibility of carbon monoxide being pushed into the workplace. Again, the selection of a suitable ventilation regime is going to be extremely difficult.

Windblasts can also create the risk of inundation of working places by significant volumes of displaced water. Such working places could include the working panel or alternatively panels in the mine that are down dip of the subject area. If the potential for inundation exists after a pillar collapse, then standing panels must be maintained free of significant volumes of water.

## 3.2. Risk assessment

A windblast risk assessment should establish the geological and mining conditions at a mine and compare them against conditions known to be associated with windblast. Previous experience has shown the following conditions to be associated with windblast:

- goaf areas having immediate roof consisting of thick, massive strata, such as conglomerate or sandstone
- goaf areas having thick, massive beds above the immediate coal or shale roof but lying within the expected height of caving
- goaf areas having horizontal igneous sills (associated with the boundaries of intrusive plugs or diatremes) lying within the expected height of caving
- significant areas of low width to height ratio, low factor of safety coal pillars.

Very thick beds of massive roof (i.e., more than 10 metres) are associated with systemic windblast. Irregular windblast events can occur when thinner beds exist. Under these conditions a windblast event does not require the entire goaf to cave. There are numerous examples of powerful windblasts on limited sections of the face or panel, where only a portion of the goaf has fallen.

On longwall faces, when most of the goaf area falls simultaneously, windblast develops most strongly in the gates roads and face ends. The effects of smaller goaf area falls can be felt along the face line. In several documented cases, mineworkers have been knocked down while standing mid-face following the collapse of only the central third of the goaf. In these cases, the windblast entered the face through the shields and travelled along the face line before returning to the goaf through the shields. The gate roads were unaffected by the windblast.

Air gaps can develop in the goaf between the top of the weak immediate roof rubble pile and the upper massive member. This occurs when a massive bed exists above the immediate coal or shale roof line but within the expected caving height of the face. Subsequent failure of the massive member will cause sheets of stone to fall into the air gap, creating a windblast. Experience has shown that the thickness of the septum between the face roof line and the lowest portion of the massive bed is important in reducing windblast effects. It is believed that a readily caving immediate roof at least twice the thickness of the coal section being mined reduces the risk of windblast considerably. This is because the bulking factor of the fallen immediate roof is understood to dampen the windblast.

While it is generally believed that commencing a goaf adjacent to a geological structure helps induce an early cave, sills may occur where there are vertical plugs and diatremes. These sills may delay caving and have been associated with unexpected windblasts on face start up.

Windblast events have occurred following the sudden collapse of coal pillars with a small width to height ratio. This mechanism may also be relevant to any partial pillar extraction techniques where the width to height ratio of remnant pillars may be low. The collapse of a series of small pillars over a substantial area can cause catastrophic damage, comparable to that experienced in gas and/or dust explosions.

For further information on managing risks under WHS MPS Regulation, including specific obligations for conducting risk assessments, see *Managing risks in mining and petroleum operations: Guide* (NSW State Government, Sep 2022). Also the *NSW code of practice: How to manage work health and safety risks* (NSW State Government, Safe Work NSW. August 2019)

### 3.2.1. Determining the likely impacts of windblast

Should the geologic conditions at a mine indicate a likely windblast event, mine operators should conduct a risk assessment. This will determine if mining is safe to continue, or the appropriate mining method in the circumstances.

Detailed risk analyses quantify each element of the hazard and form an essential part of the risk assessment. The risk assessment should estimate the magnitude of the following characteristics of windblast:

- peak velocity (measured in metres per second)
- peak over pressure (measured in kPa)
- maximum exclusion distance (measured in metres).

This quantified data will provide the basis for an estimate of the impact windblast may have on the mine’s workforce and infrastructure.

Mine operators should consider the extensive Australian windblast research during their risk analysis, including as a minimum the following research reports:

- ACARP (Australian Coal Association Research Program) report C6030 – The dynamics of windblasts in underground coal mines.
- ACARP report C7031 – Displacement of methane from the goaf into the working place as a result of windblasts in underground coal mines.
- ACARP report C10024 – Windblast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 and C8017.

## 3.3. Risk control strategies

### 3.3.1. Prevention

The primary risk control must be the prevention of windblast where mining or particular mining techniques occur in a windblast environment. Mitigation controls are not appropriate as primary risk controls. Mining design must aim at prevention of systemic windblast and this in turn can be achieved by ensuring a quick and regular goaf cave. Any mining design that is likely to result in repeated displaced goaf air velocities of more than 20 metres per second is not acceptable.

#### 3.3.1.1. Longwall extraction

The width of longwalls should be designed to achieve quick and regular caving or alternatively, that the goaf never caves. While massive conglomerate roof goaf spans of 30 metres may stand for long periods, even these narrow spans may be too wide for less competent rocks such as sandstone. Non-caving goafs require careful design as unseen geological features may critically weaken a potentially stable goaf span.

Expert geotechnical advice is essential in designing caving goafs. The following research reports form a start point for design considerations:

- ACARP report C7019 – Optimisation of longwall mining layouts under massive strata conditions and Management of the Associated Safety and Ground Control Problems
- ACARP report C7020 – Prediction and management of adverse caving about longwall faces

Under certain circumstances it may be possible to induce a goaf to cave earlier than would otherwise be the case. This can be achieved by hydraulic fracturing. This involves injecting pressurised fluid (usually water) into specialised horizons in the roof strata to create fracture patterns that assist caving.

This process has been documented in the following report:

- ACARP report C9024 – Development of hydraulic fracturing to control windblast

**Note:** The project described in ACARP report C9024 employed hydraulic fracturing as a secondary control to induce strata collapse in designs where goaf width alone has failed to induce adequate caving. Hydraulic fracturing of strata should be a substitute for selecting appropriate face widths as part of good caving design. Nor should it be seen as the primary control for windblast. Hydraulic fracturing should be viewed in the context of section 6.3 control and 6.3.2.4 Hydraulic fracturing.

#### 3.3.1.2. Pillar extraction

The same goaf width design principles apply to pillar extraction as they do for longwalls. The aim is to ensure early and complete strata caving within the goaf.

Pillar extraction design should also consider the following practices:

- commencing goaves adjacent to natural weaknesses such as faults or dykes
- where possible, using existing standing goaves to create early caving by continuing the goaf line
- incorporating into panel layouts as many entries as possible on both sides of the goaf to dissipate the velocity/pressure effects of a windblast
- making every effort to eliminate (standing) coal left in goaf areas. Stook size should be critically examined. Any decision made on the amount of standing coal to be left should be consistent with sound pillar extraction safety principles.

#### 3.3.1.3. Standing pillars

The acceptable strategy to prevent windblast from pillar collapse is to take a conservative approach to pillar design that guarantees long-term stability. The complexity of geotechnical issues such as surrounding strata stiffness are often beyond the technical expertise of mine operators. Expert geotechnical advice is therefore essential in deciding upon an acceptable pillar design.

The following research report forms a start point for design considerations:

- ACARP report C9018 – Systems approach to pillar design

### 3.3.2. Potential for windblast

Any initial mine planning and exploration program must consider the potential for windblast where this information is used in determining pillar and panel widths (amongst many other factors). Information can be gained in early exploration programs by:

- sampling for potential massive channels and beds above the coal seem that may result in delayed caving and windblast
- determining factors such as:
  - the thickness and physical properties of these channels and beds
  - the physical examination of the drill cores to determine the in-situ properties such as the joint/ discontinuities frequency and other factors that may determine the propensity to cave readily.

It is always important to seek advice from subject matter experts when devising the testing protocols to gain the required information.

Being able to predict a windblast event is critical because a windblast may develop in a panel even where it has been designed to ensure quick and regular cave. In these circumstances warning of a windblast is essential to enable timely worker withdrawal from the goaf edge to a safe place.

The following warning techniques should be considered at coal mines:

- monitoring the mine environment for physical indicators of a likely massive goaf collapse
- micro-seismic monitoring
- hydraulic roof support leg pressure monitoring.

While none of these listed methods is infallible, micro-seismic monitoring has the highest probability of detecting warning signs of windblast.

Micro-seismic monitoring detects audible emissions made as rock fails. Geophones are placed in the roof and these instruments detect seismic emissions. These responses are transmitted to a centralised computer on the surface. Here, special software analyses the data, and the results permit an operator to form an opinion as to the likelihood of a fall. If a fall is indicated, then an audible and visual alarm is relayed to the face. Unless the process is automated an operator must be dedicated to this task whilst there are workers in the area determined to be of windblast potential.

Performance measurement of micro-seismic detection systems indicate that the best detection systems available give relatively limited warning to face workers. While warning systems are essential in the management of windblast (after it has developed) they are insufficient as a sole method of risk control. Additional measures to ameliorate the impacts of windblast are necessary.

## 3.3.3. Operational controls

In addition to prediction, mines must have mitigation measures in place where a windblast may be difficult to predict. For example, in situations where a windblast develops in a panel designed to ensure a quick and regular cave. These processes must include means for protecting both the workers and the mine by mitigating the windblast effects. These processes will include both management plans and permanent measures providing continuous protection.

The mine should establish a windblast control group in the mine's emergency plan to coordinate and manage the mines response to windblast events. This group must comprise workers appropriately authorised to implement decisions, together with appropriate expertise and stakeholder representation.

The control group must maintain an event log that effectively records issues, decisions, actions and resulting events. Details for the minimum data set to be collated following a windblast event are listed in Appendix A. Any control group should not be disbanded until the risk of windblast has been eliminated. Event logs, minutes or other records should be made available to effectively communicate to the workforce (and others) matters that they need to know.

It is acceptable that line management form part of a control group. A line manager may need to be relieved of some normal managerial duties at times to effectively contribute to the group. These arrangements should remain in place until such time that the control group is disbanded.

### 3.3.3.1. Determination of a windblast zone

The mine should define this zone in relation to all accessible areas subject to the effects of windblast. It is essential to consider the maximum excursion distance. In no instance shall a windblast zone be smaller than the maximum excursion distance. This zone should be appropriately sign posted and fenced.

### 3.3.3.2. Control of access to windblast zone

The mine should develop and implement a process for controlling worker access to any windblast zone. Elements of this procedure could include (but are not limited to):

- minimising the number of workers entering the area
- identifying the conditions under which workers are permitted to enter the windblast zone exclusion area. These conditions should be sign posted at the entrances to the area
- requiring workers to either obtain authority or give notification prior to entering the windblast zone. Such notification should include the number of workers entering the area, the duration, and the nature of the work that they intend to perform
- providing for special access control during emergencies.

### 3.3.3.3. Withdrawing workers

The mine should develop and implement a process for withdrawing workers from the windblast zone where a windblast has created a potentially life-threatening situation. This process must specify the conditions that would trigger a worker withdrawal from the windblast zone and the conditions that must prevail before workers are permitted to re-enter the windblast zone. This may be achieved by developing an appropriate trigger action response plan (TARP).

#### 3.3.3.4. Controlling operations

The amount of open goaf standing is a condition frequently used to control operations in, and withdrawal from, the windblast zone. Depending upon previous experience and assessed risk, open goaf should be rated into zones being either:

- normal (or green) – meaning an area of exposed goaf that in the event of collapse will not generate a significant air velocity
- alert (or amber) – meaning an area of exposed goaf that in the event of collapse may generate a significant air velocity
- stop mining (or red) – meaning an area of exposed goaf that in the event of collapse is likely to/or will generate a windblast.

The above zones would form the basis for any TARP developed to guide workers on their actions and potential withdrawal from a dangerous position. A risk assessment should guide the development of procedures and a TARP. Procedures should include who is responsible for the change of status between various zones.

When mining under alert (or amber) conditions, the mine should implement special protective measures for workers. These include (but are not limited to):

- providing personal protective equipment (PPE). This should include as a minimum full-face helmet, safety glasses that cannot be dislodged, leather jackets, gloves, knee and elbow protectors, stout clothing for the body, arms and legs, and ensuring that items such as cap lamps and self-rescuers cannot be separated from the worker in a windblast
- limiting the nature of work to be permitted in gate roads and gate ends. This should also specify the number of workers permitted to be in these areas at any time
- providing tether lines at all points in the windblast zone. These tether lines shall be equipped to permit continuous attachment to a lifeline irrespective of a worker’s location or nature of work. The tether line shall have personal activation that will allow an individual to immediately detach from the lifeline if safety conditions require it. All tether lines will need to be equipped with inertia reels to control the extent of motion experienced by any worker subjected to windblast
- providing safe havens accessible by any worker within seconds, irrespective of their location. The safe havens must ensure that a worker is either located away from the line of air movement or is protected from the force exerted by air movement
- securing all loose objects. Any loose item such as a hand tool or step ladder or drum can become a lethal projectile
- providing pressure switches that are capable of safely isolating electric power to all equipment in the windblast zone in the event of a windblast.

### 3.3.4. Other safety controls

#### 3.3.4.1. Ventilation design

The mine must establish the risk that windblast is likely to have upon the ventilation system in the mine. Ventilation modelling could aid this process and reduce the risk to the integrity of the mine’s ventilation system from windblast. The process must also aim to minimise the impact of windblast in the windblast zone and to ensure the quickest possible return to normal ventilation conditions following a windblast.

Matters to be considered include (but are not limited to):

- ventilation quantities, pressure differentials, number of roadways, disposition of main airways, together with bleeder headings, balance roadways and waste ventilation
- the design and construction of ventilation structures that can resist the effects of overpressures created by worst case windblasts

- criteria for determining the sufficiency of ventilation monitoring at the mine to ensure it is meeting the design intent before, during and after a windblast.

#### 3.3.4.2. Gas monitoring

The mine must establish and maintain a robust gas monitoring system capable of providing real time analysis of explosive gases in the windblast zone before, during and after a windblast.

Matters to be considered include (but are not limited to):

- the type and location of gas monitoring points and information to be provided by the system
- criteria for setting, acceptance, re-setting, and reporting of gas monitoring system alarms
- the location of monitoring stations, and the measurement frequency and methods (including equipment and procedures)
- criteria for maintaining and calibrating gas monitoring systems in use at the mine
- strategies and methods to ensure consistency and repeatability in measurements
- criteria for maintenance and calibration of gas sampling and analysis equipment in use at the mine
- measures to protect the monitoring instruments, as far as reasonably practicable, from the effects of a windblast to minimise any potential outage of monitoring due to equipment damage.

#### 3.3.4.3. Preventing explosions

The mine must establish processes that prevent the likelihood of gas and/or dust explosions arising from windblast.

Matters to be considered include (but are not limited to):

- removing electric power to the panel in the event of a windblast (and the mechanisms available to do this in an acceptable timeframe, for instance, pressure switches)
- maintaining the highest level of stone dusting in the mining panel at all times
- providing explosion barriers in all gate roads
- introducing a continuous stream of stone dust in the goaf area during mining to neutralise coal dust deposits that may accumulate there. This is in addition to the normal use of trickle dusters in the return airway.

#### 3.3.4.4. Hydraulic fracturing

Hydraulic fracturing can open known zones of rock weakness that create fractures in the rock mass and reduce its integrity. This weakened rock mass should fall more regularly and in smaller amounts and reduce the risk of windblast. Experience at mines suffering from severe windblast found that hydraulic fracturing reduced the size of goaf falls by up to 60% but reduction in windblast effects was not of the same proportion. It is worth repeating that hydraulic fracturing can reduce windblast but does not eliminate it.

Hydraulic fracturing has hazards of its own and its safe and successful implementation relies on the careful and diligent management. Mines need to carefully consider the timing of both hydraulic fracturing and operation of the face. This will ensure maximum effect without adding any risk to those involved in the injection process.

Reference is again made to the following research report:

- ACARP report C9024 – Development of hydraulic fracturing to control windblast

Hydraulic fracturing can be a powerful tool in ameliorating windblast and should be included in any plan to address windblast hazards.

## 3.4. Time limits for windblast management

Windblasts develop where a mine fails to understand and/or design for prevailing conditions. Windblast controls, as listed in section 3.3.2 to 3.3.4, should be seen as short-term measures. They have limited currency until design parameters are altered to create windblast-free conditions.

It is expected that windblast prediction and controls used at a mine should apply for as short a time as possible.

## 3.5. Documenting the control management system

The control management system in the windblast management plan should:

- identify and describe threats, controls, and consequences
- use schematics (e.g., bowtie diagrams)
- justify the use of controls.

## 3.6. Incident management

In addition to the TARP process outlined above, the management of any windblast incident should be included within the emergency management plan. Details for emergency planning are contained within the NSW code of practice for Emergency planning for mines. A key element of the emergency response is the incident management process. The NSW Mines Rescue Incident Command and Control Systems is an example of how to establish and operate an incident management system.[5] Other guidance can be found in AS 3745:2010 *Planning for emergencies in facilities*.

## 3.7. Effectiveness of controls

A critical control is a control that is crucial to preventing an event or mitigating the consequences of an event. Such a control is critical because its absence or failure would significantly increase the risk of serious injury or death despite the existence of other controls. An indicator of a control's effectiveness is whether implementing the control has introduced any new hazards. For further details see the *Guide - Preparing a principal hazard management plan* (NSW State Government, Sep 2022).

## 3.8. Information, training and instruction

The mine must develop and implement training programs for the supervisory staff and mine workers.

In particular, the mine must have standards for training that define:

- who or which entities are to conduct training and the requisite level of certification or other qualification required by trainers
- the classes of people at the mine who will undergo training
- the competencies that those classes of people will be taught
- methods to assess learning of required competencies
- frequencies for reinforcing competencies through retraining
- means for identifying additional training needs.

The minimum content of training at the mine must cover (but in no way is limited to):

- the importance of compliance with windblast management plan (WMP) in effect at the mine
- roles and responsibilities of workers in relation to the operation of the WMP

[5] Mines Rescue ICCS Guide, NSW Coal Industry, Coal Services, 2014.

- means for identifying windblast related signs, including:
  - increases or changes in the caving characteristics of the goaf
  - identifiable changes in geological conditions
  - increase or change in gas concentrations
- appropriate means of recording and reporting the observation of any windblast-related signs
- standards and technical specifications associated with the WMP.

The mine must maintain objective evidence of the conduct of training and the assessment of competencies imparted by that training.

# Appendix A - Minimum information set

If a windblast risk is realised, the mine must have in place a process for the collection and recording of information relevant to windblast at the mine in a form which will assist with:

- characterising the number, type and extent of windblast events that have occurred at the mine.
- windblast event prediction
- windblast zone affected area determination
- review of the effectiveness of the WMP in managing the windblast risk at the mine.

Mines should retain the information in a form that will allow its use in a subsequent reassessment of the windblast risk at the mine and a review of the adequacy of the mine's WMP. In addition, the information should be made available for the purposes of assessing regional windblast risk or for reviewing this code as required.

Areas of measurement could include (but are not limited to):

1. mine
2. date
3. seam/s
4. geographic
   - area and depth of origin
   - location with respect to the seam, roof, floor or elsewhere
   - location of the event
5. description of the event
   - description
   - size and extent of the event
   - details of any personal injuries sustained
   - damage sustained by the mine
   - approximate extent of goaf falls
   - estimated height of goaf falls
   - air over pressures and velocities in openings near the goaf (monitoring system required before the event)
   - micro-seismic event monitoring
   - hydraulic roof support leg pressures
   - results of monitoring or other detection data
   - photographic records (of the goaf edge and adjoining gate roads at regular intervals and the affected area after a windblast has occurred).
6. evaluation of effectiveness of predictive tools, e.g.
   - results of seismic monitoring
   - results of hydraulic leg pressure monitoring
   - results of mine environment monitoring e.g., roof, rib, and roadway conditions adjacent to the area generating the windblast
7. evaluation of amelioration and protective actions
8. temporal

- time since material affected was first exposed
- date and approximate time of goaf falls
- working time for panel
- rate of retreat
- standing/interruption time/s
- face start-up/finish delays
- diary of events and decisions

9. mine environment
    - description of the surrounding mine and mine conditions
    - the position of the working face at the time of the goaf fall
    - panel dimensions (width, length)
    - roadway design - dimensions
    - strength of coal
    - cleat/jointing (including in any massive units associated with the windblast risk)
    - faulting/structures
    - stability of pillars (abutment, roadway) and adjacent areas
    - nature of roof and floor strata (including the size, type, thickness, and strength of any massive units associated with the windblast risk)
    - working height and section
    - roof/rib support
    - mining method (longwall, miniwall, shortwall, bord and pillar or any other secondary extraction method)
    - caving - closed/open goaf
    - area of standing goaf
    - water (effect of dewatering via gas drainage)
10. ventilation
    - design - single, flanking, bleeders (including the number of roadways available to dissipate the windblast)
    - nature of goaf ventilation
    - pressure and flow magnitude
    - ventilation appliances and seals. Performance before, during and after the event.
    - ventilation flows and pressures
    - ventilation stability
    - seam gases
    - airway constriction (falls, flooding).

# Appendix B – Definitions and references

## Definitions

For the purposes of this document the following definitions apply:

**Windblast** - windblast is an event, resulting in sudden, mass air movement, that:

- has the potential to cause injury to people
- has the potential to cause damage to the mine and mining equipment
- has the potential to seriously disrupt ventilation.

In almost all circumstances the event initiating mass air movement is a collapse of strata in a goaf area.

A windblast event is considered to have occurred when air velocity reaches a threshold of 20 metres per second.

**Excursion distance** – the distance that an atmosphere, expelled by windblast may infiltrate accessible areas of a mine.

**Windblast zone** - that area of a mine where conservative application of experience and/or predictive modelling identifies that windblast has the potential to cause injury to people, damage equipment or seriously disrupt ventilation.

**Risk assessment** – As per AS ISO 31000: 2018 – The overall process of risk identification, risk analysis and risk evaluation.

**Risk analysis** - As per AS ISO 31000: 2018 –The systematic process to understand the nature of and to deduce the level of risk. (Associated with an identified hazard).

## ACARP Projects

ACARP report C6030 – The dynamics of windblasts in underground coal mines.

ACARP report C7031 – Displacement of methane from the goaf into the working place as a result of windblasts in underground coal mines.

ACARP report C10024 – Windblast and methane expulsion: extension of field monitoring to generalise the results of projects C7031 and C8017.

ACARP report C7019 – Optimisation of longwall mining layouts under massive strata Conditions and Management of the Associated Safety and Ground Control Problems.

ACARP report C7020 – Prediction and management of adverse caving about longwall faces.

ACARP report C9024 – Development of hydraulic fracturing to control windblast.

ACARP report C9018 – Systems approach to pillar design standards

## Standards

AS ISO 31000: 2018 – The overall process of risk identification, risk analysis and risk evaluation.

AS ISO 31000: 2018 – The systematic process to understand the nature of and to deduce the level of risk. (Associated with an identified hazard).

## Resources Regulator codes and guidance

### Codes of practise

Work health and safety consultation, cooperation, and coordination (NSW State Government, Safe Work NSW. August 2019)

How to manage work health and safety risks (NSW State Government, Safe Work NSW. August 2019)

Safety management systems in mines (NSW State Government, Feb 2015)

Strata control in underground coal mines (NSW State Government Feb 2015)

**Guidance**

Consulting workers fact sheet (NSW State Government, September 2022).

Guide – Preparing a principal hazard management plan (NSW State Government, Sep 2022)

Managing risks in mining and petroleum operations: Guide (NSW State Government, Sep 2022).

# Appendix C – Case study

## Windblast event at Endeavour Colliery, 1995 – Resources Regulator case study[6]

At 9:50am on 28 June 1995, a windblast event at Endeavour Colliery created a subsequent inrush of methane from the goaf. This caused a significant explosion in the 300 Panel and substantial damage. Luckily, there were no fatalities.

The various investigations carried out identified several issues for which mine operators should be aware. In addition, mine operators should also note the following summary points regarding systems failures at the Endeavour mine:

- there was a failure of panel design, development, and review processes to recognise and effectively treat the hazard that the potential accumulation of gas in the 300 Panel goaf presented and the possibility of windblast
- there was a failure of workers on-shift, particularly those in supervisory roles to recognise the potential hazard that occurrences of gas and an imminent, large fall of roof in the goaf presented
- there was a failure at the mine to set and/or maintain adequate standards regarding ventilation (both practice and appliances) and the maintenance of stone dusting and barriers.

Further information on this event is available at: http://mineaccidents.com.au/uploads/endeavour-explosion-1995.pdf

[6] NSW State Government, Department of Mineral Resources (May 1996)