NSW GOVERNMENT | Trade & Investment Mine Safety

# GUIDELINE

## MDG 28

## Safety requirements for coal stockpiles and reclaim tunnels

**Produced by Mine Safety Operations Branch**

**NSW Trade & Investment**

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## PUBLICATION HISTORY

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# FOREWORD

This is guideline MDG 28 *Safety Requirements for Coal Stockpiles and Reclaim Tunnels*. It has been formulated to assist in identifying and controlling the risks associated with the use of dozers on coal stockpiles and coal recovery systems in reclaim tunnels.

This is a 'published guideline'. It provides an industry benchmark for engineering standards and fit-for-purpose equipment. It represents acceptable industry practice for reducing the risks associated with the use of this equipment.

Users of this guideline should rely on their own advice, skills and experience in applying risk and safety management systems in individual workplaces.

A feedback sheet is provided in the Appendices. Constructive comment is essential to help the department improve this guideline.

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# 1. Introduction

## 1.1 Purpose

The purpose of the guideline is to protect people against harm to their health, safety and welfare through the elimination or minimisation of lifecycle risks associated with operation of coal stockpiles and coal recover systems in reclaim tunnels.

NOTES:

1) This document provides guidance in developing and implementing hazard management plans for the elimination and control of risks associated with the operation of coal stockpiles and coal recover systems in reclaim tunnels.

2) The design and implementation of safety measures for dealing with hazards associated with reclaim tunnels and stockpiles will be influenced by the processing capacity, material characteristics and operational requirements relevant to the coal operation.

3) This guideline provides guidance on hazards and controls that are applicable to those systems on a range of sites, based on achieving an ALARP (As Low As Reasonably Practicable) risk profile.

4) Equipment, systems and the environment at each site will differ. It is the responsibility of each site operator to determine the hazards and risks that exist on the site and to develop and implement a site specific hazard management plan

## 1.2 Scope

This document provides guidance that covers the design, construction, installation and safe use (under normal and abnormal conditions) of coal stockpiles and coal recover systems in reclaim tunnels.

**Note:**

A list of Standards and guidance documents referenced by this guideline is given in Appendix A.

## 1.3 Application

This guideline applies to all coal stockpiles and coal recovery systems in reclaim tunnels with the following plant and equipment:

(a) Stockpile dozers in use on material stockpile and recovery areas; and

(b) Reclaim tunnels with a physical connection to the material stockpile and recovery area.

## 1.4 Definitions

| | |
|---|---|
| **1.4.1 Bridging** | A condition in which the hole above a draw down point for an operating feeder does not manifest at the surface of the coal stockpile. It is also known as doming, voiding and cohesive arches. |
| **1.4.2 Coal placement structures** | Coal clearance structures used for the support of gantries and the placement of coal onto a stockpile. For example rill towers, conveyors, trippers, slingers etc. |
| **1.4.3 Coal stockpiles** | The coal stockpiles referred to in this guideline are of a size that require stockpile dozers to be used to facilitate handling requirements. In most cases these coal stockpiles are over a reclaiming tunnel. Coal stockpiles are either run of mine or washed product stockpiles created from the coal mining and coal washing processes. |
| **1.4.4 Dozer driver** | A dozer driver is the operator of a stockpile dozer. |
| **1.4.5 Draw down point** | The place in the stockpile where material is drawn down into a reclaim tunnel through chutes, vibratory feeders, coal valves or ploughs. There may be a number of draw down points in a coal recovery system. |
| **1.4.6 Hazardous area** | Hazardous areas are classified into zones to facilitate the selection of the correct electrical apparatus and to ensure that the electrical design and installation meets the specified requirements to be used in different areas. The zone classification is based on the likelihood and the duration of an explosive atmosphere.<br><br>The zone classification for gases is divided into three zones, namely Zone 0, Zone 1 and Zone 2 and for dusts Zone 20, Zone 21 and Zone 22.<br><br>NOTE: Refer to the requirements addressed within Technical Reference Electrical Engineering Safety EES003. |
| **1.4.7 High risk zones** | High risk zones are areas on a coal stockpile where there is a potential for dozer drivers to lose control of stockpile dozers through ground instability or the development of voids. The site operator should use the hazard identification and risk management process to identify all such areas.<br><br>High risk zones include:<br>(a) The area surrounding a draw down point where a void can develop<br>(b) The uncompacted edges of the coal stockpile |
| **1.4.8 ISO** | International Standards Organisation. |
| **1.4.9 Rat holing** | A condition where the void created above a feeder has near vertical sides from the aperture in the feeder below the draw down point to the surface of the coal stockpile. |

| | |
|---|---|
| **1.4.10 Reclaim tunnels** | Tunnels beneath coal stockpiles and used for reclaiming coal from the stockpile. |
| **1.4.11 Rill angle** | The angle of the side slope at which stockpile coal resides after being tipped, discharged or placed on a coal stockpile. The rill angle is that of coal before being compacted by plant. |
| **1.4.12 Shall** | Indicates strongly recommended and is a requirement for compliance with this guideline. |
| **1.4.13 Should** | Indicates a recommended course of action. |
| **1.4.14 STEL** | Short Term Exposure Limit<br>An airborne concentrations of a substance, averaged over a period of 15 minutes. |
| **1.4.15 Stockpile dozer** | A generic term for plant which may be any of the following – tracked or rubber tyred dozer or loader used for pushing material on a coal stockpile. |
| **1.4.16 TWA** | Time Weighted Average<br>The average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week. |

# 2. 2. Site hazard management plans

Where a site contains stockpiles and reclaim areas and/or reclaim tunnels (as defined in Clause 1.4 Definitions) the operator should develop and implement a hazard management plan or plans to provide for the safe operation and maintenance of the systems.

Hazard management plans should be consistent with AS/NZS 4804.

Development and implementation of the plan should ensure that the following are provided:

- Controls for management of risks that include safe work systems
- Fit-for-purpose equipment
- Trained and competent people

Hazard management plans should contain details of the design parameters of the systems and a statement that design parameters should not be exceeded or changed without an engineering study and a hazard identification and risk review process.

# 3. Coal stockpiles

## 3.1 Hazards

The following typical coal stockpile hazards have been identified through consultation with industry operators, a review of accidents and incidents and a review of hazard management plans at a number of operations. This section may not include all hazards at coal stockpile facilities. Operators should identify hazards and risks of harm to people that are applicable to their own sites.

There have been a number of incidents in Australia and overseas where a stockpile dozer has fallen, or been inadvertently driven, into a draw down hole with serious consequences to the dozer driver. To date, this has been the most common and reoccurring serious incident associated with coal stockpiles and deserves special attention in the risk management process.

### 3.1.1 Change in operational use and design

Coal stockpile systems are designed for a particular capacity and have equipment designed to achieve those rates.

Where there is a change in the design parameters of the coal stockpile such as stockpile or reclaim capacity, or a change in the way the system is operated, there is a possibility that the change could result in a risk to people, equipment or the environment. A review of the hazards and risk control methods shall be conducted whenever coal stockpiles are significantly changed.

### 3.1.2 Stockpile compaction and stability

Bulk material placed by tipping, discharge from overhead conveyors and trippers and dozing will contain areas of instability. Placement areas are not designed as engineered compacted fill and the degree of compaction, size and shape is constantly changing.

Tipper discharge areas and sides of the stockpile will be poorly compacted; relatively steep and gradients will vary depending upon the method, force of placement and material properties. Draw down points can be affected by changes in the free flow of material.

Properties affecting the free flow of material include:

- Relative density
- Moisture content (affected by weather and feed quality)
- Particle size and distribution
- Segregation
- Variations in feed quality, i.e. different coal seams
- Placement rill angle
- Drawn down rill angle
- Chemicals such as flocculants and magnetite
- The passage of time, particularly where the stockpile is exposed to the elements
- Temperature - freezing and thawing

Placement and draw down rill angles on the edges of the material and adjacent to drawn down points can vary and material can be unstable. Sudden and unexpected slumping of the sides of the draw down point can take place.

Access ramps to and within the material stockpile area with inadequate compaction, gradients unsuitable for the equipment in use and inadequate width can be hazardous.

Weather and the operation of equipment have an impact on the compaction and stability of the pad.

Draw down areas vary in shape and size and can be affected by water, variation in material properties and compaction by dozers and similar.

### 3.1.3 Draw down points

The drawn down point's size, shape and degree of stability will vary, depending upon the factors set out in Clause 3.1.2, Stockpile compaction and stability.

There is a risk that a stockpile dozer will fall or be inadvertently driven into a draw down hole. A number of such serious incidents have taken place both in Australia and overseas. Major contributing factors include:

- The dozer driver was not aware of the location of the draw down point and either drove into the hole, or the dozer slid into the hole.
- The dozer driver drove over the top of a bridged hole that suddenly collapsed.
- There were no surface structures or other navigational aids that could be used by the dozer driver to identify the location of the draw down point.

Bridging and rat holing can take place. Bridging can prevent the reclaim feeder or coal valve discharging onto the reclaim conveyor and then suddenly collapse under the weight of a stockpile dozer.

Draw down points could be adjacent to or beneath stockpiling placement structures and be difficult for a mobile plant operator to see, particularly at night or in other conditions of poor visibility.

Draw down points that are clear of any stockpiling conveyors or other structures and not identifiable from surface features are particularly hazardous. If such draw down points bridge, there is no way of knowing exactly where the feeder location is and it becomes more difficult to avoid with a stockpile dozer.

Where a stockpile base and surface is not graded to allow water run-off and prevent the formation of central reservoirs, a partially extracted stockpile can become a water collection site, which at times can only be discharged through the draw down point. See Clause 4.1.7 Flooding.

Draw down holes left in an open condition, can be hazardous to dozer drivers.

**Figure 1. A stockpile dozer has fallen backwards when a bridged draw down point suddenly collapsed.**

Parking up stockpile dozers and other plant adjacent to the draw down point (within a high risk zone) is hazardous, particularly if the plant or vehicle is parked in the position of least stable alignment to, and potentially within, the area of influence of a draw down point.

Drawn down feeders or valves that are not operating can start operation without discernable warning. This causes a significant change in the surface area of the stockpile and the formation of a drawn down hole and presents a risk to mobile plant and people who could be in the area.

Indicator lights or warning sounds that indicate the start-up of a draw down feeder or valve are themselves potentially hazardous if not designed to be "fail safe" with back up redundancy or fault indication. That is, if "no indication" is supposed to indicate a safe condition, and an indicator fails to activate, a hazard could be concealed and the dozer driver be misled to believe conditions are safe and enter a hazardous area.

**Note:**

In one incident in the United States, a dozer driver, while preparing to push coal into a feeder, drove the dozer into the feeder. The operator was thrown through the windshield into the feeder entrance. The operator was not wearing a seatbelt and suffered serious injuries.

**Figure 2. The dozer driver has driven into the draw down point.**

#### 3.1.4 Dozer engulfment

The ability of a dozer driver to see the draw down hole when pushing coal is impaired by the blade and coal in front of the blade. It is difficult for the operator to see the edge of the hole.

When the stockpile dozer has a full blade of coal, the volume of coal may fill the draw down hole and reduce the risk. If there is little or no coal in front of the blade, the risk of the dozer going down into the draw down void increases.

The dimensions of the dozer and the stockpile height influence the risk. The risk of engulfment of the drivers cab is greatest when the depth of the draw down hole is greater than the distance from the dozer blade to the cab. This takes place when stockpile heights are near maximum and when operation of the drawn down feeder has caused the void to develop to its maximum depth.

The draw down point can bridge through compaction of the coal above the feeder and then suddenly collapse when the dozer passes over the draw down point.

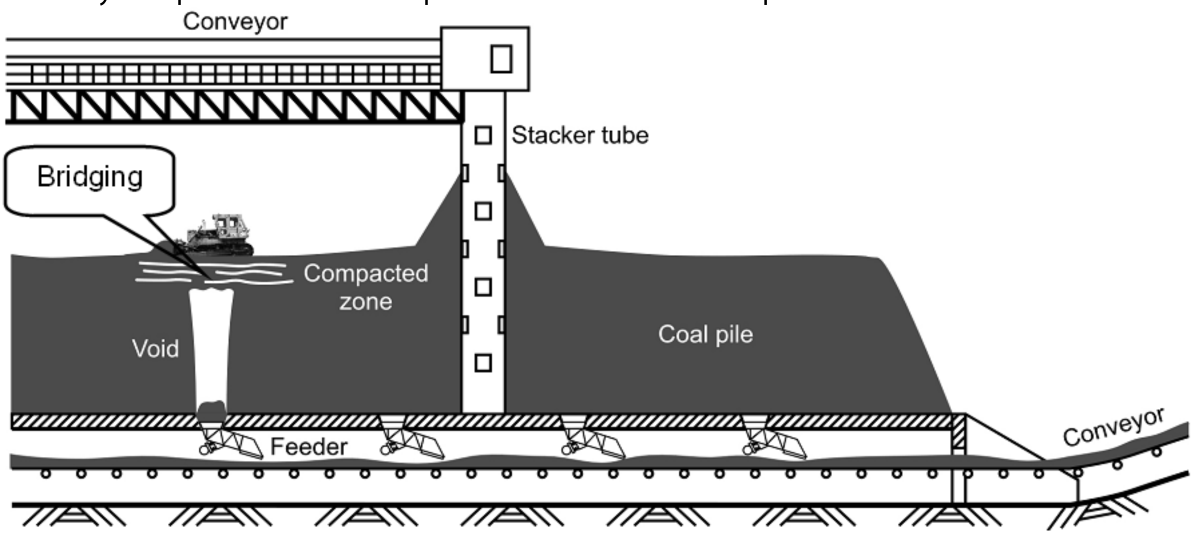


**Figure 3. Diagram of a coal stockpile and recovery facility showing bridging.**

The draw down rill angle can be steep and the edge potentially unstable. If the stockpile dozer goes down into the draw down hole, coal can collapse from the sides, burying the dozer cab. If the drawn down feeder continues to operate, this can exacerbate the situation.

If a stockpile dozer goes into a draw down hole, the event could go unnoticed by other system operators. The draw down feeder could continue to operate, perhaps increasing the depth of the hole. The safe recovery of the operator can be compromised.

**Figure 4. The stockpile dozer has fallen backwards into a draw down point following the collapse of bridging. Note the thickness of the bridged material.**

If the windows of the stockpile dozer cab are not designed to withstand the burial forces applied, material can flow into the driver's cab, placing the operator at serious risk.

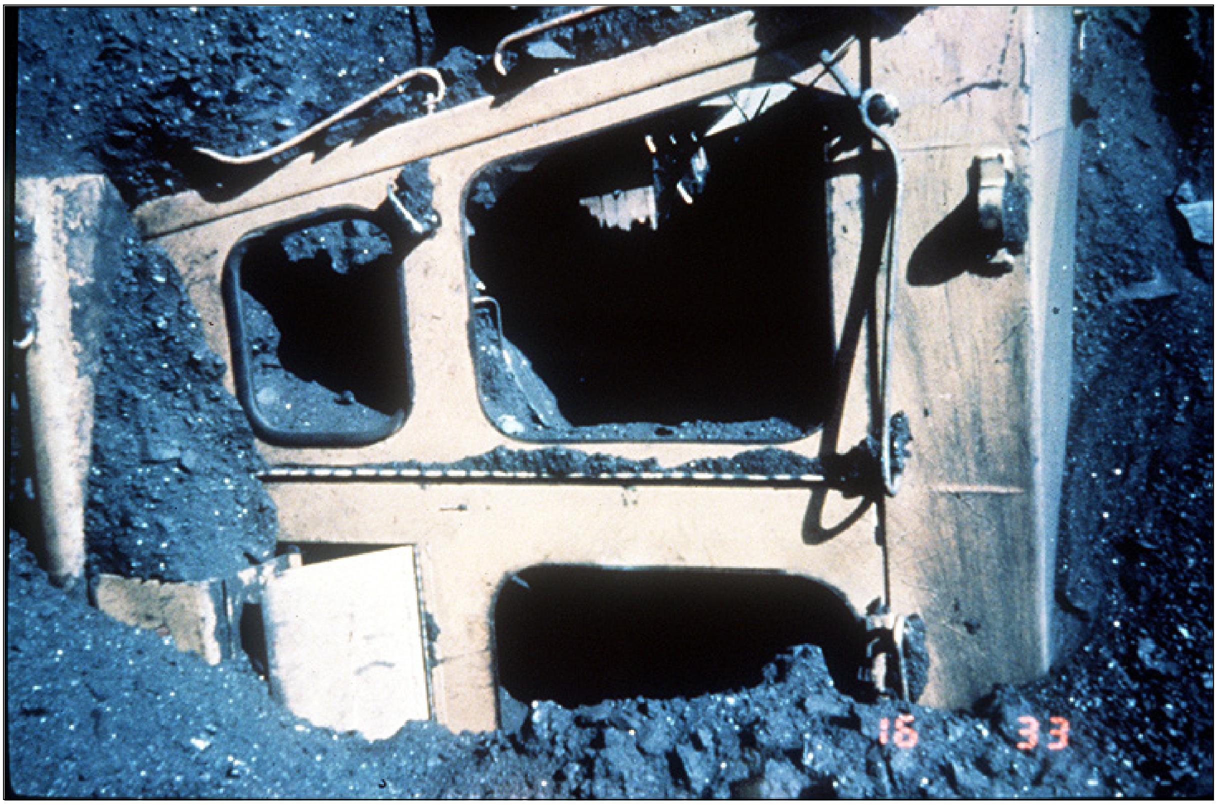


**Figure 5. Windows in the driver's cabin of this stockpile dozer have collapsed and the cab filled with coal after the dozer fell into the draw down point.**

There is a potential for coal to catch fire if in contact with heated surfaces of the dozer. The subsequent impacts from this type of event can result in contamination of the atmosphere to the operator's cab, and radiant heat effects to the operator.

The risks of harm to the dozer driver that shall be considered include:

- Time taken for other operators to note the incident and respond.
- Contamination of the atmosphere in the operators cab through a fire.
- Radiated heat effects from fire.
- The operators cab filling with coal through pressure of the surrounding coal causing collapse of the dozer windows.
- Difficulty of recovery from a relatively deep and unstable hole and the potentially lengthy time required.
- Safe access for recovery personnel.

**Note:**

A number of fatal accidents have resulted from the above causes, both in Australia and the USA and risks need to be managed accordingly at all coal operations. Clause 3.2, Controls, gives guidance on controlling hazards.

### 3.1.5 Unsafe bench heights

Material may be deposited by skyline conveyor trippers, dozers and trucks. The method of depositing material on the stockpile area will have impacts on the stockpile height, rill angles and the degree of compaction.

Material stockpiled by skyline conveyor trippers and similar can be at a significant height above the base level of the stockpile area. This can lead to circumstances where stockpile dozers are operating alongside stockpile material that is well above the height of the equipment. The risk is a sudden collapse onto the stockpile dozers.

### 3.1.6 Interaction with coal placement structures

Stockpile dozers used in and around stockpile structures could strike and damage structures leading to possible catastrophic failure.

Skyline support structures that have multiple column and angle iron supports designed for support of the placement conveyor system and not for interaction with mobile plant are most at risk.

What is the risk of collision on the stockpile involving mobile plant?

Assess the risk of impact to mobile plant/people from placement structures delivering material to the stockpile.

### 3.1.7 Provisions for stockpile access

There will be a need for stockpile dozers to be taken from the top of the stockpile area to the lower ground area to service machines and change over operators and similar.

As stockpiled material increases in height, the operation of stockpile dozers on the unconsolidated side slopes can be hazardous without the use of properly constructed ramps.

If the designed stockpile area or footprint of the stockpile area is exceeded, sufficient space to construct serviceable and safe ramps could be unavailable.

Exceeding the footprint area can also result in blocked perimeter access roads; reclaim tunnel entries, stockpile drainage systems and damage to services such as fire fighting mains.

### 3.1.8 Spontaneous combustion and fire risk

Spontaneous combustion in a coal stockpile can develop when the coal has been stockpiled for some time. Conditions that favour the development of spontaneous combustion include:

- Steep uncompacted sides – particularly those facing prevailing winds
- Maximum height of stockpiled material
- Infrequent removal and replacement of the material
- Rainfall, leading to increase in moisture

All coals are liable to spontaneous combustion; however some have a higher propensity than others. The development of spontaneous combustion is not readily visible. It takes place beneath the surface of the coal and is often not detected until well advanced and a serious problem.

The development of spontaneous combustion produces carbon dioxide and carbon monoxide at lower temperatures and methane, hydrogen, ethylene and other hydrocarbons at higher temperatures. Refer to Clause 4.2.6 “Monitoring and inspection”. Hydrogen and the higher hydrocarbons will form explosive mixtures with air.

Risks of harm to operators include exposure to smoke and flames and products of combustion such as CO and $CO_2$. A deep seated heating that has been developing for some time can cause the base material to be unstable.

Fire risk is similar to spontaneous combustion in its impacts and gaseous products except that it develops much more rapidly depending upon the heat source.

Spontaneous combustion and fire can also have impacts on the atmosphere, temperature and visibility within the dozer driver's cab.

#### 3.1.9 Impaired visibility

Conditions that can affect the ability of dozer drivers to see high risk zones and potentially hazardous areas such as overhead conveyor structures, draw down points, and stockpile edges include:

- Night time operation
- Dusty conditions
- Rising or setting sun in front of the operator
- Heavy rain
- Material stockpiled beyond designed limits
- Dirty windscreen
- Fog/mist
- Environmental considerations which pose a risk to safe operation on the stockpile

#### 3.1.10 Operator competence and awareness

When the competence of the dozer driver does not include experience on coal stockpiles associated with reclaim systems, in addition to conventional dozer operations, there is a heightened risk to the operator.

A competency-based training course is available for stockpile dozers operators "RIIMPO305A Conduct Stockpile Dozer Operations Training Resources" (refer to safework.com.au)

This course covers stockpile dozer operation in the coal mining industry including planning and preparing for activities, operating the dozer, and undertaking stockpile operations and tasks and maintenance activities.

The course covers all tracked dozers and those tasks and performance criteria that are within the legal and technical limitations of rubber wheeled dozers.

Coal operators should not rely on the course alone to provide competent stockpile dozer drivers. Provision should be made for drivers to practise the skills on coal stockpiles in varying conditions of weather, lighting and stockpile volume while under supervision until deemed competent.

The recovery of coal from some coal stockpiles may require large stockpile dozers to push material into reclaim points to supplement coal recovered from a loading bin and live storage areas.

**Note:**

Contracts negotiated with transport organisations often require reclaim to be completed within a certain time frame or cost penalties are incurred. This should not compromise the safety of the process.

A dozer driver, even when experienced and competent, is at risk of losing control of the machine into a draw down point if not made familiar with the stockpile condition and planned operational procedures. The risk is increased if the dozer driver does not communicate with the driver on the previous shift and review the site procedures (valve/feeder operations), and check whether valves/feeders are operating correctly at the start of the shift.

#### 3.1.11 Operators working alone and unobserved

Dozer drivers work alone and often are in locations where they are not in view and not under direct supervision. If the equipment they are operating becomes defective or involved in an incident, or they suffer an injury, it could be some time before this is discovered. This places dozer drivers at risk when remedial action and/or treatment is not immediately available.

The risk exists where there is no ability to manage the following by the dozer driver:

- Stop and start reclaim feeders
- Stop stacker conveyor feeding stockpile
- Activate site emergency alarm
- Stop the dozer if the operator becomes disabled in a draw down incident

At varying times people may be required to access the stockpile. This could be potentially hazardous if not managed effectively.

#### 3.1.12 Mobile plant types and interaction

A variety of plant may be required to be used on coal stockpile sites and includes:

- Stockpile dozers
- Excavators
- Cranes/elevated work platforms
- Emergency vehicles
- Service vehicles
- Front end loaders
- Trucks

Provision for the use of such plant should be considered in the development of the site hazard management plan. Hazards and risks arising from variations in the weight and dimensions of equipment, stability, ground pressures, operator position, mode of operation and other factors should be considered.

The hazards arising from interaction of multiple and different items of plant in the stockpile area should be assessed.

Where stockpile dozers and other plant have to be taken out of service (e.g. for repair), and there is a need to replace the equipment at short notice, there is a risk of the replacement equipment not being fitted with specific safety devices and other equipment required for operation on coal stockpiles.

The failure of the safety devices, machine modifications or the non-installation, or poor maintenance of this equipment can place the operator at significant risk of harm.

#### 3.1.13 Hot work on stockpile

Cutting or welding operations on the coal stockpile structures has the potential to ignite a fire within the large volume of flammable material present.

## 3.2 Controls

### 3.2.1 Recommended minimum controls

The controls set out in the following table shall be considered when assessing the potential risks for a dozer to be engulfed in a draw down point on the stockpile and be engulfed by stockpile material. A risk assessment should be undertaken to determine the likelihood of this occurrence and the effective controls to be implemented to manage this hazard.

The coal operator shall not rely solely on these controls. The operator shall make use of the hazard identification and risk assessment process to determine what other controls should be applied at the site.

| Minimum Controls | Comment |
|---|---|
| The stockpile dozer cab shall be designed to withstand engulfment forces of at least 40psi (280kpa). | Assumes a safety factor of 2:1 and is based upon USA stockpile dozer incidents and investigations. |
| Tilt switch/switches shall be fitted to allow engine shut down independent of the actions of the dozer driver.<br>Tilt switches shall operate in a 360 degree radius. | • The tilt switch operating angle should be consistent with the stockpile dozer stability specification.<br>• Tilt switches could be by-passed by the operator after confirmation the operator is in control. |
| Automatic engine fire detection and suppression, including manual activation for engine fire suppression shall be used. | Should be installed to OEM dozer and fire system specifications in accordance with AS 5062. |
| Position indicating devices to assist the dozer driver in determining location of draw down points in high risk zones shall be used. Audible or visual alarms should be provided to alert the dozer driver. | Devices to be considered include:<br>• GPS<br>• Cameras over draw down points<br>• Proximity detection<br>• Fixed structures to provide reference point (e.g. gantry) |
| Safety equipment to–<br>• ensure the dozer driver is in a safe atmospheric environment if the stockpile dozer cab is engulfed; and<br>• facilitate rescue | Devices to be considered include:<br>• Breathing apparatus<br>• Rescue harness<br>• Emergency lighting |

### 3.2.2 Operational design of stockpile

The engineered design of a coal stockpile should address the risks identified in the site risk assessment. Matters to be considered in the system design should include the following:

- Infrastructure on the stockpile, support structures

- Gantry heights, clearances, size of feeders
- Preventing of bridging
- Addressing the material characteristics to achieve correct flow
- Drainage of the stockpile and surrounds to minimise accumulation
- Identification of draw down points
- Discharge of material from a skyline conveyor
- Volume of storage
- Reclaim capacity
- The use of more than one dozer on a stockpile

Where a change to the stockpile and recovery system is considered that could impact on risk to people, equipment or the environment, the operator should conduct a risk assessment to address those impacts and, where necessary, modify the hazard management plan. Changes that can have such impacts include the following:

- Volume of the stockpile
- Maximum height
- Compaction and unconsolidated areas on the stockpile
- Footprint
- Number and location of reclaim points
- Reclaim capacity and rate
- The number and type of stockpile equipment (plant / infrastructure)
- Significant change to material characteristics compared to initial design assumptions
- Drainage design
- Reclaim tunnel access and egress in relation to length, shape, impacts
- Clearance to structures on or near the stockpile

The stockpile base and surface should be graded to allow water run-off and prevent the formation of central water reservoirs. The stockpile pad and immediate surrounds should be well drained to ensure the stability of the pad and surrounds.

The operator shall have appropriate controls developed for management of the risks associated with operating the stockpile and reclaiming systems attached at full capacity.

### 3.2.3 Stockpile compaction and stability

High risk zones around feeder(s) or coal valve draw down points shall be identified with the positions clearly delineated for dozer drivers and others required to operate and maintain the system. Similarly, high risk zones on the edges of the stockpile should be identified.

The size and shape of the high risk zones will change from time to time due to the stockpile dynamics. A conservative approach to the size of the zones should be adopted and processes should be put in place to make dozer drivers aware of the status of the drawn down points on each shift.

A graduated system of identification for high risk zones would identify areas of good compaction, areas of poor compaction and areas where voids or bridging can occur.

Access ramps to the top of the coal stockpile should be compacted ground, not rill material. Stockpile dozers may be required to construct the ramps and should travel near the centre of the ramp.

Controls should be developed to address the risk of a stockpile dozer going into the reclaim draw down hole causing harm to the operator. Harm can result from engulfment of the dozer cab, fire risk and the development of irrespirable or noxious atmosphere within the cab.

The dozer driver shall be made aware of the position of the overhead structures, high risk zones and the precise location of the draw down points.

The means of determining the location of the draw down point in all conditions in which the stockpile dozer is permitted to operate should be specified in the site hazard management plan and through the dozer operator training procedures.

In conditions where the stockpile drivers vision is impaired, or the driver could be distracted, external navigation aids may assist.

Such aids may include:

- Cameras with video display units in the operators cab
- GPS systems with indication in the operators cab
- Proximity detection devices
- sighter poles with lights
- reflective markers
- stroboscopic lights
- laser lights

Aids should be reliable and systems should be in place for alternatives where the primary system is liable to failure.

Audible warning alarms should be installed to alert the dozer driver. Where there is a choice of looking through the stockpile dozers window or looking at a camera or GPS display, the driver is at risk of not seeing an alarm on the display.

Controls for operation within the High Risk Zones may include:

- Delineation of the draw down point through additional technology (e.g. GPS, radar, wireless, cameras or similar). Any system used shall be proven and robust.
- Back-up systems in case indicators fail.
- Operator competence and training.
- Control of people entering the site.
- Fit-for-purpose equipment (for example, dozers fitted with tilt switches or similar).
- Effective lighting.
- Ability to control feeder operation from the operators cab in the case of emergency.
- Communication between operator and control room.

Evaluation tools should be developed to assess and develop appropriate dozer driver’s actions in response to various operating conditions including impaired visibility. Actions should include triggers to determine at what level and to what extent restrictions are placed on operations.

### 3.2.4 Recovery of bridging

Procedures should be developed through the risk assessment process for the early detection and recovery of bridging.

Considerations for the prevention, detection and control of bridging shall include:

a) designing draw down points based upon tests of the coal (e.g. mechanical properties, shear characteristics and similar).

b) a process for the early detection of bridging. Trained and competent dozer drivers will assist in this determination. Bridging may also be detected by an inspection within the reclaim tunnel.

c) shutting down the feeder or coal valve when bridging is first detected. In some circumstances this will limit the size of void or cavity that has to be dealt with.

d) shutting down an overhead discharge point that is operating.

e) a process for removing coal and unblocking the bridge.

f) use of equipment other than stockpile dozers.

#### 3.2.5 Stockpile dozer engulfment

Where there is a risk of engulfment, stockpile dozers should be designed to protect the operator and provide for means of prompt recovery of the dozer driver.

Draw down points should be filled after use.

Controls for stockpile dozer engulfment include the minimum controls in Clause 3.2.1, Recommended Minimum Controls.

Rescue of a dozer driver is hampered by the steep and unstable sides and surrounds of the draw down point. The following options shall be considered:

- The use of an overhead stockpile conveyor system as a stable recovery platform (where an overhead conveyor is available).
- Provision of a harness in the operators cab to facilitate the recovery of the dozer driver using a mobile crane or similar.
- Mats or portable bridges that can be placed to bridge the gap from stable ground to the engulfed dozer.
- Breathing apparatus within the driver’s cab.
- The stability of the dozer within the void. What risks are introduced with additional heavy machinery on the stockpile?

Where special recovery equipment needs to be procured from external sources, the availability and time taken to bring the plant on site shall be considered together with the impact on a trapped dozer driver.

Consideration shall be given to the rescue of people in the event of an emergency. Recovery systems and fire fighting methods should be developed and tested.

#### 3.2.6 Control of bench heights

The risk of equipment operating alongside relatively steep benches with heights above the safe limits of stockpile dozers should be assessed and controls should be developed.

Operation of stockpile dozers on the stockpile requires a safe method of work based upon equipment specifications, operational requirements and a risk assessment.

Safe work systems that do not require operation alongside bench heights above safe operating parameters for stockpile dozers shall be developed and implemented.

The use of different sized stockpile dozers should be considered in the development of the system. Address the suitability of equipment for the stockpile design and operating environment.

### 3.2.7 Design of coal placement structures

Overhead structures designed to place coal on the stockpile should be designed for interaction with mobile plant.

Operating procedures for high risk zones and zones adjacent to structures should require dozer drivers to report contact with structures. Where the contact is significant, the dozer driver shall report the damage immediately.
Stockpile dozers shall be fitted with roll over protection structure (ROPS) and falling object protection structure (FOPS). The plant shall comply with ISO 3471, Earth-moving machinery - Roll-over protective structures - Laboratory tests and performance requirements, and ISO 3449, Earth-moving machinery - Falling-object protective structures - Laboratory tests and performance requirements.

Infrastructure on the stockpile should be inspected and maintained in accordance with applicable Australian Standards and the Mechanical and Electrical Engineering Management Plans.

### 3.2.8 Control of people on the site

Procedures should be developed from a risk assessment to address the movement of people on the coal stockpile site so that only authorised and competent people are permitted to enter stockpile and reclaim area.

The names, position and status of such people should be known at all times.

Considerations for developing and implementing a system of control shall include:

- induction of people who inspect and operate the system.
- sign posting and control of access roads to the site.
- authorisation of people to enter the site.
- competent people to operate items of plant.
- supervision of people on the site.
- communication with dozer drivers and others on the site.
- emergency procedures.
- the recording of activities and events.

Where possible all, personnel not operating stockpile dozers should be kept off the stockpile. Only essential work, permitted to be carried out under control safe work procedures, should take place on the coal stockpile area.

A Safe Work procedure should be developed to provide for a safe means of access for inspection and maintenance purposes to all items of equipment within the Coal Stockpile Area.

The following controls shall be considered:

- Systems for control of people and equipment
- Notification of stockpile status on each shift
- Safe work systems
- Monitoring and supervision of those tasks

All people who enter a coal stockpile shall be able to maintain communication with a control operator or supervisor and others on the stockpile at all times.

Controls should be established to prevent harm to people and plant required to access high risk zones.

### 3.2.9 Operational control

Dozer drivers and other relevant personnel on site should be made aware of the planned work program at the commencement of the shift and changes that may take place during the shift.

Such work and changes to be communicated should include:

- The location of overhead discharge points in use or planned to be in use
- The location of feeder draw down points in use or planned to be in use
- Status of visual/ audible indicators and warnings
- Operating and maintenance functions
- Location of ramps
- Maintenance activities planned

Dozer drivers, other people on the site and control room operators should have means to communicate with each other at any time, and should communicate with each other to manage risks and ensure the safe operation of the system.

The system should cater for the immediate closure of draw down feeders or valves if required by a dozer driver, control operator, or emergency condition.

When draw down feeders and coal valves are not operating, the draw down points should be filled so that there are no voids to create a hazard for stockpile dozers.

Resumption of operations that would cause draw down holes to form should not take place until dozer drivers have been notified and stockpile dozers and any other personnel on the coal stockpile are withdrawn to a safe location.

Stockpile dozers should not be driven over an active draw down point or operating coal valve or feeder. Where possible, dozer drivers should avoid and minimise compacting material over drawn down points.

Dozer drivers should not drive or operate directly under an active discharge point.

Systems that should be considered to assist in determining the position and operation of a drop point can include;

- An audible warning device to indicate that an overhead discharge point is being relocated or visual displays
- Alarms within the dozer cab and positive communication between the dozer driver and the control room operator

A visual indicator such as prominently placed lights should be provided to warn personnel located on the stockpile which feeders are operating.

Multiple redundancies or alternate safe work systems should be provided to cater for failure of the primary system.

Adequate and suitable visual cues shall be available to allow the dozer driver to position themselves safely on the stockpile.

### 3.2.10 Operator awareness and practice

Feeder rates should be governed by achievable dozer push rates based on the operator and machine capabilities, the coal recovery push distances, environmental considerations and similar. Feeder rates should not be governed by time based loading requirements.

Due consideration should be given to the management of this activity, and make reference as to how this is achieved.

A procedure should be developed and implemented to ensure that a safe method of pushing coal to feeder points is adopted at each operation.

Dozer drivers should be required to adopt the following practices:

(a) Keep mobile equipment facing the draw hole, approach directly in line and not at an angle.

(b) Communicate regularly with the control operator as to conditions and actions.

(c) In the event of an incident where the dozer goes into a draw down point – the driver should remain in the cab until advised otherwise.

A monitoring system should be implemented to ensure that procedures and safe work systems are being implemented as required.

During loading operations on the stockpile the coal feeders shall be controlled at all times.

### 3.2.11 Stockpile footprint and access ramp

The footprint of the designed coal stockpile area should be clearly marked. There should be space available for safe access ramps to be constructed, without exceeding the designed stockpile footprint.

Access roads, drains, service easements and the entries to the reclaim tunnel should be kept clear at all times. The stockpile footprint with ramp locations, access roads and all relevant features should be communicated to all relevant people at the site.

### 3.2.12 Spontaneous combustion

Stockpiles shall be managed to address spontaneous combustion. In most instances the high risk zones or areas not compacted by mobile plant, nor affected by prevailing winds and moisture on the stockpile are most liable to spontaneous combustion. The retention time of the coal on the stockpile has a major impact in making spontaneous combustion more likely.

Effective controls that address the risk of spontaneous combustion include:

- Detection of rises in temperature in areas of the coal stockpile
- Compaction and grading of areas of low compaction and steep slopes facing prevailing winds
- The regular removal and replacement of coal on the stockpile to minimise the impacts of oxidation and retention of heat
- Recording results of temperature monitoring and coal movements to establish a signature for the propensity of the coal to heat in the conditions on the stockpile

Spontaneous combustion typically develops as small "football" sized shapes within larger masses of coal, so most of the stockpile does not initially heat. Those small shapes will increase in size when not treated.

This means that monitoring of temperature should be undertaken in numerous locations rather than one or two in the erroneous expectation that the entire mass of coal will behave in the same manner in all areas.

### 3.2.13 Cutting and welding operations

Special precautions against hot slag falling onto the coal stockpile from hot work on any overhead gantry should be formulated within the "Hot Work Permit" procedures.

Procedures should be developed in compliance with MDG 25.

### 3.2.14 Inspection

Inspections and reports should be completed and durably recorded to identify the condition of the stockpile, stockpile dozers, reclaim tunnel, feeders, coal valves and similar. This information should be provided to dozer drivers, control room operators and maintenance personnel.

The system should ensure that dozer drivers, when first entering a coal stockpile, are aware of the status of the stockpile and operating conditions at time of entry. Dozer drivers should be updated as conditions change.

Before starting dozer operation, any report detailing stockpile status should be read and initialled.

The person most at risk on a coal stockpile associated with a reclaim tunnel is a person on foot. The inspection routine should, wherever possible, avoid the need for people to enter the stockpile area.

The structure supporting an overhead discharge point often affords the best vantage point to assess the status of a coal stockpile. This may be combined with a visual inspection from a vehicle that is able to traverse the perimeter of the stockpile.

### 3.2.15 Maintenance

An interlock should be provided to prevent a mobile overhead discharge point from passing over an area where work (e.g. maintenance work on a feeder) is being carried out. Isolation procedures shall be developed to address this hazard. Consideration should be given to the use of mechanical stops/rail clamps. Where control system interlocking is used to provide a risk control, such as limitation of the discharge point movement, such interlocking systems shall be subject to a functional safety assessment to determine that the level of reliability is suitable for the hazard being controlled.

Stockpile dozers should be maintained in a safe location. Arrangements should consider hazards on the stockpile and include controls to ensure that plant is maintained in a safe manner.

In the event that plant breaks down on the stockpile, a safe system of work shall be developed that addresses hazards and includes controls to be implemented to safely maintain the plant.

# 4. Reclaim tunnels

## 4.1 Hazards

### 4.1.1 People accessing the reclaim tunnel

The nature of reclaim tunnel operations is that the presence of people in the tunnel is required on an infrequent and irregular basis. Control room operators might not expect people to be in the reclaim tunnel on a regular basis which can lead to hazardous situations. Loading operations are remotely activated and a person is not required in the tunnel to operate it. Personnel should only enter the reclaim tunnel to inspect, clean or maintain the system.

Access to the reclaim tunnel could be hazardous to people in the following circumstances:

(a) The person has not received instruction on the hazards and controls that have been developed to manage safety within the tunnel.

(b) An unsafe condition has developed in the reclaim tunnel, eg, accumulation of gas, cessation of ventilation, outbreak of fire or similar, and the person is not aware of the condition.

(c) A person in the tunnel suffers an injury and other operators on the mine site are not aware.

### 4.1.2 Tunnel blocked impeding means of egress

Reclaim tunnels could become blocked so that egress is not available to people who may be within the tunnel. There could be a risk of harm to people through atmospheric contamination, flooding, fire, inundation of stockpile material or similar.

The means of tunnel blockage can include the following:

- inflow of stockpile material through draw down points or entrances to the reclaim tunnel
- flooding through rainfall and stockpile water inflows
- conveyor malfunctions
- gas explosion

### 4.1.3 Atmospheric contamination

Atmospheric contaminants (refer to National Standard for atmospheric contaminants) within the tunnel can become harmful to people through effects that could include the following:

- Gaseous products from a stockpile material fire, spontaneous combustion or surface (bush) fire
- Products of combustion from flammable materials within the tunnel
- Gaseous emissions from the stockpile material
- Ventilation flow blocked
- Hazardous chemicals
- Cutting and welding
- Introducing mechanical apparatus to the tunnel

- Atmospheric contaminants from diesel vehicles
- High levels of airborne dust

Methane can be given off from stockpiled coal. Although not toxic, it can displace oxygen in low air flow and act as an asphyxiant and poses an explosive risk. If the tunnel is not adequately ventilated the risk of methane layering or other atmospheric contamination can occur, and poses a significant risk to health and safety of people.

Products of combustion from a fire can contain toxic gases such as carbon dioxide and carbon monoxide and constitute a greater risk of harm to people.

Exposure of operators to airborne dust over an extended period can cause a risk to health.

#### 4.1.4 Electricity

Electricity has the potential to cause electric shocks and electrocution. Reclaim tunnels are often damp or wet due to dust suppression systems, continual cleaning and drainage associated with the stockpile above.

To minimise the risk of electric shock or electrocution, control system voltages should be kept below 25 volts, preferably Direct Current (DC).

The IP (Ingress Protection) rating of electrical enclosures is critical to minimising dust and moisture ingress into the enclosures. The IP rating for all electrical equipment should be at least IP55 (see AS 60529). Consideration shall be given to the placement of electrical equipment to minimise the exposure to water sources, especially jets of water from hosing or continual exposure to dripping water.

Poorly designed and installed installations pose a risk of electric shock, electrocution or fire due to inadequate electrical and/or mechanical protection of electrical apparatus and cabling systems.

Electricity has the potential to be an ignition source to gases and dust within the reclaim tunnel. These ignition sources can be caused by arcing and/or sparking, or from thermal effects. These events are commonly caused by the damage to, or overheating of equipment.

#### 4.1.5 Fire

The operator of a coal operation shall ensure that any fire on any belt conveyor or any other part of a reclaim tunnel or other enclosed space on the surface of the coal operation is:

- prevented by using appropriate means to control fuel and ignition sources
- detected as soon as possible, in the event a fire initiates
- effectively brought under control as soon as possible

Fire can prevent safe egress, contaminate and obscure the atmosphere within the tunnel. Combustion of some flammable materials produces gases that can be very harmful to people. Spontaneous combustion shall also be considered.

The major flammable material hazard in the reclaim tunnel is coal on the conveyor belt, coal spillage and coal in the draw down points.

There could be flammable fluids and other flammable materials.

Conveyor fire is a significant hazard which exists in all reclaim tunnels. Controls shall be developed to manage the potential for this occurrence.

Fires involving electrical cables often give off a variety of toxic and corrosive gases. Low smoke zero halogen cables reduce the amount of toxic and corrosive gas emitted during combustion and should be considered for use on control, communication and power circuits within the reclaim tunnel.

Coal will distill flammable gases if on fire. If the ventilation in the tunnel is inadequate to dilute the gases and move the mixtures away from the fire site, there is a risk of explosion. A large and very hot fire can create its own ventilation circuit.

#### 4.1.6 Explosion

Gases such as methane that are given off from stockpiled coal are explosive in certain concentrations (5% to 15%). Gas ignition requires the required mixture of methane/ air and an ignition source. Gas explosion can propagate coal dust explosions.

Coal dust accumulations within the tunnel pose an explosive hazard.

#### 4.1.7 Flooding

Flooding can be gradual or a sudden catastrophic event. An inrush from the material stockpile area through the draw down point, or entrances to the tunnel can occur in conditions of heavy rain and flooding.

Such an event can cause direct harm to people or block the means of egress.

#### 4.1.8 Conveyor failure

Failure of the conveyor in the reclaim tunnel can cause direct harm to people or impede access through the following:

- Sudden displacement of conveyor drive-head and boot end including belt structure
- Fire due to uncontrolled conveyor movement or other frictional ignition cause
- Excessive spillage of conveyed material

#### 4.1.9 Drawdown equipment failure

Drawdown systems include:

- Feeders
- Coal valves
- Ploughs
- Chutes

Failures of these systems can occur because of changes in the head feed and environmental conditions such as heavy rain and flooding.

The possibility of a significant head of water or water / coal slurry existing above a feeder point should be considered in the hazard management plan.

#### 4.1.10 Airborne dust

Exposure of operators to airborne dust over an extended period can cause a risk to health.

#### 4.1.11 Maintenance on feeders and valves

People performing maintenance work on feeders, coal valves, chutes or similar are at risk from engulfment, and inadvertent operation of machinery (gates, rams).

## 4.2 Controls

#### 4.2.1 Minimum controls

The following minimum controls apply where the coal handled through the system desorbs gas and there is a risk of hazardous accumulations of gas within the tunnel without the ventilation system operating. The coal operator shall not rely on the minimum controls alone and should make use of the hazard identification and risk assessment process to determine what other controls are necessary to control risks applicable to the site.

Gases, dust and other atmospheric contaminants can be produced during the handling; transport and maintenance of reclaim tunnels. A risk management process shall be completed on the reclaim tunnel(s) to ensure that gas detection, ventilation requirements, installations and maintenance of the reclaim tunnel is in accordance with Clauses 4.2.2 to 4.2.14.

| Minimum controls | Comment |
|---|---|
| A system to control the entry of people to the reclaim tunnel | This could be signs and lights.<br>Signs alone are not sufficient to manage the hazard. |
| A system to indicate when the tunnel is occupied | This could be a light at the entrance to the tunnel or access controlled through the control room. |
| A system to require people in the tunnel to evacuate when conditions are unsafe | This could be an audible alarm or flashing light system within the entire length of the tunnel |
| Ventilation of all parts of the reclaim tunnel to control airborne dust and prevent accumulation of gas or other atmospheric contaminants. | Hazardous area classification assessment. Ventilation audits including explosive atmosphere assessment should be completed. |
| Use of fire resistant and anti-static (FRAS) conveyor belting and conveyor accessories | FRAS conveyor belt and accessories will assist in preventing the initiation and propagation of a fire, see AS 4606 and MDG 3608. |
| Methane detectors shall be placed at strategic points within the tunnel including all valves/ feeders within the reclaim tunnel:<br>• Roof of vaulted/ recessed areas<br>• Ventilation exit point | A ventilation audit could identify the required number and location of methane detectors. |
| Methane detectors in the reclaim tunnel should have the following alarms and action set points:<br>**0.5%:** Alarm to a monitored control centre<br>Stop coal feeding at the relevant location<br>**1.25%:** Remove power to non-explosion protected equipment in the tunnel | Having appropriate alarm and action setting on methane detectors will assist in controlling risks from methane. |
| Carbon dioxide detectors shall be placed in the following locations (where the presence of the gas is deemed to be a risk):<br>• Low areas and sumps<br>• Ventilation exit point | Ventilation audit will assist in determining location of detectors and levels for alarm |
| Carbon Monoxide detectors shall be established within the tunnel to allow for prompt detection of fire or heating within the tunnel. | A ventilation audit would assist in determining location of CO detectors and levels for alarm set points.<br>Alarm/trip set-points should be calculated based on CO make and ventilation flow rates.<br>CO trip should stop coal flow and clear the valve and chutes but should not stop the conveyor. |
| Emergency lighting and communications that are rated for safe operation in explosive atmospheres shall be provided and be operational in the event of a power failure. | Both communications systems and emergency lighting systems should be rated as suitable for use within the reclaim tunnel based on the hazardous area classification of the tunnel.<br>Communications should be from a monitored control room directly to a person who may be in the reclaim tunnel. |
| A system should be established to control the use of equipment within the tunnel. That is, only allow the use of fit for purpose equipment and identify and prevent entry of prohibited articles. | Hazardous area assessment will assist in determining level of controls required to manage the risks posed from apparatus to be used within the reclaim tunnel. A permit system may be used to manage these hazards. |

### 4.2.2 Operational design

The reclaim tunnel structure and major components should be designed for the life of the facility. The structural design should be based upon the maximum expected future stockpile loading. Where this hasn't occurred provision should be made for replacement. This will impact on structural integrity review frequency.

Structural integrity review of the tunnel should be conducted on a risk based assessment. The age, size, condition, design factor of safety would all be considered in the determination of the review. In any event it is recommended that the review be conducted every two years for all tunnels.

Consideration should be given to the shape and size of the vaulted or recessed chambers that house coal valves and feeders to improve airflow and reduce the risk of dust and gas accumulation in poorly ventilated areas.

The design criteria for the reclaim tunnel should be kept as a record. Any modifications proposed to the system should be cause for a structural assessment and review based upon the original design and the scope of the changes.

Coal or other debris should not be stockpiled within or near reclaim tunnel entries or the ventilation fan and should not obstruct any access/egress to the tunnel.

A drainage system capable of diverting flows from heavy rainfall and accidental water system flow failures shall be maintained to prevent uncontrolled inrush of water and coal into the tunnel.

The conveyor drive and associated electrical equipment such as the substation and starter should be outside the reclaim tunnel, clear of ventilation flowing into the tunnel, to reduce the risk of fire and contamination of the tunnel atmosphere.

There may be circumstances that require the tunnel conveyor belt to be cleared with the draw down feeders stopped. Consideration should be given to providing bunkerage between the tunnel conveyor and any conveyor onto which it discharges

There should be sufficient clearance to enable safe continuous access to both sides of the conveyor belt installed in the reclaim tunnel. AS 1755 specifies minimum standards for clearance. This might not be sufficient for all purposes. Increase in clearances may be required for:

- Transport of an injured person on a stretcher.
- The use of a skid steered vehicle or equivalent for cleaning the tunnel.
- Transport of replacement components in the tunnel.

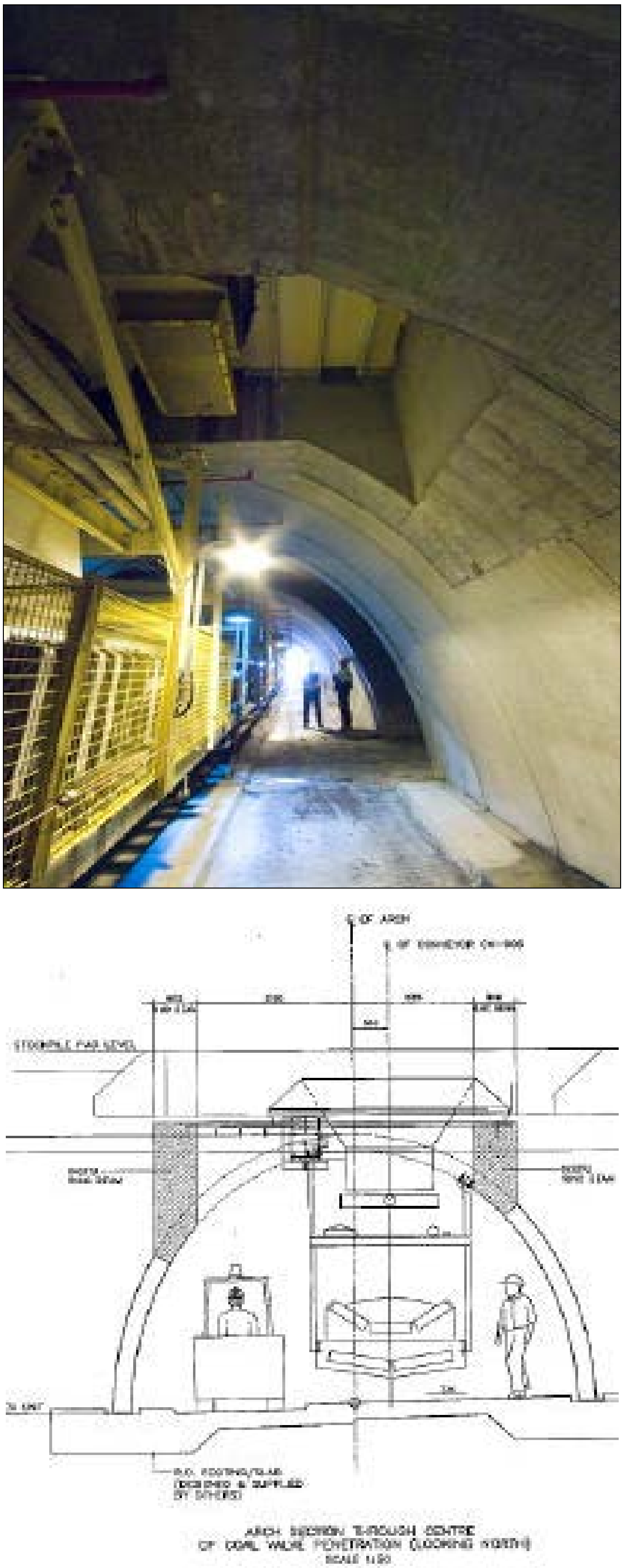


**Figure 6. Reclaim tunnel showing coal valve and access way alongside conveyor.**

The tunnel should be graded so that it is self draining with no possibility of flooding or ponding.

Services in the tunnel should be located with due regard to ready access, cleaning of structures, efficient ventilation and prevention of damage by the passage of equipment.

The conveyor system shall conform with AS 1755 as far as reasonably practicable. Consideration shall also be given to requirements therein for conveyors used in underground coal mining.

All conveyor belting and other rubber components in the coal discharger and conveyor system such as skirting, V belts, impact rollers and lagging shall be rated FRAS (fire resistant anti-static) material in accordance with AS 4606 or otherwise AS 1332 and AS 1333 as applicable.

Consideration should be given to an effective and efficient method of cleaning of the reclaim tunnel. Sloping the reclaim tunnel to a minimum of 1 in 100 will facilitate drainage. A cross grade and gutter will provide increased water flow to assist with hydraulic cleaning. Tunnel arrangements that will allow water to form ponds or become flooded should be avoided.

Where pumps and sumps within the tunnel are necessary, the system capacity should be more than capable of handling the maximum expected flow of water and the maximum lump size of material.

The return conveyor belt and support idlers should be sufficiently elevated to facilitate inspection and cleaning. Dust deposited on the structure and roadway shall be periodically removed or cleaned, preferably by hosing.

Applicable standards for the design of reclaim tunnels and conveyor systems include:

- AS 4024.1 – Safety of machinery - series of standards
- AS 1755. Conveyors - Design, Construction, Installation and Operation – Safety Requirements.
- MDG 1032 – *Prevention and early detection and suppression of fires*
- MDG 25 – *Safe cutting and welding operations at mines*

### 4.2.3 Alternate egress

The reclaim tunnel should have an alternate method of egress to provide an escape route in case the primary entry becomes blocked. The alternate means of egress should be risk assessed to determine requirements.

The primary entry and alternate means of egress should both provide for transport of an incapacitated person on a stretcher. Consideration should be given to the distance the person(s) is to be conveyed and the support requirements for the injured party.

The alternate means of egress should be clearly marked, adequately ventilated, well maintained (clear of debris) and well lit.

### 4.2.4 Ventilation

Where the hazards of airborne dust, atmospheric contaminants and desorption of gas have been identified, all accessible parts of the tunnel, including primary and alternate means for egress, should be ventilated to the following standards:

(a) Respirated dusts should meet the requirements of the '*Workplace Exposure Standard for Airborne Contaminants*'.

(b) Gas levels should meet the requirements of the '*Workplace Exposure Standard for Airborne Contaminants*'.

(c) The percentage of methane in the air should not exceed 0.25% with the tunnel ventilation system operating.

Atmospheric contaminants from diesel vehicles in the tunnel should meet the requirements set out in MDG 29 *Guideline for the management of diesel engine pollutants in underground environments*.

Where possible, the ventilating fan motor and starter and reticulated supply cables should be located in a position that eliminate the risk of running or restarting a fan in an unsafe atmosphere.

In tunnels where it has been determined that forced ventilation should be provided, people should be prohibited from entering, or remaining in, the reclaim tunnel when the ventilation system is not operational. (Other than for effecting repairs under conditions set out in the hazard management plan)

Ventilation of the vaulted/recessed areas that are not in the direct airflow along the tunnel may require special consideration (such as hurdles or similar) to meet the requirements of this clause.

Where a fan is utilised to manage air flow within the reclaim tunnel, appropriate controls shall be developed to address the loss of power and the resumption of power to the fan.

After the ventilation system is commissioned, an audit of the efficiency of the system should be conducted to confirm the standards are met. That audit should be repeated when the stockpile is first near planned capacity, and at periodic intervals determined by risk potential of the tunnel. The ventilation audit shall determine the requirements to dilute/disperse atmospheric contaminants from the reclaim tunnel and address the performance and efficiency of the fan with reference to air flow within the tunnel.

The people conducting the ventilation audit shall be competent, appropriately trained and qualified (eg. ventilation officer). Where there is a requirement to use gas monitoring equipment, supervisors, employees and contractors shall receive training in the identification, control, awareness of alarms and PPE requirements for normal and emergency situations.

Homotropal ventilation should be used with the airflow passing in the same direction as the coal flow. This will reduce airborne dust and unwanted gas levels.

In the event that a coal fire develops within the reclaim tunnel, consideration should be given to continuing ventilation to control the risk of an explosion of flammable gases distilled from the coal.

#### 4.2.5 Electricity

A hazardous area classification assessment shall be undertaken in accordance with the requirements of AS/NZS 60079.10.1:2009 Classification of areas—Explosive gas atmospheres and AS/NZS 60079.10.2 Classification of Areas – Explosive dusts.

**Note:**

These assessments are required under clause 7.7 of AS/NZS 3000:2007.

Assessments in accordance with AS/NZS 60079.10.1 (gases) and AS/NZS 60079.10.2 (dust) shall be undertaken by people with appropriate skills, knowledge and experience in assessing hazardous areas. These assessments shall consider hazards associated with both gases and dusts.

Electrical equipment for use in areas identified as hazardous shall be selected in accordance with the requirements of AS/NZS 60079.14:2009 Part 14: Electrical installations design, selection and erection.

Where electrical safeguards are provided for electrical and nonelectrical hazards, the safeguards shall have a probability of failure appropriate to the degree of risk posed by the hazard. Functional safety assessments in accordance with recognised safety standards shall be undertaken on safety critical systems associated with the reclaim tunnel.

The IP rating for all electrical equipment should be at least IP55 (see AS 60529). Consideration shall be given to the placement of electrical equipment to minimise the exposure to water sources, especially jets of water from hosing or continual exposure to dripping water.

An effective and appropriate maintenance regime for electrical installations servicing the tunnel will assist in negating the potential for ignition sources occurring. These maintenance regimes need to address the adequacy and frequency of electrical installation inspections, including both external (visual) and internal examinations.

Electrical installations within the reclaim tunnel shall comply with the requirements of the electrical engineering management plan for the coal operation.

#### 4.2.6 Monitoring and inspection

**4.2.6.1 Exposure standards**

The exposure standards for airborne contaminants are expressed as a time weighted average TWA concentration over an eight-hour working day, five days per week. During this eight hour averaging period, the instantaneous concentration may take excursions above the TWA exposure standard, providing these excursions are compensated for by equivalent excursions below the standard during the working day. However, because some substances can give rise to acute health effects even after brief exposures to high concentrations, it is evident that excursions above the TWA concentration should be restricted.

The short term TWA concentration should not be exceeded at any time during a normal eight hour working day. Workers should not be exposed at the short term exposure limit (STEL) concentration continuously for longer than 15 minutes, or for more than four such periods per working day. A minimum of 60 minutes should be allowed between successive exposures at the STEL concentration.

**4.2.6.2 General**

An inspection of the tunnel should be conducted on a routine basis. It is expected that a system would be developed to address inspection timeframes following train loading, or shift operations.

Gases that can be given off from coal or develop through heatings and fires shall be identified and the hazards and risks at the site identified and assessed.

An effective control for accumulations of dangerous gases is a system of monitoring and inspection.

Consideration shall be given to monitoring the following gases on the site:

a) ***Methane –***

Procedures shall be developed to implement appropriate precautions where an explosive methane mixture is detected, e.g. evacuate personnel, turn off all non explosion-protected electrical circuits, and ventilate the area.

Notes:

- Methane can be desorbed from coal
- It is lighter than air (SG 0.55) and most likely to accumulate in the upper parts and poorly ventilated areas of the tunnel (such as those that house the feeders)
- Methane is explosive in the range of 5% to 15% in air

b) ***Carbon dioxide –***

Notes:

- Carbon dioxide can be desorbed from coal
- It is denser than air (SG 1.53) and most likely to accumulate in downhill

dead ends and sumps

- Carbon dioxide increases the respiration rate and acts as a narcotic above 5% to 10%
- Time Weighted Average (TWA) – 5,000ppm (0.5%)
- Coal Mine Health and Safety Regulation 2006, Clause 21(b) requires that carbon dioxide levels are not more than 1.25%

c) ***Carbon monoxide –***

Notes:

- Carbon monoxide is not desorbed from coal
- Its presence usually indicates a heating or a fire (also a product of diesel exhaust). It has a similar density to air (SG 0.97) and is a cumulative and highly toxic gas with no taste or smell
- It is explosive in the range of 12.5% to 74%
- TWA - 30ppm

d) ***Hydrogen sulphide –***

Notes:

- Hydrogen sulphide can be given off from coal but is not usually present
- Slightly denser than air (SG 1.19)
- It is toxic and explosive in the range of 4.5% to 45%
- (TWA) – 10ppm
- (STEL)- 15ppm

e) ***Oxygen –***

Notes:

- It is unlikely that concentrations of desorbed gases will reduce oxygen to unsafe levels, however this cannot be ignored
- The exposure limit for people is 19.5% to 23.0%

In most circumstances, the detection of methane and carbon monoxide should provide a satisfactory level of control for accumulations of gas in reclaim tunnels and the early development of fire. But the particular coal types and risk of gas accumulation shall be assessed before making that determination.

Coals that give off carbon dioxide and the presence of low lying areas in the reclaim tunnel would indicate a requirement for monitoring of this gas.

The process of mining and transporting coal from the underground or open cut mine involves breaking the coal to smaller sizes. This causes gases to desorb from the coal and the residual values in the coal stockpile areas are generally much lower than at the mining area.

The range and value of gases given off from coal on the stockpile shall be measured to determine the level of risk and degree of monitoring required to control the risk.

Varying coals are often handled in a stockpile and reclaim system. A conservative approach should be taken and should be design for the gassiest product and range of gases likely to be encountered.

Measurements of gas levels should be linked to action plans or Trigger Action Response Plans.

Where there is a risk of accumulation of methane, without the ventilation system operating, methane detectors should be place in the high vaulted or recessed areas where the coal valves or feeders are located. There is a greater risk in these areas because methane rises and the air flow is likely to be reduced.

There should also be a methane detector in the general body of the roadway near the ventilation exit point.

All sections of the gas monitoring and detection system located within the tunnel shall be certified as intrinsically safe to "Ex ia" (see AS/NZS 60079.11) with reference to the hazard classification.

The placement of a CO detector near the ventilation exit point should provide early warning of fire or spontaneous combustion.

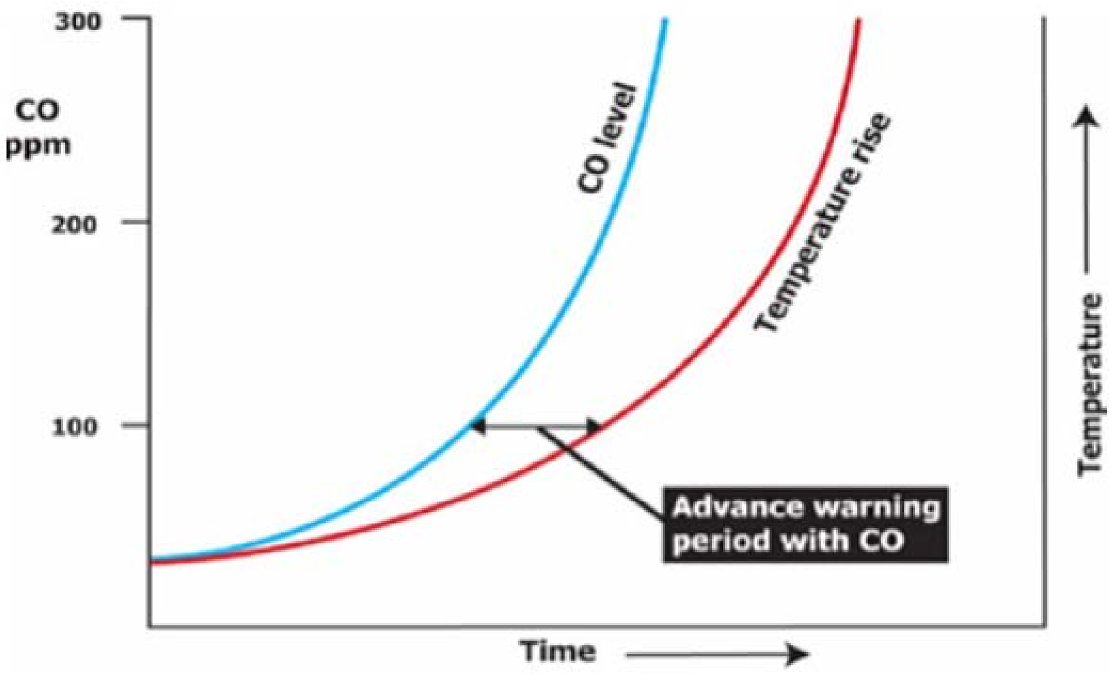


**Figure 7. Fire advanced warning – CO vs. temperature.**

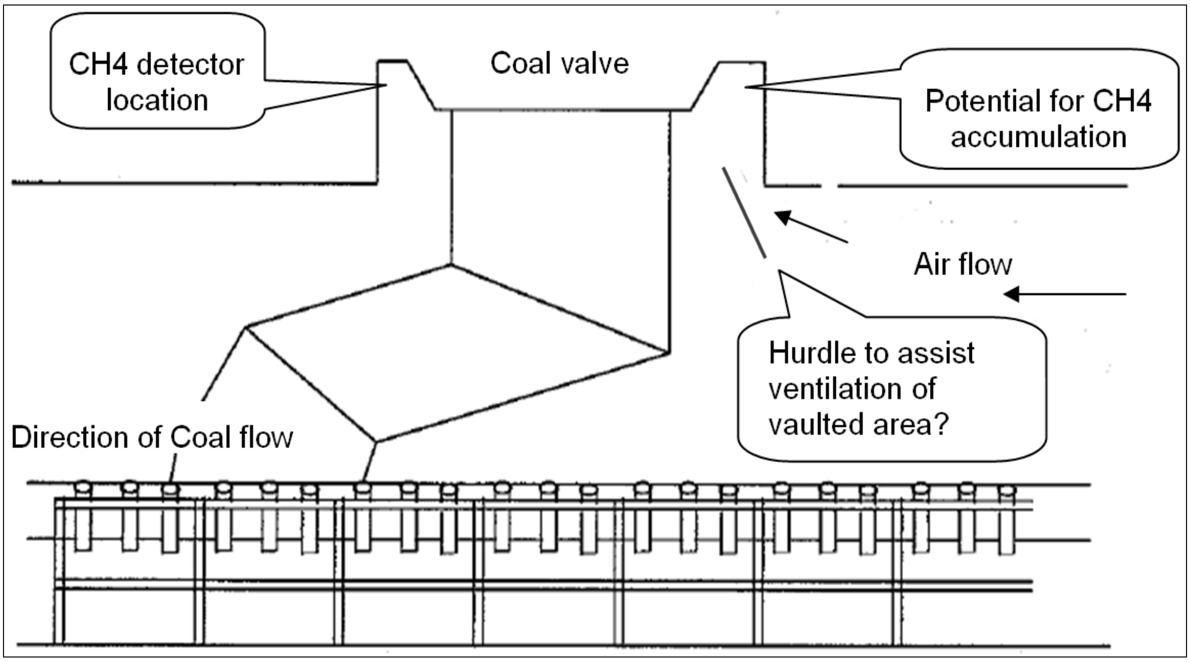


**Figure 8. Location of methane detectors.**

The set limits and system shut down values for methane that are stated in the table to 4.2.1 "Minimum Controls" should be adopted. For other gases, the standards shall meet the national published '*Workplace Exposure Standard for Airborne Contaminants*'.

Where an accumulation of gas can cause a serious risk to people, monitoring and reaction should not be limited to a screen display in a monitored control centre and a Trigger Action Response Plan. Reactive alarms to alert operators to the hazardous condition and automatic removal of power provide more rapid and positive responses to control the risk.

The reclaim tunnel should be inspected on a regular basis to confirm that the reclaim tunnel, conveyors, feeders, coal valves and chutes, ventilation, power and water supply, communication and lighting, fire fighting system, gas monitoring and other equipment and infrastructure is in safe operating condition. The frequency of inspection will depend upon the risk, site electrical and mechanical engineering plans, the Original Equipment Manufacturers (OEM) recommendations and the standards that apply for reclaim tunnels.

Some inspections should be carried out on an event rather than a time basis. The reclaim tunnel should be inspected after loading operations for the purpose of identifying heating caused by defective rollers, poor tracking of belts or similar, and for accumulations of spillage and dusts.

### 4.2.7 Starting and shut down systems

The tunnel conveyor should have an audible alarm that will activate to warn people in the reclaim tunnel that the conveyor system is starting. The alarm should be audible for the full length of the tunnel.

Conveyor signalling and emergency stop systems shall comply with AS 1755.

Appropriate controls shall be developed to manage the start-up, shut down and restoration of power to the fan.

### 4.2.8 Control of people entering the reclaim tunnel

Access to the reclaim tunnel should be controlled so that only properly inducted and trained people, with permission to do so, enter the tunnel and only in the circumstances that the conditions in the reclaim tunnel are safe.

All entrances to the reclaim tunnel should be clearly marked to indicate conditions in the tunnel and entry requirements. In addition there should be a system in place to draw attention to the notices and awareness system.

Means of drawing attention to signposting and entry conditions include lights and alarms.

Signs and systems to draw attention should be clearly and easily seen and be unambiguous.

The operator should ensure that no person enters the tunnel without being made aware of the hazards and controls in place to manage safety. The signs and awareness devices at the entrances should clearly indicate when it is not safe for a person to enter the tunnel, such as when ventilation is inadequate, and gas levels have exceeded threshold levels.


**Figure 9. Entrance to reclaim tunnel.**

Awareness devices within the tunnel should cause people to evacuate if conditions are not safe.

A person entering the reclaim tunnel should be required to:

- Contact a control operator on site before entering and advise of his/ her intention to enter
- Carry a communication device
- Advise the control operator on site when he/ she has left the tunnel

All entrances and exits to the tunnel should be kept clear of obstructions and debris, and negate the possibility of material to “rill” or “fall” over the tunnel.

#### 4.2.9 Communication

A system of communication should be provided so that people in the reclaim tunnel can contact people who can remotely affect the operation of machinery within the tunnel.

The communications system could be the use of hand held radios or a fixed system installed within the reclaim tunnel that provides communication with a monitored control room. A risk based approach should be observed to determine the most effective method of communication.

Whichever system is provided it should enable communication with a person at any location within the reclaim tunnel, entries and alternate egress.

Failure of the ventilation system within the tunnel should not impact on the effectiveness of the communications system.

There should be a system in place to provide for a failure of the primary communication system. This could be an alternative system or a requirement that the reclaim tunnel be evacuated in case the communication system fails.

The system of communication should ensure that the control operator is aware that the reclaim tunnel is occupied and the number and identity of people in the tunnel is known.

#### 4.2.10 Fire and spontaneous combustion

Fire in the coal stockpile and advanced spontaneous combustion are similar hazards. A fire can develop rapidly depending upon the heat source. Spontaneous combustion will develop much more slowly.

Monitoring for carbon monoxide gas, temperature levels in the coal stockpile and an inspection regime should provide early warning of the development of spontaneous combustion. Actions should be developed where there is a risk of spontaneous combustion.

An adequate number of sensors should be installed at strategic locations based on knowledge of the potentials for ignition.

#### 4.2.11 Fire

The coal operator shall assess the risk of fire on any belt conveyor in a reclaim tunnel and implement controls to manage that risk. Conveyor belt and accessories in the reclaim tunnel should be flame resistant and anti-static.

Means for the preventing the fire from occurring and the early detection of a fire and suppression of a fire should it eventuate, shall be provided for within the reclaim tunnel. Refer to the requirements of MDG 1032.

A reticulated water supply shall be provided for the full length of the tunnel and the perimeter of the coal stockpile.

The capacity of the system should be such as to provide adequate flow and pressure for the purposes of fire fighting. Refer to MDG 1032 *Guideline for the prevention, early detection and suppression of fires in coal mines*.

A system to suppress a fire on the conveyor should be installed and may be a sprinkler system, deluge system, a system of hydrants, hoses, branches and nozzles, or a combination of these systems.

Sprinkler and deluge systems can be activated by fusible links or plugs and are, to that extent, fail safe and not reliant on action by people. It should be noted that these systems may not always direct the optimum water flow to the most active part of the fire.

Fire suppression systems should be designed such that people can approach a fire from the intake or non-smoke side, with ventilation flowing in the normal direction.

To minimise fire risk, reclaim tunnels should be designed with high risk components such as electrical equipment, tail end pulley, pumps, and similar placed outside the tunnel. Fire extinguishers should be placed at high risk areas such as electrical equipment, tail end pulley, pumps, and similar.

Fire fighting depots containing back up equipment and tools should be located external to the tunnel where such equipment can be readily accessed.

Systems that are installed should be regularly inspected and tested to ensure they will operate efficiently if required.

A fire fighting plan should be formulated. Provisions of the plan shall include;

- Training in awareness of the fire hazards in the reclaim tunnel and risk to people from various types of fires
- Training in the operation of the fire suppression systems installed in the tunnel
- Requirements for maintenance and inspection of the fire suppression equipment.
- The level and nature of communication needed during a fire fighting emergency

#### 4.2.12 Lighting

All accessible parts of the tunnel (including access points) should be well lit.

It is recommended that twin circuits be provided with adjacent lights on opposite circuits, so that the failure of one circuit would then not place the tunnel into darkness. This allows for redundancy in the event of a fault on either circuit.

Provision should be made for emergency lighting should the power supply or primary system fail.

Where the hazardous area assessment has identified a risk of accumulation of flammable gas or dust, emergency lighting and communications equipment should be capable of being left on safely in a hazardous atmosphere. These systems shall be certified as suitable for the classification of the area as determined through assessment.

#### 4.2.13 Emergency equipment

Regulatory codes of practice provide standards for first aid however, no two workplaces are exactly the same. It is the responsibility of the employer to provide first aid facilities that are adequate for the immediate treatment of any injuries and illnesses that arise in the workplace.

In order for an employer to determine the nature and location of the first aid facilities and the number of trained first aid personnel that are required for their particular workplace, these factors shall be considered:

- the type of work performed and the nature of the hazards
- potential injuries/illnesses, and likely causes
- number and distribution of employees and others in your workplace
- size and layout of the workplace
- location of the workplace (i.e. isolated)

A first aid room should be provided within a reasonable distance of the reclaim tunnel so that prompt and effective resources and aid can be provided if required.

Resources required for use in an emergency for a reclaim tunnel should be considered through a risk assessment process. That equipment may be located on site or sourced through adjacent external providers. Resources may include:

- Breathing apparatus for rescue in a hostile atmosphere
- Harness and special equipment for rescue from heights or sumps
- Equipment for fighting flammable liquid fires
- Extrication gear for removing heavy equipment and debris

A stretcher designed for use in the reclaim tunnel should be located near the entrances to the tunnel. For use in longer tunnels consideration should be given to the provision of a wheeled trolley.

There should be provision external to the tunnel for the isolation of power within the tunnel.

#### 4.2.14 Maintenance

Life cycle maintenance plans should apply for all equipment within the reclaim tunnels and all maintenance work should comply with the relevant mechanical or electrical engineering management plans.

Permit systems may be used to manage non day to day work processes. The use of welding, grinding and abrasive cutting equipment provides a source for ignition. Hot work permits should be used to manage these types of activities within the reclaim tunnel. The requirements of MDG 25 shall be complied with.

Structural integrity audits of the reclaim tunnel shall be completed in accordance with the mechanical engineering management plan.

# Appendix A Referenced documents

## A1 Referenced Australian Standards

The following Australian Standards are referenced in this guideline.

| | |
|---|---|
| **AS 1332** | Conveyor belting - textile reinforced |
| **AS 1333** | Conveyor belting of elastomeric and steel cord construction |
| **AS 1755** | Conveyors - Safety requirements<br>(If AS 1755 has been withdrawn at the time of using this guideline, see the series AS 4024.3610 to AS 4024.3615) |
| **AS/NZS 3000** | Electrical installations (known as the Australian/New Zealand Wiring Rules) |
| **AS 4024.1** | Safety of machinery |
| **AS 4606** | Grade S fire resistant and antistatic requirements for conveyor belting and conveyor accessories |
| **AS/NZS 4804** | Occupational health and safety management systems - general guidelines on principles, systems and supporting techniques |
| **AS 5062** | Fire protection for mobile and transportable equipment |
| **AS 60529** | Degrees of protection provided by enclosures (IP Code) |
| **AS/NZS 60079.10.1** | Explosive atmospheres—Classification of areas—Explosive gas atmospheres |
| **AS/NZS 60079.10.2** | Explosive atmospheres—Classification of Areas—Explosive dusts |
| **AS/NZS 60079.11** | Explosive atmospheres—Equipment protection by intrinsic safety 'i' |
| **AS/NZS 60079.14** | Explosive atmospheres—Classification of Areas—Electrical installations design, selection and erection |

## A2 Referenced guidance documents

The following guidance documents are referenced in this guideline:

| | |
|---|---|
| **EES003** | LifeCycle Management of Explosion Protected Equipment<br>www.resources.nsw.gov.au/__data/assets/pdf_file/0014/101741/EES003-LifeCycle-Management-of-Explosion-Protected-Equipment.pdf |
| **MDG 25** | Guidelines for safe cutting and welding operations at mines |

| | |
|---|---|
| **MDG 29** | Guidelines for the management of diesel engine pollutants in underground environments |
| **MDG 1032** | Guideline for the prevention, early detection and suppression of fires in coal mines |
| **MDG 3608** | Non-metallic materials for use in underground coal mines |
| Workplace Exposure Standard for Airborne Contaminants | At time of publication means:<br>'Workplace Exposure Standard for Airborne Contaminants', published by Safe Work Australia 22 December 2011. see www.safeworkaustralia.gov.au |

## A2 Referenced International Standards

The following International Standards are referenced in this Guideline:

| | |
|---|---|
| **ISO 3449** | Earth-moving machinery - Falling-object protective structures - Laboratory tests and performance requirements |
| **ISO 3471** | Earth-moving machinery – Roll-over protective structures – Laboratory tests and performance requirements |

## A3 Additional Relevant Australian Standards

The following list of relevant Australian Standards is provided for information:

| | |
|---|---|
| **AS 1021** | Protection by Purging of Electrical Equipment for Explosive Gas Atmospheres |
| **AS 1076** | Code of Practice for Selection, Installation and Maintenance of Electrical Apparatus and Associated Equipment for use in Explosive Atmospheres (other than mining) |
| **AS 1482** | Electrical Equipment for Explosive Atmospheres – Protection by Ventilation – Type of Protection V |
| **AS 1593** | Electrical Equipment for Explosive Atmospheres – Increased Safety Apparatus – Type of Protection E |
| **AS 1670** | Automatic Fire Detection and Alarm Systems – System Design, Installation and Commissioning |
| **AS 1674** | Fire Precautions in Cutting, Heating and Welding Operations |
| **AS 1825** | Electrical Equipment for Explosive Atmospheres – Pressurized Enclosures - Type of Protection P |
| **AS 1826** | Electrical Equipment for Explosive Atmospheres – Special Protection – Type of Protections |

| | |
|---|---|
| **AS 1828** | Electrical Equipment for Explosive Atmospheres - Cable Glands |
| **AS 1850** | Portable Fire Extinguishers – Classification, Rating and Fire Testing |
| **AS 1851.1** | Maintenance of Fire Protection Equipment – Portable Fire Extinguishers |
| **AS 1851.2** | Maintenance of Fire Protection Equipment – Fire Hose Reels |
| **AS1851.3** | Maintenance of Fire Protection Equipment – Automatic Fire Sprinkler Systems |
| **AS 1854.4** | Maintenance of Fire Protection Equipment – Fire Hydrant Installations |
| **AS 1915** | Electrical Equipment for Explosive Gas Atmospheres – Battery Operated Vehicles |
| **AS 1939** | Classification of Degrees of Protection Provided by Enclosures for Electrical Equipment |
| **AS 2220.1** | Emergency Warning and Intercommunication Systems in Buildings – Equipment Design and Manufacture |
| **AS 2220.2** | Emergency Warning and Intercommunication Systems in Buildings – System Design, Installation and Commissioning |
| **AS 2236** | Electrical Equipment for Explosive Atmospheres - Dust – Excluding Ignition Proof (DIP) Enclosure |
| **AS 2238** | Electrical Equipment for Explosive Atmospheres – Non Sparking Apparatus – Type of Protection N |
| **AS 2275** | Combustible Gas Detection Instruments for use in Explosive Atmospheres |
| **AS 2290** | Electrical Equipment for Coal Mines - Maintenance and Overhaul |
| **AS 2380** | Electrical Equipment for Explosive Atmospheres – Explosion Protection Techniques |
| **AS 2381** | Electrical Equipment for Explosive Atmospheres – Selection, Installation and Maintenance |
| **AS 2419** | Fire Hydrant Installations – System Design, Installation and Commissioning |
| **AS 2430.1** | Classification of Hazardous Areas – Explosive Gas Atmospheres |
| **AS 2340.2** | Classification of Hazardous Areas – Combustible Dusts |
| **AS 2431** | Electrical Equipment for Explosive Atmospheres – Encapsulated Apparatus - Type of Protection M |
| **AS 2444** | Portable Fire Extinguishers – Selection and Location |

| | |
|---|---|
| **AS 2480** | Electrical Equipment for Explosive Atmospheres – Flameproof Enclosure – Type of Protection D |
| **AS 2745** | Electrical Welding Safety |
| **AS 2865** | Safe Working in a Confined Space |
| **AS 2941** | Fixed Fire Protection Installation – Pump set Systems |

# Appendix B Feedback sheet

Your comment on this guideline will be very helpful in reviewing and improving the document.

Please copy and complete the Feedback Sheet and return it to:

*The Senior Inspector of Mechanical Engineering*

*NSW Trade& Investment*

*PO Box 344*

*Hunter Region Mail Centre NSW, 2310*

How did you use, or intend to use, this guideline?

What do you find most useful about the guideline?

What do you find least useful?

Do you have any suggested changes to the guideline?

Thank you for completing and returning this Feedback Sheet