Emergency Preparedness and Mines Rescue Guidelines

CS Mines Rescue

These guidelines are intended to provide guidance to Incident Management Teams (IMT) and New South Wales Mines Rescue (MR) officers in regards to their responsibilities and conduct in an underground coal mining emergency.

These guidelines have been developed through detailed risk assessments and consultation with industry and mines rescue experts both within Australia and Overseas. Ongoing reviews will be conducted taking into account underground mine emergencies, simulated emergencies and general application of the guidelines to ensure that they remain both functional and practical.

The Procedures within these guidelines are designed to allow for an immediate mines rescue deployment where risks to the team are able to be measured and controlled utilising standard techniques and equipment. Due to the number of variables in an underground coal mine emergency situation, the procedures and limits/barriers in the guidelines may not always be appropriate or practical. (One such example is post an underground explosion where the explosibility of the atmosphere cannot be established, and the risk of a subsequent explosion cannot be eliminated.) Should this occur then IMT and MR Officers must adopt a documented risk management approach referencing the guidelines to identify likely risks associated with the proposed operation/ actions and the barriers to be implemented. External expert advice or cross referencing (taking into account time constraints) should be considered especially with dynamic incidents.

The re-entry and exploration within a mine for the recovery of bodies or restoration of operations is not normally considered an emergency situation. These activities should be a pre-planned operation, using a risk management approach (with reference to the guidelines to identify the likely risks associated with the proposed operation), and under the direction of mine management. There are times when body recovery may be an extension or part of the initial emergency.

Emergency response contact details

Mines Rescue is structured on a regional basis with major facilities in each region

Region	Location	Emergency	Business telephone	Facsimile	Mobile Number
Hunter Valley	6 Lachlan Ave, Singleton Heights	1300015551	02 6573 9000	02 6573 2007	
Newcastle	533 Lake Road, Argenton		02 4922 4400	02 4958 3504	
Southern	558-580 Princes Hwy, Woonona		02 4286 5499	02 4285 1397	
Lithgow	3 Proto Ave, Lithgow		02 6350 1000	02 6352 3684	
Moolarben	Murragamba Road Ulan		02 6350 1000	02 6352 3684	
CMTS	1/30 Ralph Black Dr, North Wollongong	Brian Howell Robert Strang	02 4229 7133	02 4229 3133	0419 419 275 0419 418 455
Head Office	PO Box 146 Boolaroo	Wayne Green (General Manager) Steve Tonegato (State Manager)	02 4922 4410 02 42865470	02 4950 6629 02 4285 1397	 0418 203242

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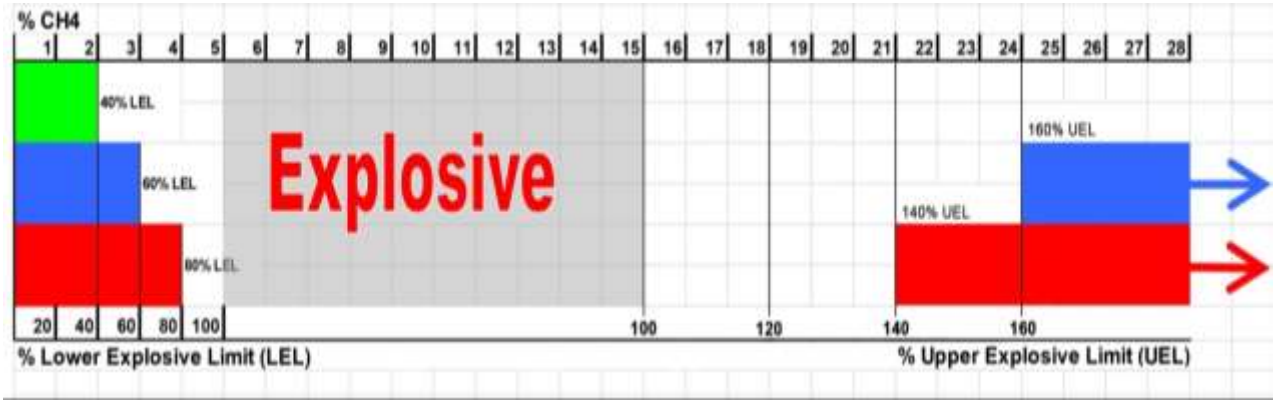
1. Risk categories

If the lives of miners are at risk, brigadesmen may be deployed within acceptable risk categories to carry out a rescue.

Acceptable risk categories are:

- Category 3 Training
- Category 2 No life at risk
- Category 1 Lives at risk

Entry exclusion limits



1.1 Explosibility

Entry into a mine should not be attempted when the atmosphere in the general body is within the exclusion limits as below:

Risk category	Lower limit	Entry exclusion limits for explosive mixtures	Upper limit
3	40% LEL (2% CH_4)	No entry above this level for training purposes	
2	60% LEL (3% CH_4)	-No entry -	160% UEL (24% CH_4)
1	80% LEL (4% CH_4)	-No entry-	140% UEL (21% CH_4)

CH_4, H_2 and CO are flammable products of mine fires and explosions. Consideration must be given to the contribution of all these gases in explosive mixtures.

The LEL and UEL percentages can be accurately determined by integrating gas chromatographic analysis with Hughes and Raybold explosibility determination. The LEL can also be estimated using a multi-gas detector, providing the oxygen concentration is sufficient. When the oxygen concentration of the atmosphere to be tested is below approximately 10%, the accuracy of flammable gas readings from these devices may be unreliable and inaccurate.

Where entry into mine environments is proposed at Risk Category 1 appropriate barriers should be introduced. e.g.

- Isolate and control potential ignition sources considered (e.g.; total isolation of all power, wearing and/or using non-static or non-sparking clothing, tools and equipment);
- Continual monitoring of the atmosphere with a multi-gas detector by the brigade;
- An air lock is utilised by the brigade to enter into or egress from an atmosphere greater than the upper exclusion limit (e.g., 140% UEL)
- SCBA is worn and a SCSR is carried by brigadesmen.

Information necessary to make a well-considered decision:

Nature of Gases

When evaluating the explosibility (or toxicity) of an atmosphere an assessment must be made of the nature, type and source of all potentially flammable (or toxic) gases including:

- methane make under non-mining conditions
- known or potential blowers
- methane drainage systems
- active or sealed goaf areas
- fire gases and other gases driven off when coal is heated
- barometric variations
- ventilation changes

The extent of natural or induced ventilation effects and the impact of seam geometry/dip also needs to be considered to understand the dynamics of the mine atmosphere.

Gas Sampling

Where manual samples are to be collected the container (vessel, bag, flask or cylinders) should be thoroughly purged with the atmosphere to be sampled to remove any potential contaminants.

Where aluminised wine cask bags are used to sample gases in an emergency they should only be used once and then destroyed if the presence of hydrogen is detected. Hydrogen may, if present, diffuse into the inner lining of the bag and then contaminate subsequent samples by diffusing back into the sample.

Where galvanised pipes are used to sample from remote, inaccessible or hostile environments acidic mine water may react with the zinc galvanising to produce hydrogen which could contaminate samples and corrupt results.

Where an underground mine is situated under or adjacent to an open cut, residual nitrates from shot firing may form nitrous oxide N_2O which has a high cross-sensitivity to CO readings on some makes of infra-red analysers.

Gas Analysis

All relevant gases should be included in the analysis, particularly any hydrocarbons. The accuracy of the results must be assured. Factors such as the physical condition of system hardware, calibration regime, sensor range, cross sensitivity and ability to operate normally in Oxygen depleted atmospheres should be taken into account.

Ideally surface installations will be ventilated by fresh air to avoid contamination.

The reliability of results should take into account the appropriateness of the sampling location and the time elapsed between sample acquisition and analysis. The results should be trended and interpreted by trained and experienced personnel.

Resources

A mine-wide gas monitoring system is preferred with incorporation of gas chromatography and purpose trained/qualified personnel preferred.

Matrix 1 defines the relationship between % LEL, % UEL and % CH_4 for Categories 1, 2 and 3 for methane only atmospheres

Risk category	Lower limit		Upper limit	
	%LEL	%CH_4	%UEL	%CH_4
3	40	2	-	-
2	60	3	160	24
1	80	4	140	21

Matrix 2 details the flammable gas limits for atmospheres containing methane, hydrogen and carbon monoxide.

Flammable gas limits				
	Lower		Upper	
	Conc%	%LEL	Conc%	%UEL
CH_4	5	100	15	100
CO	12.5	100	74	100
H_2	4	100	74	100

Contribution of individual flammable gases to the overall flammability of the mixture is cumulative according to their respective Lower Explosive Limits (LEL) / Upper Explosive Limits (UEL).

Example 1

The LEL of a mixture of gases from a fire containing 1% CH_4, 1% H_2 and 1% CO is calculated as follows:

$$1\%\ CH_4 = \frac{100 \times 1}{5} = 20\%\ LEL$$

$$1\%\ H_2 = \frac{100 \times 1}{4} = 25\%\ LEL$$

$$1\%\ CO = \frac{100 \times 1}{12.5} = 8\%\ LEL$$

The LEL of the mixture is 53%.

Example 2

The % UEL of a mixture of gases from a fuel rich fire containing 18% CH_4, 5% H_2 and 5% CO is calculated as follows:

$$18\%\ CH_4 = \frac{100 \times 18}{15} = 120\%\ UEL$$

$$5\%\ H_2 = \frac{100 \times 5}{74} = 7\%\ UEL$$

$$5\%\ CO = \frac{100 \times 5}{74} = 7\%\ UEL$$

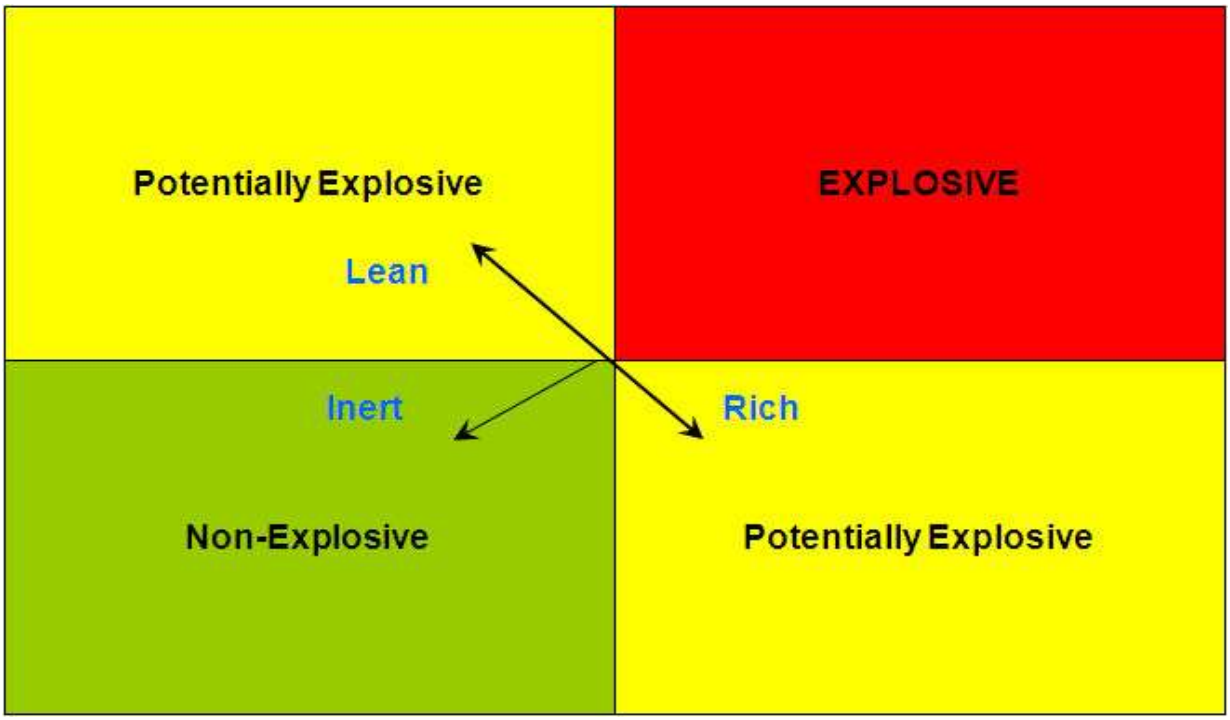
The UEL of the mixture is 134%.

2 Ellicott's diagram

Oxygen deficiency in air reduces the flammable range when mixed with flammable gases. The presence of carbon dioxide also reduces the explosibility of a mixture of flammable gas and air.

Ellicott's diagram accounts for the carbon dioxide effect and oxygen deficiency and enables the explosibility to be trended on a single four quadrant diagram that defines the 'explosive', 'non explosive' and two potentially explosive areas. Movement towards the upper left quadrant signifies dilution with fresh air. Movement towards the lower left quadrant signifies dilution with inert gases. Movement towards the lower right quadrant signifies enrichment with extra combustibles.

The Smartmate explosibility program also includes the exclusion zones on the Ellicott diagram according to the 'Guidelines'. This enables Incident Management Teams to accurately assess the Category and the trend prior to the entry of a mines rescue brigade.



3 Emergency preparedness guidelines

The emergency preparedness guidelines provide a framework for Incident Management Teams to manage an emergency and provide MR Officers with direction in regards to their responsibilities and conduct in an emergency. (See also Reference 1 ICCS)

In an emergency the senior mine official should establish an Incident Management Team to manage and control the response and intervention. It is likely that the IMT will comprise representatives of mine management and the appropriate Inspector of Mines, Industry Check Inspector and MR Regional Manager (or delegate).

Depending on the nature of the emergency the Escalation Arrangements as detailed in the NSW Government Mine Sub Plan (A sub plan of the NSW State Emergency Management Plan, March 2015) may be implemented and include the following:

- The LEOCON (Local Emergency Operations Controller) will determine when the arrangements in the Sub Plan will be implemented, and this may be based on a request from the person in control of a mine emergency or when the LEOCON becomes aware that the mine emergency plan arrangements are inadequate to deal with the mine emergency or as directed by the SEOCON (State Emergency Operations Controller) or the Minister administering the SERM Act.
- The Local Emergency Management Officer (usually the Regional Police Commander) may assume control and manage the response to the event and/or determine an appropriate management structure to manage the response to the event and/or access the required resources
- The LEOCON will determine the control structure and location form which to operate, and may include passing the control of the response to a higher level EOCON (Emergency Operations Controller)
- The EOCON will consult with the Department, the mine operators representative, the combat agency for other events specified in the EMPLAN (NSW State Emergency Management Plan) and any other reasonably available specialists e.g. Mines Rescue

Responsibilities are generally defined as:

- The Mine Operator (or delegate) as per the Emergency Management System (EMS) has statutory responsibility for the management and control of the emergency operation. This person may be replaced by a police officer if rescue is required of the Mine Sub plan is applied
- Police retain responsibility for any rescue

- The Inspector of Mines has the authority to suspend or limit the intervention where the Inspector deems that persons are being exposed to unacceptable levels of risk.
- The Industry Check Inspector can also suspend or limit operations where the Inspector deems that persons are being exposed to unacceptable levels of risk.
- The MR Regional Manager (or delegate) can provide specialist knowledge and expertise on rescue, control, exploration and recovery/restoration techniques and in particular, the deployment of the Mines Rescue Brigade.
- As the Mines Rescue Board's representative, the MR Manager (or delegate) maintains full responsibility for the detailed operation of the Mines Rescue Brigade and should ensure that when the Mine Operator (or delegate) requires them to be utilised, the Brigade is deployed in accordance with these Guidelines and sound rescue practice. The MR Manager (or delegate) should veto deployment of the Mines Rescue Brigade where he deems that persons are being exposed to unacceptable levels of risk, or where the techniques and procedures proposed are not in accordance with these Guidelines and sound rescue practice.
- In the event of an incident involving the loss of life or lives, Police Officers act as the Coroner's representative and have statutory responsibilities for investigation and interviewing, reporting, and the removal of bodies.

NSW Emergency Management Plan

NSW Government

http://www.emergency.nsw.gov.au/media/1621.pdf

Sub Plan to the NSW Emergency Management Plan

NSW Government

http://www.mpes.nsw.gov.au/content.php/1395.htm

4 Nature of the emergency

The IMT should consider:

4.1 The nature of the emergency/incident:

- Ignition
- Explosion
- Spontaneous combustion
- Fire
- Fall of ground/entrapment
- Fall of ground/wind blast
- Outburst
- Inrush
- Unknown or unidentified?

Static incidents such as a fall of ground, outburst or flash ignition are unlikely to develop into an uncontrolled event and may enable a fast resolution and early intervention.

Dynamic incidents such as fires, spontaneous combustion or explosions may develop into uncontrolled events. They warrant extreme caution and the detailed evaluation of all relevant factors utilising data that is accurate, reliable (timely, valid location/s, correctly interpreted), and trended.

4.2 The intensity of the emergency/ incident:

- Blast damage
- Colour and extent of smoke
- Visible flame
- Type and level of gases produced
- Ventilation
- Information from survivors
- Poor visibility

Determination of the nature of the emergency/incident and an evaluation of its intensity will enable an assessment to be made of the:

- Extent of disruption to essential services such as ventilation, mine monitoring, methane drainage
- Degree of confinement to a specific face, heading, panel or district
- Nature and extent of injuries to survivors
- Potential for escape, rescue or re-entry.

5 Action required

What action or response is required to remedy the emergency/incident?

- Escape, rescue or extrication of persons
- Control of a situation (e.g.; firefighting, sealing)
- Exploration and recovery of bodies
- Exploration and restoration of operations
- Surface emergency procedures.

Establishing the desired outcomes provides a framework for determining the type, extent, reliability and accuracy of data required to identify and evaluate potential strategies. It will be a factor in determining acceptable risk levels and also provide a framework for evaluating overall logistics.

Re-entry and exploration within a mine for the recovery of bodies or restoration of operations should be a pre-planned operation using a risk management approach.

The Guidelines may be adopted as a framework for identifying the hazards associated with the proposed operation. However, entry limits as identified in References 2, 5, 6 and 7 will need to be reviewed with appropriate limits determined by the Incident Management Team and Inspectorate.

6 Escape, rescue or extraction

6.1 Are people trapped or unaccounted for?

Identification of the number of persons endangered (if any) will enable the relative severity of the emergency to be quickly assessed.

6.2 What is the nature of the Environment?

- Flammable
- Toxic
- Oxygen deficient
- Heat and smoke affected
- Exposed to unstable strata, heights or depths

Depending upon the type, extent and limits of gases present or suspected the nature of the environment may impact upon the potential for escape or survival prospects, or predicate and limit response strategies:

- a flammable atmosphere will prevent rescue and re-entry particularly if there is the likelihood of an active ignition source
- a toxic or oxygen deficient atmosphere may limit the duration of rescue and/or require the use of breathing apparatus
- a heat and smoke affected atmosphere may similarly limit the duration and type of rescue.

The static/dynamic nature of the emergency also needs to be evaluated in respect to the evolution of gases and the potential to develop a hazardous environment over time.

Refer: 1.1 explosibility & references 2 - 7

6.3 According to the Mines Emergency Management System where are the persons known or expected to be, and how long have they been trapped or missing?

An evaluation of the nature of the emergency and mine environment, coupled with the known/expected location of personnel, the duration of their exposure, and the availability and type of escape systems will determine the escape/survival potential.

6.4 What are the expected actions of U/G personnel according to the mines escape and rescue plan? What are the prospects for their escape or survival and can they be enhanced?

What escape strategies are available to endangered personnel?

- location and numbers of self-rescuers, caches, refills and refuge points
- location of all personnel U/G
- visibility assessment and use of lifelines
- communications and locating devices
- primary / alternative escape ways
- training in mines rescue, escape and survival techniques
- materials and equipment for rescue, escape and survival
- transport systems
- estimated time for U/G personnel to escape from various locations
- man access door and air lock inseam response
- Refer MDG 1020 + 1022

6.5 What is the nature of the mining environment and operation?

- Depth, type of overburden
- Seam thickness, dip
- Propensity to spontaneous combustion
- Type and make of seam/strata gases
- Mining method; longwall, pillar extraction, development
- Ventilation system and quantities
- Segregation of intakes
- Transportation systems
- Stopping/sealing methods & material
- Fire and explosion suppression systems
- Other materials; plastics/synthetics
- Water make

- Surface constraints
- Gas management and extraction systems

An understanding of the mining environment and operation is necessary in order to:

- Identify the type, nature and extent of the hazards contained within the environment, e.g.; presence of major gas and ignition sources
- Assess the contribution of these factors to the incident, their potential interaction, and the stability of the environment or atmosphere
- Determine the potential for development of a secondary incident, e.g.; explosion, fire
- Evaluate factors that may limit or reduce the potential for escape or rescue

6.6 Is rescue and or the use of breathing apparatus a necessary and viable strategy?

- An evaluation of the nature of the emergency and mine environment, coupled with the known/expected location of personnel, the duration of their exposure and the availability, type and effectiveness of escape/survival systems will determine the escape/survival potential. Where escape is unlikely but survival possible the potential for rescue can be assessed and risks evaluated.
- Escape/survival potential is dependent upon :
    - Mine environment
    - Expected location

If the mine environment is such that survivors require rescue the environment will similarly preclude fresh air rescue by untrained rescuers.

Refer: procedures 1-7

6.7 What escape or rescue systems and technologies are necessary and available? Can they be readily deployed and effectively utilised?

- Inertisation coupled with refuge and rescue
- Large diameter boreholes
- Emergency response vehicles

- Mine rescue brigadesmen
- Other emergency services (paramedics, police and/or fire rescue)?
- Depending upon the type, extent and limits of gases present or suspected and the static/dynamic nature of the emergency the overall situation may predicate that alternative rescue technologies be utilised due to unacceptable risk levels to rescue personnel as determined by the Incident Management Team.
- Alternative rescue technologies and specialist services can be resourced through the regional mines rescue station.

Refer: 1.1 Explosibility and 10.7

6.8 Can personnel underground be safely and effectively deployed and what measures need to be introduced to ensure their safety? (e.g. first response to an Outburst).

- Rescue from flammable atmospheres is prohibited as is the conduct of rescue operations in a mine where the presence of a flammable atmosphere and active ignition source is likely. Rescue operations may be conducted in a mine that contains a flammable atmosphere in another location provided there is no likelihood of active ignition sources. The explosibility of the mine atmosphere should be continuously monitored to ascertain that atmospheric conditions are trends are known.
- If rescue brigadesmen are entering atmospheres likely to contain more than the 60% LEL appropriate measures should be introduced to eliminate, isolate and control potential ignition sources (e.g.; isolation of all power, anti-static and non-sparking clothing, tools and equipment).
- Communication should be maintained between the active brigade team and the FAB/surface control with agreed systems of emergency communication established before entry.

Refer: 1.1 Explosibility and References 2-7

6.9 Can personnel on the surface be safely and effectively deployed and what measures need to be introduced to ensure their safety?

- Before establishing the control centre and operations base in existing surface infrastructure, due consideration must be given to the possible occurrence, magnitude and effects of any secondary event.

- Evacuation procedure to designated muster points should be established and made familiar to all required personnel.
- Barriers should be erected on the surface to prevent unauthorised access into the predetermined blast windows of all surface entries.
- To obtain atmospheric samples from surface entries, after initial establishment of the sampling point, the sample line should extend at least 100m minimum away from the entry with regard given to blast direction.
- Due consideration should be given to direction of prevailing winds over a 24 hour period in relation to atmospheric contaminants from surface entries with continuous monitoring points (audible alarm) established at appropriate locations.
- Consideration should be given to surface personnel having access to adequate protection from potential atmospheric contamination.
- Consideration should be given to safety of neighbours and public roads
- All exposed non-mining personnel should receive instruction in the use of escape breathing apparatus.

6.10 When people have been trapped or pinned under debris or heavy equipment and cannot be removed by hand then hydraulic, pneumatic and cutting tools are needed for their extrication.

Rescuers should be aware that:

- Advanced life support techniques such as treatment of crush syndrome and haemorrhage may need to be implemented as victims are freed
- Pivotal points of debris and equipment may be altered during extrication
- Heat transfer from cutting tools to victims may cause burns.

6.11 When people require extrication from heights and depths victims and rescuers are exposed to hazards unique to those situations.

- Persons currently accredited as vertical rope rescue operators should be utilised for the extrication of personnel from heights and depths.
- These specialists can be resourced through the regional mines rescue station.

7 Controlling a situation

7.1 What is the nature of the environment?

- Flammable
- Toxic
- Oxygen deficient
- Heat and smoke affected

Depending upon the type, extent and limits of gases present or suspected the nature of the environment may impact upon the potential introduction and effectiveness of control strategies:

- A flammable environment will prevent deployment of rescue brigadesmen, particularly if there is the likelihood of an active ignition source
- A toxic or oxygen deficient atmosphere may limit the duration of rescue and/or require the use of breathing apparatus
- A heat and smoke affected atmosphere may similarly limit the duration and type of rescue.

The static/dynamic nature of the emergency also needs to be evaluated in respect to the evolution of gases and the potential to develop a hazardous environment over time.

Refer: 1.1 Explosibility (b) and references 2 - 7

7.2 What is the nature of the mining environment and operation?

- Depth, type of overburden
- Seam thickness, dip
- Propensity to spontaneous combustion
- Type and make of seam/strata gases
- Gas management systems
- Mining method longwall, pillar extraction, development
- Ventilation system and quantities
- Segregation of intakes

- Transportation systems
- Man access doors at surface entry seals
- Stopping/sealing methods and materials
- Fire and explosion suppression systems
- Other materials; plastics/synthetics
- Oils e.g. Transformer oil
- Water make
- Surface and environmental constraints.
- Mine monitoring
- Gas drainage system
- Communication system
- Location and numbers of self-rescuers, caches / changeover stations / refuges
- Escape ways, primary and secondary
- Man access doors at surface entry seals

An understanding of the mining environment and operation is necessary in order to:

- Identify the type, nature and extent of the hazards contained within the environment, e.g.; presence of major gas and ignition sources
- Assess the contribution of these factors to the incident, their potential interaction, and the stability of the environment or atmosphere
- Determine the potential for development of a secondary incident, e.g.; explosion, fire

Evaluate factors that may limit or reduce the potential introduction and effectiveness of control strategies.

7.3 What intervention and control techniques could be utilised? Are they available? Can they be readily deployed?

- Ventilation
- Inertisation
- High expansion foam
- Emergency response

- Vehicles
- Sealing
- Flooding
- Mine Rescue Brigade

Depending upon the type, extent and limits of gases present or suspected and the static/dynamic nature of the emergency the overall situation may predicate that alternative intervention techniques be utilised due to unacceptable risk levels to rescue brigadesmen.

7.4 Can mine rescue brigadesmen be safely and effectively deployed? What measures need to be introduced to ensure their safety?

- Rescue from flammable atmospheres is prohibited as is the conduct of rescue operations in a mine where the presence of a flammable atmosphere and active ignition source is likely. Rescue operations may be conducted in a mine that contains a flammable atmosphere in another location provided there is no likelihood of active ignition sources.
- The explosibility of the mine atmosphere should be continuously monitored to ascertain atmospheric conditions and trends.
- Under Cat 1 conditions appropriate measures should be introduced for the elimination, isolation and control of potential ignition sources (e.g.; isolation of all power, anti-static and non-sparking clothing, tools and equipment).
- Communication should be maintained between the active brigade team and the FAB/surface control with agreed systems of emergency communication established before entry.

Refer: 1.1 explosibility, references 2 - 7

7.5 Can the restoration and repair be completed without breathing apparatus? What measures need to be introduced to ensure the safety of workers?

- The mine atmosphere should be continuously monitored to ensure that fresh air conditions are maintained and heat and humidity guidelines are observed as appropriate.

Refer: references 2 - 7

8 Exploration and recovery (of bodies)

Re-entry and exploration within a mine for the recovery of bodies should be a pre-planned operation using a risk management approach.

- The Guidelines for rescue and extrication of personnel may be adopted as a framework for identifying the risks associated with the proposed operation. However, entry limits as identified in References 2, 3, 4, 5, 6 and 7 will need to be reviewed with appropriate limits determined by Mine Management and Inspectorate.
- Body Recovery Guidelines will be adopted in every case
- Where bodies are to be recovered consideration should be given to the wearing of breathing apparatus and protective clothing to provide protection against odours emanating from the body/bodies and reduce subsequent psychological impacts.

Refer: AS/NZS 31000, MDG1010 and MDG 1029

9 Exploration and restoration of operations

Re-entry and exploration within a mine for the restoration of operations should be a pre-planned operation using a risk management approach.

These Guidelines for emergency preparedness and mines rescue may be adopted as a framework for identifying the risks associated with any proposed operation, however, entry limits identified in this document will need to be considered in conjunction with appropriate limits determined by Mine Management and Inspectorate.

Refer: AS/NZS 31000

10 Emergency response equipment

10.1 Primary response equipment

Region	Primary Response Vehicles	Location of Sub-Stations and Depots
Hunter Valley	2 Underground Response* 1 Surface Response	Whitehaven Coal Narrabri Sub station (12 sets SCBA)
Newcastle	2 Underground Response*	
Southern	2 Underground Response*	
Lithgow	1 Underground Response 1 Training/Secondary Emergency Response shared with Moolarben	
Moolarben	1 Underground Response 1 Surface Response	

*At this Station one Underground Response vehicle is utilised in a primary standby/emergency response role, with the second vehicle in a primary training/secondary back-up emergency response role.

Each of the primary response vehicles is equipped with a range of emergency equipment capable of supporting two active mines rescue teams including:

- Breathing Apparatus (12 sets SCBA)
- Escape apparatus
- First aid equipment
- Gas detection equipment
- Resuscitators
- Stretchers

The surface mines rescue primary response vehicles at Hunter Valley and Moolarben are equipped with a range of emergency equipment capable of supporting rescue operations in a surface situation, including:

- Basic hand tools and PPE
- CABA (compressed air breathing apparatus)

- Synthetic slings, shackles, steel wire rope, tirfor
- Extrication and pneumatic lifting equipment
- First aid equipment
- Hand operated hydraulic and power hydraulic rescue equipment
- Lighting plant and generators
- Rescue roping equipment

10.2 Secondary response equipment

A range of secondary response equipment is also maintained at each of the regional rescue facilities including:

- Compressed air breathing apparatus (CABA)
- Escape apparatus
- Firefighting (extinguishers, suitable foam generators and foam compounds)
- Fire protective equipment (FPE)
- Gas monitoring and detection equipment
- Extrication and lifting Equipment
- Lifelines
- Non sparking tools
- PPE (kneepads, work gloves, clothing, latex gloves, respirators).

10.3 Tertiary response equipment

A range of tertiary response equipment can also be resourced through the regional mines rescue facilities including:

- Cutting and burning
- Earthmoving (large scale, surface)
- Fans/exhausters (mobile)
- Generators/alternators (mobile)
- Lifting/extrication
- Lighting plants (mobile)
- Mobile cranes

- Mucking (underground)
- Pumping
- Spiling
- Low and High Expansion Foam

Each facility maintains a master list of suitable equipment available in their respective region detailing; item, number available, capacity, usual location, contact names of operators and numbers (business and after hours).

10.4 Coal Mines Technical Services (CMTS)

Coal Mines Technical Services is a business unit operating separately from the regional rescue stations. It is equipped with state of the art gas chromatographic and gas analysis equipment and can provide a mobile laboratory and remotely operated gas chromatographic analysis system in the event of an emergency, or for routine gas analysis.

Trained and qualified technical officers can operate the equipment and provide result enhancement and interpretation both remotely via modem to Smartgas installations or on-site in the mobile laboratory. The officers are contactable through mobile phones during office hours (see page 2 of this document for mobile contact number).

10.5 Specialist services

A range of specialist services can also be resourced through the regional mines rescue facilities including:

- Airlifting equipment and personnel (helicopter and fixed wing)
- Expert resources on fires, explosions and intervention techniques
- Hazmat facilities through local Fire Brigades
- Local Emergency Operations Controller (LEOCON) with full access to all civil emergency services
- Medical and critical incident stress debriefing
- Mobile laboratories and gas analysis
- Police, Fire and Ambulance rescue services

Each facility maintains a master list of specialist services available in their respective region detailing; services, capabilities, usual location, contact names and numbers (business and after hours).

10.6 Basic support services

A range of basic support services may be necessary in an emergency and may be accessed and resourced through the LEOCON. These services are summarised below:

- Emergency services; Ambulance, Fire, Police, Hazmat, Rescue, SES, VRA
- Accommodation; motels, hotels, temporary and/or mobile offices, marquees, ablutions
- Catering; Salvation Army, restaurants and fast food outlets
- Communications; emergency and/or secure lines, additional remote systems, spares
- Coroner and morgue
- Media services and control
- Security; access and buildings
- Suppliers; rescue consumables (oxygen, soda lime, foam compounds, BA spares, PPE, rope)
- Suppliers; mine operations consumables (brattice, stopping materials, hand tools, rope, hardware)
- Transport; taxis, mini buses, couriers, delivery trucks and prime movers.

Each facility maintains a master list of basic support services required to support an emergency at a mine in their region detailing; services, requirements, capabilities, usual location, contact names and numbers (business and after hours).

10.7 Alternative intervention technologies

A range of alternative intervention technologies can be resourced to enhance the decision analysis process in an emergency:

a) Borehole cameras	b) Emergency winder, winding ropes and capsules
c) Inertisation - Mineshield	d) Locating devices
e) Other remote sensing and exploration apparatus	f) Sealing materials, fly ash, grout
g) Surface drill rigs (and drillers), large and small diameter	h) Thermal imaging camera

A master list of alternate intervention technologies, that could be utilised in an emergency, will be kept in each region detailing; technologies, requirements, capabilities, usual location, contact names and numbers (business and after hours)

The LEOCON is a likely source of additional equipment.

11 Roles and responsibilities

11.1 Overview

- Under the direction and control of the State Manager, staff of Mines Rescue provides the systems, procedures and expertise necessary to effectively manage and deploy the Mines Rescue Brigade to respond to and deal with an emergency at a mine.
- The Emergency Preparedness and Mines Rescue Guidelines have been developed to provide Mines Rescue staff and the Mines Rescue Brigade with direction in regards to their responsibilities and conduct in an emergency situation.
- Where, for the safety of life or property in an emergency situation, action is considered necessary that differs from the standards established in these Guidelines the Mines Rescue Regional Manager or authorised delegate may exercise discretion and depart from these standards providing due consideration is given to all relevant factors.
- Providing that Mines Rescue staff can demonstrate that they have in good faith executed their duties in accordance with these Guidelines that person or persons will not be subject to any action, liability, claim or demand. This protection does not extend where it is demonstrated that the person concerned acted carelessly or wilfully.

11.2 Mines Rescue officers and staff

General Manager

Has responsibility to the board.

State Manager

Has overall responsibility to the General Manager to ensure that the Board's principal functions and responsibilities are achieved in an emergency, that the Guidelines are observed, and that MR Officers conduct themselves appropriately.

- Will not normally participate in the Incident Management Team unless required due to the nature or extent of the emergency, or to provide support, knowledge, expertise or resources to the IMT.
- Will act in an overview/auditing/supporting role to ensure that the resources of the MR are effectively deployed and utilised, and to co-ordinate resources from other regions in the event of a protracted or specialised emergency.
- May perform a media liaison role.

- Should liaise with the media officials of the affected mine.

Regional Manager or Delegate

- Ensure that the Brigade is effectively mobilised, that adequate numbers of brigadesmen are available at all times as required, and that systems and facilities are established to maintain and sustain the Brigade and MR personnel involved.
- Implement the inter-regional mutual support scheme.
- Ensure that first response and minimum equipment is mobilised to site and prepared for immediate use.
- Identify and resource additional emergency and rescue equipment as appropriate to the incident.
- Identify and resource additional technical expertise as appropriate from within the MR.
- To participate as a member of the Incident Management Team and provide advice on the utilisation and deployment of escape/rescue/control and exploration systems and techniques, including the Mines Rescue Brigade.
- Retain full responsibility for the detailed operation of the Mines Rescue Brigade and if necessary veto the use of the Brigade, or the objectives and procedures established for the Brigade, if the deployment, objectives and procedures are not in accordance with these Guidelines and sound rescue practice.
- Establish succession plans to relieve MR personnel in a protracted emergency.
- Ensure briefing and debriefing of mines rescue teams prior to and after deployment in an emergency.

Support Personnel

In an emergency situation regional support personnel will initially be deployed in two primary roles namely; first response co-ordination and communications. In these roles they are responsible to the Regional Manager or Delegate to:

- First Response Co-ordination
  - transport first response and minimum equipment to site
  - establish facilities and equipment for the Brigade- prepare first response and minimum equipment for immediate response
  - maintain and refurbish equipment as necessary
  - address any deficiencies and defects and report such to the Manager/delegate.
- Communications
  - obtain and record all relevant information regarding the emergency and the deployment of the Brigade and MR personnel
  - facilitate deployment of the Brigade, MR personnel and ancillary equipment.

The primary role of support personnel is to deploy the Brigade and rescue equipment and provide ongoing resources to ensure the Brigade/equipment can be sustained and maintained. Subject to the above primary roles being established and given effect other MR support personnel may be deployed at the MR facility or on site to support ongoing operations including:

- assembling and marshalling of Brigades
- briefing and debriefing of Brigades
- communications and recording
- gas monitoring
- maintenance and refurbishment of equipment
- surface and/or FAB Controller
- transport

MR support personnel may also be required to participate as brigadesmen should circumstances warrant such.

Technical Services Staff

Technical staff may be deployed in an emergency to provide specialist technical expertise to the Incident Management Team and/or establish and monitor the MR's mobile laboratory and specialist equipment. The Regional Manager or delegate of the region called-out will be responsible for the call-out of the CMTS technical staff. During the emergency the CMTS technical staff will be responsible to the Technical Services Manager or Regional Manager (or delegate) for the establishment, operation and maintenance of their facilities and equipment and the reporting of observed conditions to the Incident Management Team.

Statutory Notification and Liaison with Other Emergency Services

In all operational deployments contact will be made with local Police to notify them of the fact that rescue vehicles have been dispatched and are travelling under lights and siren. If a call out involves a fatality, or if equipment is required that is not readily available to Mines Rescue, a senior level Police officer (LEOCON if possible) must be contacted and utilised in IMT if required. If a call out involves a fatality, 'Body Recovery Guidelines' will be referenced (MDG 1029) in conjunction with the Coroners representative.

11.3 Mines Rescue brigade/rescue team

The Mines Rescue Brigade is established to provide a mines rescue service for responding to and dealing with emergencies arising at underground coal mines in NSW and other mines. By delegation from the Board the Brigade is under the control and direction of Mines Rescue and specifically, in the event of an emergency, the Regional Manager or his delegate present at the site. The Brigade will conduct itself in accordance with the objectives and procedures as determined for its deployment and by adopting standard operation procedure/sound rescue practice, specifically:

- To be properly briefed on their objectives, route, limitations and expected timing.
- Carry out their assigned task in a safe, efficient manner.
- Operate within their capability and capacity and observe established limits on exposure to flammable, toxic or hazardous atmospheres and substances.
- Observe standard operation procedure whilst in an environment immediately dangerous to life and health.
- Maintain communications with the FAB and/or surface control as required and return to the FAB within the assigned time.

- To be properly debriefed on their observations and conditions encountered so that proper strategies can be developed for subsequent rescue, control, exploration and recovery/restoration activities.
- Ensure facial hair meets the requirements of AS1715: as per ref 13.
- Maximum duty under oxygen is to be 6 hours in any 24 hour period. If hot and humid atmosphere is anticipated refer to Reference 4 and ensure brigades can recognise and understand heat illnesses and sign on for each period of duty.

Rescue brigadesmen/team member

In an emergency or training situation rescue brigadesmen should ensure that they:

- Obey all road rules and restrictions when travelling to the site.
- Advise the rescue co-ordinator or team captain if they are aware or become aware of any medical, physical or psychological condition or symptom, including coughs, colds and flu that could impair their capabilities or the safety of the team.
- Check team equipment and breathing apparatus prior to use.
- Advise the rescue co-ordinator and/or team captain if they are aware or become aware of any defect in apparatus that could impair their capabilities or the safety of the team.
- Carry out their assigned task in a safe, efficient manner and in accordance with standard operating procedure.

NB: participation as a brigadesman in an active operation is on a voluntary basis.

Rescue team captain/leader

In an emergency or training situation the rescue team captain is responsible for the safe and effective conduct of their team. They should:

- Maintain discipline.
- Allocate the checking of team equipment and breathing apparatus duties to team members prior to use.
- Ensure that the team's assigned task is carried out in a safe and efficient manner in accordance with standard operational procedure/sound rescue practice and within the designated time.
- Report observations on conditions encountered so that proper strategies can be developed for subsequent rescue, control, exploration, recovery and restoration activities.

- Ensure a brigadesman is appointed prior to deployment to carry out the captain's duty in the event of the captain being unable to do so and/ or other responsibilities as delegated.

Colliery rescue co-ordinator

The colliery Rescue Co-ordinator is appointed by the Mine Manager and provides liaison between the mine and MR regional station on all matters pertaining to rescue training, team structure and competitions.

Support personnel

In an emergency Brigadesmen and/or other suitably trained and authorised personnel may be utilised to assist or replace MR personnel in support roles at the mine site or MR facility. The support roles include, but are not limited to:

- Assembling and marshalling of Brigades
- Briefing and debriefing of Brigades subject to delegation by the Mines Rescue Regional Manager
- Communications and recording at the MR facility or mine site
- Gas monitoring
- Maintenance and refurbishment of equipment
- Surface and/or FAB Controller
- Transport

PROCEDURES

Procedure 1: Response by less than 5 persons – life at risk

ENTRY REQUIREMENTS			
	STAND BYE TEAM	**F.A.B.**	**ACTIVE TEAM**
PROCEDURE 1	At mine or ½ duration of SCSR.		200 m FAB

In order to mitigate against a potential disaster or life threatening situation, a response team of less than five persons who have been trained and accredited in mines rescue or have received other appropriate training and accreditation, may use SCBA to enter an irrespirable atmosphere provided the following barriers are established:

- Entry into the irrespirable atmosphere is only permitted for brigades of two or more members.
- Mines Rescue's "SMP-10 Team Deployment Procedure" is followed.
- Each person carries a SCSR and due care is exercised to complete the critical task within the capability and protection afforded by the SCBA and SCSR.
- The brigade members support each other.
- They return to the FAB prior to the low warning whistle activating on the CABA breathing apparatus or with more than 30 bar oxygen capacity in the SCBA.
- They do not travel more than 200 metres if the conditions are good and the terrain is level or 60% of the rated duration of their SCSR whichever is least.

  (This is based on trials conducted which indicated that 95% of all personnel tested will be able to comfortably wear a SCSR for 60% of its rated duration. NOTE: Wearers of SCSR's should be trained and aware of the limitations of the unit. For Mines Rescue purposes the duration of SCSR's will be calculated to be 60% of the approved rated duration.)
- The FAB contains at least one person whose role is to ensure the expected contaminants, within FAB, remain below their statutory limits and to activate the emergency system if a contingency situation develops.
- The FAB must be located and equipped to ensure the safety of all persons operating at or from the FAB.
- Standby arrangements are as follows:

Response (No of People)	FAB Officials	Standby (No of People)	
2 Inbye	1 (Minimum) 2 (Preferred)	2	Refer to procedure 5
3 Inbye	2 (Minimum)	2	
4 Inbye	2 (Minimum)	3	

Note 1: A single official at the FAB is allowed in a lifesaving situation requiring a rapid response of short duration with only one active team.

Note 2: A person wearing a SCSR while at rest may achieve three times the approved rated duration compared to a person escaping. This may allow an active team to leave a wearer inbye for recovery by a standby team.

Minimum team equipment required
SCBA for each member
SCSR for each member
Suitable gas monitoring instrument

FAB requirements
Suitable gas monitoring instrument
Communications, underground to surface is preferred

Procedure 2: Response by less than 5 persons – for non-strenuous activities (see glossary for definition)

ENTRY REQUIREMENTS			
	STAND BYE TEAM	F.A.B.	ACTIVE TEAM
PROCEDURE 2	🧍🧍	🧍🧍	500 m 1000 m with comms FAB → 🧍🧍 → 🧍🧍

This procedure allows for the re-entry of a response team of less than five persons who have been trained and accredited in mines rescue or have received other appropriate training may use the SCBA to enter an irrespirable atmosphere to mitigate, control or contain an emergency situation provided the following barriers are established:

- Entry into the irrespirable atmosphere is only permitted for brigades of two or more members;
- Mines Rescue's "SMP-10 Team Deployment Procedure" is followed.
- Each person carries a SCSR and due care is exercised to complete the critical task within the capability and protection afforded by the SCBA and SCSR;
- The brigade members support each other;
- They return to the FAB prior to the low warning whistle activating on the CABA breathing apparatus or with more than 30 Bar oxygen capacity in the SCBA;
- The FAB is fully equipped and manned (Procedure 4);
- If communication from the operational team to FAB is unavailable, they do not travel more than 500 metres if the conditions are good and the terrain is level or 60% of the rated duration of their SCSR, whichever is least;
- If communications from the operational team to FAB is available, they may travel up to 1,000 metres for non-strenuous tasks provided the visibility is good and the terrain is level or 60% of the approved rated duration of their SCSR, whichever is least;
- If the visibility or terrain is poor, consideration must be given to reducing the distance travelled.
- Standby arrangements are as follows:

Response (No of People)	FAB Officials	Standby (No of People)
2 Inbye	2	2
3 Inbye	2	2
4 Inbye	2	3

Note: A person wearing a SCSR while at rest may achieve three times the approved rated duration compared to a person escaping. This may allow an active team to leave a wearer inbye for recovery by a standby team.

Minimum team equipment required
SCBA for each member
SCSR for each member
Suitable gas monitoring instrument
Captain's folder and plans
Route marking equipment
Communications if travelling more than 500m
Sling psychrometer/hygrometer

FAB requirements
As per Procedure 4

Note: If visibility is limited, lifelines and/or link lines may be used as described in Reference 7.

Procedure 3: Response by teams of 5 or more persons

ENTRY REQUIREMENTS			
	STAND BYE TEAM	**F.A.B.**	**ACTIVE TEAM**
PROCEDURE 3			1000 m plus with comms FAB → →

If a response to an incident requires the deployment of teams beyond 1,000 metres then the following additional barriers should be established:

- The team will comprise no less than five (5) mines rescue trained and accredited brigadesmen.
- Mines Rescue's "SMP-10 Team Deployment Procedure" is followed.
- Each member will be equipped with long duration SCBA (>60 minutes) and carry a SCSR
- The extent of the task assigned to the team will be limited to enable the team to return to the FAB within three hours of going under oxygen and with no less than 30 bar of oxygen pressure duration capacity of the SCBA in reserve, and the team is able to return directly to the FAB at any stage within the capability and protection afforded by the SCSRs and CABA.
- The team should carry an appropriate stretcher
- Communications protocols should be established as per the Mines Rescue Team Deployment Control Document.
- A manned and equipped fresh air base (FAB) is established, and a standby team with a minimum of 5 members is at the FAB. In "Life at risk" situations the standby team may be on the surface but available at FAB within half the expected duration of the SCBA.

Minimum team equipment required
SCBA for each member
SCSR for each member
Suitable gas monitoring instrument
Captain's folder and plans
Route marking equipment
Communications if travelling more than 1000m
Sling psychrometer/hygrometer
Resuscitation unit with one O_2 cylinder
Minimal first Aid Equipment

FAB requirements
As per Procedure 4

Note 1: If visibility is limited, lifelines and/or link lines may be used as described in Reference 7.

Note 2: The SCSR issued to each team member is to cover the failure of two SCBA within the team and to provide an oxygen based system to allow the two team members to return to FAB.

This means a minimum of two SCSRs are for team safety, however all SCSRs could be included, depending on the distance to FAB.

The distance (or duration) a team can travel from the FAB is then governed by the expected duration of the SCSR being carried.

Example: A 6 man team with SCSRs of 50 minute rated duration (30 minute expected duration) would require 2 SCSRs for team safety if the team was located within 30 minutes from FAB and 4 SCSRs if the team was within 60 minutes from FAB. SCSRs in excess of team safety requirements could then be used for the recovery of injured persons before any additional units are needed to be taken by the team.

Note 3: Be aware of the possibility of a sudden increase in CO_2 in the SCSR when the KO_2 chemical is completely used.

Additional equipment carried by a team would be governed by the risk category, the distance, the people missing and the job to be done and may include:

a) Communications	b) Resuscitators	c) Tools
d) Additional SCSRs	e) Spare oxygen cylinders	g) Stretchers
h) Firefighting equipment		

Procedure 4: Establishment of a fresh air base (FAB)

The FAB must be located and equipped to ensure the safety of all persons operating at or from the FAB.

- The FAB is the planned point of departure and return for active (operational) rescue teams and is located in positively ventilated respirable air with gas levels within the current Work Health and Safety (Mines) Regulations 2014 specified limits (CH_4< 2%, O_2 > 19.5%,), and Work Health and Safety Regulations 2017 (CO< 30 ppm, CO_2 < 1.25%, O_2 > 19.5% <23.5%).
- Consideration should also be given to Work Health and Safety (Mines) Regulations 2014 limits for use of electrical apparatus and diesel equipment if such apparatus or equipment is required at FAB.
- The FAB should be manned with at least two persons, one of whom is competent in Mines Rescue Techniques and life support. One person should be nominated as the FAB controller.
- A standby team must be available at the FAB. In life at risk situations the standby team may be on the surface but available within half the expected duration of the active team's SCBA.
- Equipment at the FAB should, where practicable, include one stretcher per active team if the active teams are not equipped with their own stretchers. Other equipment may include but is not limited to resuscitators, communication to active teams and surface, life support, recording, mine plans, relocation plan, gas monitoring and sampling.
- If hot and humid conditions are expected, FAB must be equipped with dry clothing or blankets and drinking water for teams after exposure.
- The FAB may be located on the surface or underground and requires an assured supply of fresh air, a travel way for men and materials, good lighting if possible, a safe area with respect to security of roof and ribs if underground, sufficient room and facilities to work efficiently.
- Wherever possible arrangements must be in place to enable all persons to be evacuated without undue delay.

Procedure 5: The standby team

- The standby team is an operational rescue team which can be readily deployed to assist the active team in a contingency situation.
- The standby team must be at the FAB or in life at risk situations on the surface and available at the FAB within half the expected duration of the active team's SCBA.
- If a standby team is required to assist the active team in a contingency situation then a further team should be mobilised to act as the standby for a further contingency.
- One standby team can act for more than one active team provided the following arrangements are in place:
    - The active teams do not have the same time of return so they cannot both become overdue at the same time.
    - The standby team is at the FAB to immediately respond prior to the first team going active except for the conditions described in Procedure 1 and their travel time is less than the estimated time of arrival (E.T.A.) of the first active team to the FAB.
    - A second standby team is on the surface ready to proceed to the FAB if required.

Example: If two five member teams are active and there is a 30 minute difference in their E.T.A., this situation would require two FAB officials, one 5 member team at FAB and a second 5 member team ready on the surface with a travel time of less than 30 minutes to the FAB.

Procedure 6: Coupling up inbye the fresh air base

If response to an incident can be safely facilitated by proceeding beyond the FAB uncoupled, then mine rescue teams may do so, providing the following additional barriers are established:

- The team is equipped with and utilises a multi-gas instrument to continuously monitor the environment.
- Long duration SCBA are worn by brigadesmen, ready for rapid donning.
- A sudden change in the environment through roof fall, air reversal or ventilation failure is not anticipated.
- Toxic fire products from synthetic materials are unlikely to be present in the atmosphere.
- Communication is maintained with FAB.
- Team to couple up if a gas level as specified in the current Work Health and Safety (Mines) Regulation 2014 (CH_4, CO_2, CO) & Work Health and Safety Regulation 2011 (O2) is exceeded (see Procedure 4)
- The team is aware of the response time lag, (t(90)), of the sensors installed in the multi-gas instrument.

N.B. Methane detectors for underground coal mines in NSW are required to be design registered. To achieve registration, a methane detector must comply with the requirements of Australian Standard AS/NZS 60079.29.1. This standard requires the time for a sensor to reach 90% of the test gas concentration (t(90)) of no greater than 30 seconds.

AS/NZS 4641 covers requirements for toxic gas sensors and oxygen sensors. The t(90) for these gases is 60 seconds.

The average person will walk between three and four metres per second. At this pace, a person may travel a significant distance into a hazardous or dangerous environment before a gas detector alarms and starts to indicate elevated levels of gas.

Procedure 7: Return to the fresh air base

- The team captain must ensure that an active team returns to the FAB within three hours of going under oxygen and with no less than 30 bar oxygen pressure duration capacity in each team member's SCBA.
- If CABA is used, the team leader must ensure that an active team returns to FAB before the warning whistle on any suit is activated.
- An active team must return to the FAB before their task is completed if any of the following occasions arise:
    - Breathing apparatus failure.
    - Abnormal rate of oxygen/air consumption.
    - Loss of communication (where required by these Guidelines)
    - Failure in an item of minimum equipment.
    - An injury or adverse physical or mental condition occurs to or is observed in a team member.
    - An adverse condition or alteration to the environment is encountered.
    - The captain is instructed to return by the FAB or IMT.
    - The task set is beyond the capabilities of the team.

Procedure 8: Setting operational times

- Brigadesmen should not be allowed to perform more than two periods of duty under oxygen/air in any twenty four hour period and at least 4 hours rest should be observed between those two deployments.
- Maximum duty under oxygen/air is to be 6 hours in any 24 hour period. If hot and humid atmosphere is anticipated refer to Reference 6
- Ensure brigades sign on for each period of duty.
- Brigadesmen should not be on duty (including standby at the mine site, rescue facility or at home) for more than twelve hours in any twenty four hour period.

Procedure 9: Developing succession plans

- In a protracted emergency, a succession plan (roster) should be drawn up after approximately 4 hours and should include the change out of personnel in primary roles such as incident management, surface controller, fresh air base controller and rescue facility communications.
- Changeover should commence after 8 hours and involve a period of at least one hour to fully brief the successor.
- At an early point in the plan consideration should be given to sending personnel home to rest. Where practical operational times should be limited to 12 hours.

References

Reference 1 - Incident command and control system

An Incident Command and Control System (ICCS) should be used for managing emergency incidents. Mines Rescue has developed a guide to assist with the development of this function.

Its use will assist in:

- Establishing an effective decision making structure
- Establishing resource and facility requirements
- Identifying key members of the Incident Management Team (IMT)
- Establishing training requirements
- Incorporating external agencies, such as Police.

http://www.minesrescueservices.com/Downloads.aspx

Reference 2 - Toxicity

- CO and CO_2 are the main mine gases considered toxic although other gases such as sulphur dioxide, hydrogen chlorides, cyanides and halogens may be produced in mine environments. In some mine environments H_2S occurs.
- An assessment should be conducted to determine other likely fire products based on the equipment, materials and consumable present in the fire zone, and the permissible limits of these gases.
- Trained rescue personnel wearing breathing apparatus are protected from the toxic effects of CO, CO_2 and H_2S. Consequently there are no entry or exclusion limits for trained, currently accredited and motivated brigadesmen wearing breathing apparatus in a toxic atmosphere. However, due care should be taken when operating or training in such environments.
- Breathing apparatus will be worn in all circumstances where there is more than 30 ppm CO, 10 ppm H_2S and/or 1.25% CO_2 present, or other toxic fire products are likely to be present.
- Due to the limited cooling effects of CO_2 and its reaction with body fluids to cause skin irritations high concentrations of CO_2 may cause discomfort to rescue brigadesmen. High concentrations of H_2S may similarly cause eye and skin irritations and appropriate protection should be considered.

Reference 3 - Oxygen deficiency

- There are no entry limits for trained and currently accredited rescue brigadesmen wearing breathing apparatus in an oxygen deficient environment providing due care is taken when operating or training in such environments.

Note: O_2 concentrations of 18% or less, although not life threatening can affect a person's night vision & disturb the ability to reason

Reference 4 - Smoke and fire

- If smoke is hazy, light coloured and not backing up against the incoming air the fire is localised and well ventilated. Provided that flammable gases are not in danger of being ignited then firefighting procedures can be applied.
- If smoke is dark and dense a fuel rich fire is evident and the introduction of additional air or disruption to the ventilation circuit may lead to a potential explosion. If back-up is observed or ventilation control of the fire zone is not possible then immediate evacuation of all persons underground should be initiated. Consideration should also be given to the potential ignition of fire gases when diluted with other ventilation circuits. Synthetic materials may also produce dark smoke on combustion however this relationship should not be relied upon to defer evacuation or approve re-entry.

Mines Rescue firefighting trigger action plan

Deployed when	Level	Characteristics	Requisite Actions
Lives at Risk **or** **Incident Control**	**Low**	**Size** Visual observation indicates smouldering/small flames (less than 1 metre) Gas analysis indicates small fire/heating **Potential** Not near known easily ignitable source of fuel (e.g. goaf, flammable fuel, gas drainage line), other than seam coal **Level of current control** Firefighting activities ongoing at site of fire **Environmental temperature and humidity** Normal mine atmosphere	**Mines Rescue process** Standard Mines Rescue operating/deployment protocols **FF method** Water and or foam dependent on class of fire **Personal Protective Equipment** Standard PPE including long sleeved shirt, long pants, (or overalls), safety glasses, leather gloves. **Environmental monitoring** Monitoring as per MR guidelines **Considerations** Ease of accessibility
Lives at Risk **or** **Incident Control**	**Medium**	**Size** Visual observation indicates active fire with extensive flames Gas analysis indicates active fire. **Potential** Not near known easily ignitable source of fuel (e.g. goaf, flammable fuel, gas drainage line), other than seam coal. Potential for strata failure at fire site due to fire effects. **Level of current control** Firefighting activities ongoing at site of fire **Environmental temperature and humidity** Normal mine atmosphere with substantial radiant heat emanating from fire	**Mines Rescue process** Standard Mines Rescue operating/deployment protocols **FF method** Water and or foam dependent on class of fire **Personal Protective Equipment** PPE ensemble needs to protect wearer from radiant heat, other fire hazards and possibility of hot gases/material from any fall onto fire. Breathing apparatus mandatory. **Environmental monitoring** Monitoring as per MR guidelines **Considerations** Ease of accessibility

Lives at Risk Only	**High**	**Length of burn** Greater than 4 hours **Size** Size unknown Gas analysis indicates active fire **Potential** Unknown or high potential for recirculation / ventilation changes Unknown or high potential ignition of flammable material/atmosphere High potential for strata failure at fire site due to effects of fire **Level of current control** No firefighting activities ongoing at site of fire **Environmental temperature and humidity** Unknown	**Mines Rescue process** Complete a Risk Assessment which must be signed off by Regional Manager or above **FF method** To be determined from RA – consider remote methods/sealing **PPE** To be determined from RA **Environmental monitoring** Monitoring as per RA determination. **Considerations** Ease of accessibility

Reference 5 - Polycyclic Aromatic Hydrocarbons (PAH)

Formed in mines by incomplete combustion of coal, oil, gas and other organic substances, some polycyclic aromatic hydrocarbons are considered to be carcinogenic and their presence should be considered as part of any re-entry planning after fires or explosions.

In the underground environment they are most likely to be found in dust, smoke and soot.

Breathing Apparatus, gloves and full body coverage clothing should be considered as minimum requirements if their presence is suspected.

Decontamination showers prior to doffing BA may be required.

Reference 6 - Heat and humidity

Certain precautions should be observed when persons are required to work or train in hot and humid atmospheres. These include the utilisation of well rested people, a preference for light clothing, the regular determination of temperature and humidity, advice to people to inform the leader of any sign or symptoms of heat stress. Deployment times for trained rescue brigadesmen based on the wet bulb temperature and the difference between wet and dry bulb temperatures are given over. After any period of duty in a hot and humid atmosphere approximating the permissible deployment times, rescue brigadesmen should be normally rested for 24 hours before they are again called on to perform another such period of duty.

The following precautions are recommended for work in hot and humid conditions:

- Before entering:
  - Team members should have rested, preferably in a cool place and be properly hydrated by drinking water. The drinking of coffee should be avoided.
  - Experience has shown that “Skins^{tm} compression clothing” or other similar undergarments may be of value in hot and humid conditions.
  - Team members having a cold or cough or other infection should not be allowed to work in hot and humid conditions.
  - Team members must be reminded of the signs and symptoms of heat illness or hyperventilation and instructed to inform the captain at the first sign or symptom.
  - Team members who have consumed a significant quantity of alcohol in the previous 24 hours may suffer from dehydration and should not be allowed to work in hot and humid atmospheres.
- In the hot location
  - Work should be done at a slow even pace with a minimum of movement

- Rest pauses should be frequent and taken in turn.
- All team members should watch for each other for heat illness or hyperventilation signs and symptoms.
- The captain should not engage in physical work. He should observe his team members, regulate the work, allocate rest periods and plan for the return trip.
- The use of personal cooling devices and ice packs should be considered.

- After exposure
  - Team members should not cool down too quickly and should wait until sweating ceases before having a shower. They should lie down while waiting and rest after the shower.
  - Team members should rest as much as possible, avoid heavy work and driving.
  - Lost sweat should be replaced by drinking fluids.
  - Dry clothes or blankets should be made available at FAB.
  - Consider management of electrolyte levels with sport drinks.

Team Deployment Table

It should be remembered that these times were determined for atmospheres where air movement exists. Sealed areas or areas of dead air may require an even more conservative approach. (Deployment potentially reduced to half the times set out in the table)

Deployment Times For Rescue Brigadesmen Wearing Drager BG4					
% Relative Humidity	100-85	84-73	75-62	67-53	60-45
Temperature °Celsius △	0-2	3-4	5-6	7-8	9-10
Wet Bulb Temperature	Duration of Exposure (Mins)				
26	95	100	105	110	115
27	85	85	90	95	100
28	75	75	80	80	85
29	65	65	70	70	75
30	55	60	60	65	65
31	50	50	55	55	60
32	45	45	50	50	50
33	40	40	45	45	45
34	35	35	40	40	40
35	30	35	35	35	35
36	30	30	30	30	30
37	25	25	30	30	30
38	25	25	25	25	25
39	20	20	20	25	25
40	20	20	20	20	20
41	15	20	20	20	20
42	15	15	15	15	20
43	15	15	15	15	15
44	15	15	15	15	15
45	10	10	10	15	15
△**Temperature = Difference between wet and dry bulb temperatures**					

Reference 7 - Visibility

- Where visibility is limited survivors and/or rescuers should use a guideline, or be fastened together with a link line if smoke is dense or visibility seriously affected. In some roadways rail track work, pipelines and conveyors can be used as a guideline by sliding a foot or hand along the rail, pipe or structure. It may also be advantageous to carry the cap lamp in hand. Following an incident visibility can be seriously affected. This can lead to disorientation and impair the escape of survivors, and also impact upon re-entry by rescue brigadesmen. Where visibility is limited any rescue attempt must be planned using a rigorous risk assessment approach.
- Poor visibility significantly reduces a team's travelling speed, ability to search and general orientation. Information from NIOSH indicates that if visibility falls below 13m difficulties will be experienced by anyone who is not familiar with their immediate surroundings. If visibility falls below 4m, disorientation will be experienced by all – including those most familiar with the terrain. If an active team experiences a sudden reduction in visibility, the team should report the situation to FAB and return ASAP.
- If visibility below 4m is expected for an active team the distance a team is asked to travel and the task expected of them should be carefully assessed prior to deployment. Guidance lines such as telephone cables or radio aerials should be first installed by rescue brigadesmen from the FAB to the working area. Risk Assessment should consider – link lines, existing mine structures, familiarity with surroundings, distance to travel, experience of team members in low visibility, criticality of task in low visibility, etc.

Reference 8 - Gas analysis

A mine-wide gas monitoring system is preferred with incorporation of gas chromatography and purpose trained/qualified personnel preferred.

- Gas chromatographs are the preferred method for determining the presence and concentration of gases following a mine fire, explosion or heating as all explosive gases can be identified. Consideration should therefore be given to the utilisation of gas chromatographic systems where brigades may be deployed in Category 1 situations (greater than 60% LEL).
- Infrared gas analysers do not identify or measure hydrogen. If a gas chromatograph is not available and explosibility determinations are required, then infrared gas analysis may be adopted providing a CO: H_2 ratio of 1:2 is utilised where H_2 levels cannot be otherwise determined.
- Telemetric gas analysis systems incorporate catalytic methane sensors which also respond to hydrogen and carbon monoxide. When other flammable gases (e.g.; H_2 and CO) are present the methane scale can be utilised to indicate the explosibility of the mixture. High off-scale readings may indicate an explosive atmosphere. If low oxygen readings are indicated methane and explosibility determinations may be unreliable and inaccurate due to the incomplete combustion of the flammable gases on the catalytic sensor. Other preferred means should be used to determine the actual situation.
- Utilisation of gas chromatography or infrared analysers for atmospheric analysis requires samples to be drawn from the underground environment, either manually or via tube bundling systems. In analysis, interpretation and decision making due regard should be given to the associated time delay and the implications of trend analysis.
- Where gas chromatographs are utilised high levels of methane (>15%) may obscure low levels of carbon monoxide (<10 ppm). Consequently specially calibrated gas chromatographs or infrared analysers may be needed to validate the carbon monoxide readings in these circumstances.
- Teams should carry and utilise adequate and appropriate hand held gas detectors to enable atmospheric conditions to be closely monitored whilst undertaking operations in a hostile environment.
- Multi-gas hand held detectors have catalytic methane sensors which also respond to hydrogen and carbon monoxide. When other flammable gases (e.g.; H_2 and CO) are present the methane scale can be utilised to indicate the explosibility of the mixture with a 5% CH4 reading approximating to 100% LEL of the mixture. High off-scale readings may indicate an explosive atmosphere. If low oxygen readings are indicated

methane and explosibility determinations may be unreliable and inaccurate due to the incomplete combustion of the flammable gases on the catalytic sensor. Other preferred means should be used to determine the actual situation.

- Well maintained and calibrated multi-gas detectors are only reliable within ± 10% of the true reading. Further, the presence of other gases influences the instruments reliability. When these instruments are being used as a barrier due consideration of this reliability and sensitivity should be given. The brigade should be excluded or withdrawn from an atmosphere of >60% LEL to <80% LEL if a trend indicates a deteriorating situation within the reliability or sensitivity of the instrument/s being used.
- CO sensors fitted to multi-gas instruments can be adversely affected by high concentrations of CO and may take a number of hours to re-zero to fresh air after being exposed to high concentrations of CO.
- Acidic/ corrosive gases (NO_2, SO_2, H_2S, and CO_2) may be lost in sampling by reaction with the vessel wall or dissolving in moisture.
- Decision makers should be aware that if the oxygen concentration is reduced to below 12.2%, methane-air mixtures cannot explode and flames cannot be supported. If hydrogen is present in the mixture, oxygen concentration below 12.2% must be achieved to render the mixture non-explosive.
- Coal will continue to smoulder until the oxygen level is reduced to below 2%. This level must be maintained until the area cools down or a flare up may occur if air is re-introduced.'

The book **Mines Rescue Gas Detection and Emergency Preparedness** contains a much deeper treatment of gas analysis and interpretation than is listed above

Reference 9 - Nature and intensity of incident

Explosions and Ignitions

When methane/air mixtures are ignited the temperature increases from ambient to approximately 2000°C in 2 to 3 seconds causing up to a 7:1 expansion in volume. The resulting pressure wave separates from the flame front and continues throughout the workings until vented or dissipated. Roadways with obstacles such as belt conveyors, fixed and mobile equipment may generate increased pressure and turbulence and the same degree of separation may not be obtained.

The intensity of the pressure wave depends upon the location of the ignition source and the concentration of methane in air. Higher pressures are created when the source of ignition is within a body of methane/air mixture rather than when ignited on the periphery of the mixture.

Pressure (kPa)	Wind speed (km/h)	Effect
1	160	Ears pop
4	300	Glass windows break
7	400	People knocked over, plaster stoppings, disrupted, water barriers activated
35		Eardrums ruptured, people thrown up to 7 metres
50		300mm brick walls fail
100		Lungs damaged
240		Probably fatal
450		Certainly fatal
500		Likely maximum overpressure of a methane explosion

Notes:

The intensity of the pressure wave is halved:

- every 300 metres down a single straight roadway, or
- each time the pressure wave encounters a T intersection.

The presence of plant and equipment in these roadways will impact on these dissipation effects (as above).

- After the fuel is consumed the pressure wave will continue to proceed in a direct line and will not enter dead ends and cut-throughs. A person situated in adjacent headings, dead-ends or behind existing falls may not be affected by the shock wave.
- After the initial ignition and expansion of the atmosphere the area cools rapidly causing a reflected wave of lower intensity to move back into the area. Up to ten oscillations of air movement can occur in a single entry roadway or dead-ends before equilibrium is restored. This can result in lighter objects originally located outbye being drawn in towards the point of ignition.
- Afterdamp will remain in the area traversed by the fireball or flame and can contaminate the main ventilation circuit.
- Afterdamp from rich methane/air mixtures contains high concentrations of CO and H_2.

CH4% in air	Maximum Pressure Wave(kPa)*	Residual CO%	Residual H_2%
8	350	0.02	0.02
9	700	0.5	0.3
12	240	8.0	8.5

* As measured in an experimental gallery

- In a methane explosion pressure waves greater than 100kPa are unusual in practice, and extremely unlikely at or above 140 kPa.
- Coal dust in suspension can lower the ignition temperature of methane from 650 to 450°C and the LEL from 5.0% to zero. If raised into suspension by a pressure wave it can propagate an explosion throughout the mine with greater destructive force than with a methane/air ignition.

Unlike methane, coal dust behind falls and in dead-ends, will not participate in the propagation of an explosion.

Reference 10 - Safety of persons on the surface from secondary explosions

Mine Emergency Management Systems should take into account the dangers of potential surface damage caused by an explosion underground. The location of surface facilities should be planned with consideration of possible blast pressure waves, gas clouds and projectiles in mind. Consideration should also be given to the effects of prevailing winds on such dust and gas clouds. Sampling points should be preinstalled within the portal areas to allow sampling without the incursion of men to install them.

Suggested Reading

Safety of Persons in Proximity to Underground Coal Mine Openings

Mark Parcell Mine Safety Institute

Reference 11 - High expansion foam

One litre of foam concentrate generates 34 m^3 of foam, therefore

$$\text{Litres to fill a roadway} = \frac{\text{section area x length}}{34}$$

Example Litres of foam concentrate required to fill a 5m by 5m drift, 1 km long = 735 litres

Note 1 The minimum water pressure is required to be 700kPa giving a minimum flow rate of 7litres/sec or 420litres/min (good foam can require in excess of 1100 kPa)

Note 2 Variables to be assessed include

- intensity of fire
- moisture on roof or sides
- type of high expansion foam generator
- foams effect on ventilation or VCDs

Reference 12 – Mobilisation of the Mine Shield Inertisation plant

Call Out Process

Mine:

An official (with the appropriate authority) from the affected mine shall request the mobilisation of the Mine Shield.

The local Mines Rescue station should be contacted on the emergency number:

1300015551

The request must be confirmed in writing stating acceptance of liability for the emergency callout fee plus all other costs associated with the operation.

A purchase order number should accompany the request if possible.

Local Mines Rescue Station:

On receipt of request the Manager/Duty Officer of the affected mine's local Mines Rescue Station shall -

- Confirm the request for the Mine Shield with the affected mine
- Explain the costs to the mine representative
- Send an activation checklist for a mine representative with the appropriate authority to sign
- Mobilise the Mine Shield through the manager/Duty Officer of Hunter Valley Mines Rescue Station (the Mine Shield is garaged at HVMRS).

Notes:

There is call-out charge for the Mine Shield during an emergency and a cancellation fee may also apply.

To offset this charge, collieries are encouraged to notify their local Mines Rescue Station early of an impending problem so that the Mine Shield may be placed on standby and programmed into BOC Gases schedules, thereby greatly reducing the emergency call-out charge.

Mine Site Requirements:

It is the affected mine's responsibility to supply -

- a clear and stable access road for the Nitrogen Plant and nitrogen supplies
- a location site for the Nitrogen Plant capable of holding 5.7 t/m^2 with sufficient room for B-Double trucks to be able to turn (dia. Page 6)
- Electrical installation fitted with 1 off 415 Volt 150A CMA plug receptacle to be supplied from a 500kVA gen set or mine power
- a clean water supply of approximately 10,000 litres for initial fill and an ongoing supply
- site lighting
- site shed with 240v power, microwave, fridge, urn, sink and reverse cycle air-conditioning
- toilet facilities (if remote from the mine pit top area)
- labour to handle nitrogen hoses when required
- after hours off site food and accommodation for BOC operating personnel (normally 2 people)

When calculating approximate amounts of materials required and/or used, the following conversions should be used.

One tonne of liquid nitrogen converts to 844 cubic metres.

One tonne of liquid CO_2 converts to 535 cubic metres

Example 45 tonnes of liquid nitrogen has been pumped into the U/G workings. What volume or void would that be expected to fill? 45 x 844 = 37,980 cubic metres

Reference 13 - Facial seal of respirators

(Reprinted from AS 1715 Selection, use and maintenance of respiratory protective devices)

E1 General

Beard growth, some hairstyles and other facial features prevent an adequate seal between the wearer's face and the fitting surfaces of a face piece or mouthpiece. Facial hair may also interfere with inhalation and exhalation valve operation. Male wearers in particular shall be made aware of the general rules in Paragraph E2 to E5.

E2 Beards

Bearded persons cannot expect to achieve adequate respiratory protection when wearing a full face piece respirator or a half face piece respirator. Accordingly, no one who requires respiratory protection shall attempt to wear either a full face piece respirator or half face piece respirator over a beard.

E3 Moustaches

Moustaches may spoil the fit of a half face piece respirator and may interfere with the peripheral seal of a full face piece respirator. Moustaches should not protrude beyond projected lines, drawn vertically from the corner of the mouth.

E4 Sideburns

When a full face piece is being worn, sideburns shall not extend below a line drawn through the top of the tragion (the notch in the cartilage of the ear just above and immediately in front of the ear hole) and the canthus (corner) of the eye. This line is illustrated in Figure E1.

E5 Stubble growth and long hair

Stubble growth, depending on its length and stiffness, interferes to some degree with proper sealing of a face piece and it is necessary that make wearers of respirators shave daily.

When the hair is worn long, particular care should be taken to ensure that none is trapped beneath the fitting surface.

Figure E1

Length of sideburns

Legend:

A = notch in the cartilage of the ear

B = canthus of the eye

C = line below which the sideburns should not extend

Reference 14 - Recommended reading

Mines Rescue, Gas Detection and Emergency Preparedness

Various NSW Mines rescue

http://www.minesrescueservices.com/

Gas chart

Gas	Chemical Symbol	Relative Density	Flammability	Exposure Standards
Air		1		
Nitrogen	N_2	0.97		Nil
Oxygen	O_2	1.11		19.5% Minimum
Methane	CH_4	0.55	5% - 15%	1.25% Power off 2% Withdraw Men
Carbon Monoxide	CO	0.97	12.5% - 74%	30 ppm
Carbon Dioxide	CO_2	1.53		1.25%
Hydrogen Sulphide	H_2S	1.19	4.5% - 45%	10ppm
Hydrogen	H_2	0.07	4% - 74%	Nil
Nitrogen Dioxide	NO_2	1.6		3ppm

Terminology and abbreviations

Terminology	Meaning
Distance from Fresh Air Base	Is the distance from FAB as a Radius and not the actual distance travelled
Don/Doff	To put on/to take off
Emergency	Means an emergency due to an actual or imminent occurrence (such as fire, explosion, accident or flooding) which has resulted in the death or injury of a person or is endangering or is threatening to endanger the life of physical well-being of a person or the current and continued operations of the mine.
Explosion	A violent and rapid increase of pressure in a confined area?
Filter Self Rescuer (FSR)	A personal breathing device that converts carbon monoxide to carbon dioxide.
Fire	An implemented burning or combustion manifested by the evolution of light or heat.
Flammable Gas	Is a gas that when mixed with air within prescribed limits will propagate a flame away from a source of ignition
FPE	Fire protective equipment.
Fresh Air	The atmosphere that meets the requirements of the Work Health and Safety (Mines) Regulations 2014 with regards to flammable, noxious gases, other contaminants.
Fresh Air Base (FAB)	A designated safe location either on the surface or underground that is the departure point for active teams. Underground locations to have a positive supply of fresh air.
General Body	The mine atmosphere which has been determined by a process of cross-sectional atmospheric sampling at a location under consideration.
Heat Stress	Failure of the body to cope with high environmental heat and humidity resulting in higher than normal inner body temperature.
Heating	See ‘Spontaneous Combustion’.
Hot and Humid	A general body that has a wet bulb temperature greater than 26° C.
ICCS	Incident Command and Control System

Terminology	Meaning
Incident	Unplanned event that impacts upon the safety or welfare of personnel, or the continuity of operations, which requires an effective and timely response in order to contain, or mitigate the situation.
Incident Management Team (IMT)	This team is established by the senior mine official in an emergency to advise him in the management and control of the response and intervention.
Irrespirable Atmosphere	An atmosphere which is unsafe for a person to breathe as a result of either oxygen depletion or the presence of toxic fumes, gases and contaminants as determined by WHS(Mines) and WHS Regulations
LEL	Lower Explosive Limit: This is the concentration of flammable gas in air representing the lowest point at which a flame will propagate away from a source of ignition.
Minimum Equipment	The equipment carried by a mines rescue team to provide for team safety in an active deployment and other equipment?
MR	The duly constituted Mines Rescue organisations of both the NSW and Queensland coal industries.
Nominal Duration	Is the effective life of a breathing apparatus as determined by Department of Industry & Investment testing.
Non-operational Team	Is a rescue team held in readiness during an emergency.
Non-Strenuous activity	Routine activities which are not carried out in a `hot and humid' atmosphere nor require carrying heavy loads (equipment and/or persons) over extended distances. Examples: taking air / gas readings, quick exploration of roadways, inspecting stoppings, checking water flow and pressure at hydrants, etc.
WHSR	Work Health and Safety Regulations
Operational Team	Is a rescue team in an emergency. It may be a standby team or an active team.
Oxygen/Air Based System	Is a system that enables underground persons to proceed to a place of safety independently from the underground atmosphere.
PAH	Polycyclic Aromatic Hydrocarbons
PPE	Personal protective equipment.

Terminology	Meaning
PPM	Parts per million.
Rescue	Processes whereby surface personnel are directly involved in assisting underground persons to escape from a mine in an emergency situation.
Risk Assessment	The process used to determine risk control priorities by evaluating and comparing the level of risk.
SCBA	Self-contained breathing apparatus.
Self-Contained Self-Rescuer	A self-rescuer that provides the wearer with oxygen or respirable air from a source carried by the wearer.
Self-Escape	The process of a person escaping from a mine in an emergency situation without direct assistance from surface personnel.
Spontaneous Combustion	The process by which certain materials can ignite as a result of internal heat which arises spontaneously due to chemical reactions liberating heat faster than it can be lost to the environment.
Standby Team	Is fully equipped in readiness to become active.
UEL	Upper Explosive Limit: This is the concentration of flammable gas in air representing the highest point at which a flame will propagate away from a source of ignition.

Revised May 2019 Issue No: 19

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