Resources Regulator
Department of Regional NSW

Technical reference guide

Withdrawal and emergency escape from underground coal mines

Produced in consultation with the Mines Rescue working group

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Amendment schedule		
Date	Version	Amendment
December 2021	1	Consultation draft Supersedes MDG 1020 Guidelines for underground emergency escape systems and the provision of self-rescuers, MDG 1022 Guidelines for determining withdrawal conditions from underground coal mines and Guidelines for in-seam response using CABA for events where life is at risk. This version has been revised in consultation with the Mines Rescue Working Group which includes representatives from the NSW Resources Regulator, Industry, CFMMEU and Coal Services.
February 2023	1.1	Amended to reflect feedback from stakeholder submissions and final internal review

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1. Purpose and scope

This technical reference guideline replaces Mining Design Guidelines 1020 and 1022.

Regardless of size, all incidents are easier to resolve if they have been assessed in the planning stages. Having adequately trained and resourced personnel responding to emergencies in a safe manner will reduce the likelihood of injury to those response personnel.

This technical reference guideline has been prepared to support the development, implementation, and assessment of emergency withdrawal and escape systems in underground coal mines. It applies to all workers directly and indirectly affected by emergencies.

The provision and maintenance of withdrawal and Emergency escape systems is essential for the safe passage of people from an at-risk area to a place of safety. This includes the training of personnel, the provision of Emergency escape systems, and supporting risk assessments and procedures. These systems must work effectively when required. Identifying key elements of withdrawal and Emergency escape systems as critical controls and establishing verification processes is likely to improve the readiness of these systems for use in an emergency.

Escape strategies developed from this technical reference guideline should form part of the Emergency Plan for a mine. This document is to be read in conjunction with the NSW Emergency Planning for mines Code of Practice that provides advice on how to develop, implement and test the Emergency Plan prepared in accordance with Work Health and Safety (Mines and Petroleum Sites) legislative requirements. Development of the escape strategy should also be done with reference to the Mines Rescue Gas Detection and Emergency Preparedness Manual.

2. Definitions

The terms “escape,” “evacuation” and “withdrawal” should be defined and recognised within a mine or petroleum site’s safety management system.

Duty Card System: Provides a structure for allocating tasks when an emergency occurs through the issuing of cards to individuals which outline specific duties for each card holder. Each duty card should contain:

- the preferred person or position to be allocated the card
- specific duties for the person allocated the card
- equipment required for the duties
- any reporting requirements associated with the duties.

Examples of duty cards can be found in the NSW code of practice Emergency planning for mines Appendix A.

Escape: Evacuation that enables a person to safely reach an exit to the surface during an emergency.

Evacuation: Evacuation is an orderly and controlled movement of people at the mine from the emergency to a place of safety (as opposed to escape).

Place of Safety: A place of safety is a designated place where workers will assemble without being in any danger from the hazard that triggered the evacuation. It must reflect a consequence of the hazard that has initiated the evacuation. It must, as far as is reasonably practicable have communication to the surface. During an emergency escape, the place of safety is the surface.

Withdrawal: Precautionary measure to move (or evacuate) people from an area of the mine to a place of safety before the situation becomes an emergency. This occurs at a level before an emergency occurs.

3. Withdrawal

Safety management system requirements are set out in the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHS(MPS) Regulation). Safety management systems are to include procedures and conditions under which workers at the mine or petroleum site are to be withdrawn to a place of safety. They must also include procedures conditions under which workers must remain withdrawn as a precautionary measure where a risk to health and safety warrants that withdrawal. This enables the operator to assess whether the situation is normalising, to enable recommencement of normal operations, or if the situation is escalating, requiring emergency escape.

4. Withdrawal conditions

This technical reference guideline provides the key elements for defining a process for the withdrawal of workers to a place of safety, and includes the required outcomes, main risks, and main risk considerations. This list is not exhaustive or site specific, and other considerations will also need to be addressed.

4.1. Conditions requiring withdrawal

Conditions requiring withdrawal may include, but are not limited to:

- fire or explosion
  - heat, flames, or fire that may occur on or in vehicles, underground fuel depots, active goaf, sealed goaf, standing pillar, electrical or other equipment
  - a spontaneous combustion or fire event, or the detection of product gases that indicate the presence of these events
  - detected toxic or flammable gases greater than TARP limits that could indicate an impending or actual fire or explosion event
  - fires at the surface including bushfires
  - gas and dust explosion
- irrespirable atmosphere
  - detected or suspected contaminated atmosphere
  - oxygen deficient atmosphere, toxic or flammable gases as the result of an outburst, goaf fall, barometric change, toxic seam gases, combustion products, seal failure
- ventilation failure

  A ventilation failure could lead to contaminated atmosphere/s in any accessible part of the mine, including but not limited to:
  - extended failure of the main mine ventilation fan(s) including booster fans
  - auxiliary fan
  - airway blockage (such as flooding or roof fall)
  - failure of Ventilation Control Devices
  - excessive gas or fume emission
- inrush or inundation
  - an actual or imminent inrush
  - water, other flowing material or gas from strata, old workings, new workings, adjacent mines both surface and underground, surface impoundments, reservoirs or natural water bodies, boreholes, shafts, wells, pipelines, tunnels, aquifers

- fall of ground
  - an actual or imminent failure of the strata
  - local, district, mine (already fallen or indication of imminent failure)
- injury
  - single/multiple (resources required for amelioration and control)
- major vehicle/equipment accident
  - injury, loss of second means of egress
  - winder failure
- criminal activity
  - bomb threat
  - sabotage
- sealing of goaf/part of mine
  - the development of an explosive atmosphere in a newly sealed area
  - ventilation changed/interrupted, fire present, fire risk present, gas present, explosion risk present, strata instability, loss of automatic gas monitoring capability
- outburst
  - irrespirable atmosphere, explosive atmosphere, injuries, reduced visibility, return airway contamination, explosive atmosphere at main fan
- general environmental
  - loss of second means of egress from the mine for whatever reason
  - loss of critical controls for major hazards
  - present or perceived risk of exposure to hazardous substances
  - loss of emergency response capability, including local mine services such as firefighting water and availability of external services to access the mine
  - inability to contact external services due to communications outage
  - loss of power to the mine
  - excessive dust, failure of underground communication
  - surface fires including bushfires, smoke, CO (influencing background levels that make it difficult for systems to distinguish between CO introduced into the mine and CO generated within the mine), restricted access on roads.

4.2. Risk identification and assessment

A risk assessment should be undertaken to identify the following but not limited to:

- hazards requiring withdrawal of workers
- all parties with a valid interest at mines
- key indicators for each hazard or hazardous condition
- the attributes of a well-defined communication process which will ensure all affected workers are clearly advised of both the risk and the need to withdraw with adequate time to move to a place of safety
- the location of the places of safety from risks
- the method of travel and route to be taken

- the specific withdrawal requirements of any Principal Hazard Management Plan or Principal Control Plan developed for the mine
- the statutory requirements associated with any principal hazard
- the process to monitor principal hazards
- the mine's induction and refresher training needs, particularly in relation to emergency procedure training
- the means of accounting for workers after being withdrawn from the mine or a part of the mine
- agreed mine re-entry strategies for all foreseeable withdrawal circumstances
- what records need to be kept.

4.3. Training

The safety management system should include a training plan which ensures that all personnel are appropriately trained and competent to perform the tasks required of them. This includes providing training and accountabilities in the implementation of Trigger Action Response Plans (TARPs). The training plan should identify and integrate specific training needs and competencies associated with the withdrawal conditions. The mine should maintain evidence of the conduct of training and the assessment of its imparted competencies. All workers should receive refresher training at scheduled intervals.

4.4. Trigger levels

4.4.1. Required outcome

Trigger levels should be developed for each condition under which workers are to be withdrawn. Trigger levels should:

- be clearly defined, measurable or observable
- be kept current and accurate to the current mine
- be consistent with statutory requirements and requirements of site management plans
- recognise the normal or background conditions and recognise both actual and relative changes and trends to the conditions
- be relevant to the risk being considered
- initiate predetermined actions and action response plans for each role within the TARP
- end in the withdrawal conditions and the designated place of safety relevant to the circumstances
- be recorded in the safety management system and referenced in the emergency plan
- be displayed in prominent locations throughout the mine and be easily accessible to all relevant people who have roles and responsibilities for carrying out actions and/or responses to any trigger
- be reflected in the duty card system.

4.4.2. Main risks

- sub-optimal trigger levels which lead to a loss of confidence, namely by nuisance triggering when levels are too low, or unacceptable worker exposure to dangers or threats to health or safety when levels are too high
- triggers are set with insufficient testing of the mine's response capability and time required to respond
- trigger levels fail to account for relative or percentage changes from normal or background conditions, delaying the identification of a threat

- triggers are not recognised
- triggers are not monitored or responded to appropriately
- monitoring of triggers fails
- normalisation of risk (changing/changed conditions)
- background levels are acknowledged and accommodated
- triggers are not re-evaluated in a timely manner.

4.4.3. Main risk considerations

- whether workers are trained to identify triggers and provide appropriate response
- whether the correct selection of triggers has been identified for the conditions
- whether a risk-based approach has been taken in setting trigger levels
- predetermined actions to be taken when trigger monitoring capability lost.

4.5. Trigger action response plans (TARPs)

4.5.1. Required outcome

Trigger Action Response Plans (TARPs) tables should be established for each trigger level and consider all stages of an escalating event and responses at each stage. TARPS must end in the final response, such as withdrawal or evacuation rather than using terms like “more inspection” or “more monitoring.”

4.5.2. Main risks

- inappropriate or no responses to triggers
- workers panic and fail to adopt a controlled withdrawal mode, resulting in failure to make the workplace secure
- inappropriate response plans
- the cycle of investigation and further observation causing delays in activating trigger point actions.

4.5.3. Main risk considerations

- the availability of workers competent in identifying hazards, triggers and trigger levels
- the availability of workers competent to implement clear actions depending on conditions at the time
- the availability and levels of training for personnel who have specific roles under the withdrawal conditions
- whether training differentiates emergency evacuation with the withdrawal of workers as a precautionary measure
- whether plans are developed having regard to relevant guidelines and in consultation with worker representatives possessing appropriate skills, knowledge and experience.

4.6. Place of safety

4.6.1. Required outcome

A place of safety is a designated place where workers will assemble without being in any danger from the hazard that triggered the withdrawal before it becomes an emergency requiring escape. The specific situation will determine where a place of safety may be. A place of safety:

- must reflect the consequence of the hazard that has initiated the withdrawal

- must, as far is reasonably practicable have an effective means of communication with the surface control
- depending on the situation, may include, but is not limited to, the following locations:
  - crib rooms
  - main headings opposite a district ventilation split
  - pit bottom or the base of intake shaft or drift
  - surface location
  - safe changeover station.

4.7. Communication

4.7.1. Required outcome

The Work Health and Safety (Mines and Petroleum Sites) legislative framework provides detailed requirements of the communication systems and procedures for the underground mine.

A communication system must, as far as is reasonably practicable be established to:

- allow all trigger events and alarms to be received
- initiate a mechanism that ensures key personnel are advised of the TARPs (for example TARP conditions – green, amber, or red)
- allow communication between surface control and designated places of safety
- allow communication between surface control and statutory function holders
- allow communication between surface control and external emergency and regulatory agencies
- allow communication between surface control and the incident control room

Procedures for communication should be established to provide for circumstances when:

- an instruction relating to the withdrawal of workers is given, there should be a process to allow the instruction to be received, understood, and acknowledged
- workers are withdrawing, there should be a process to allow the notifications to the surface to be received, understood, and acknowledged
- remote workers are identified and included in the communication strategy.
- a follow-through on corrective actions is required

4.7.2. Main risks

- people are not alerted to a potential or actual emergency and do not escape to a place of safety
- not all relevant personnel are notified of the potential or actual emergency
- failure to convey critical information relating to the incident to the surface/decision makers
- unreliable communication systems.

4.7.3. Main risk considerations

- the protection of communication systems and connecting lines
- the types of emergency events identified and their potential impact on the communications system installed are factored into the risk assessments and controls
- protocols for how to communicate, who communicates and what is communicated in either verbal or non-verbal ways
- a communication system's testing regime
- redundancy of communication hardware.

4.8. Route and method of transport

4.8.1. Required outcome

The Work Health and Safety (Mines and Petroleum Sites) legislative framework provides detailed requirements for emergency exits and means of travel to escape to the surface. Emergency procedures should define the route and means of travel from the work location to a place of safety.

4.8.2. Main risks

- insufficient ventilation for diesel transport
- insufficient transport
- normal route of travel is impassable.

4.8.3. Main risk considerations

- whether alternate methods of withdrawal are considered
- the distances which workers may need to travel during an emergency
- seam height and grade
- travelling conditions
- the physical fitness of underground workers
- availability of transport, guidance systems
- walking distances to places of safety (i.e., extended distances can no longer be considered adequate although this eventuality must be planned for).

4.9. Checking system

4.9.1. Required outcome

When an instruction pursuant to the withdrawal procedures is given, mechanisms should be in place to check that all affected workers have received, understood, and acknowledged the instruction. In the same way, when the affected workers provide information relating to their situation, mechanisms should be in place to check that the information has been received, understood, and acknowledged.

4.9.2. Main risks

- misinterpretation of instruction
- personnel do not acknowledge receipt of message to withdraw.

4.9.3. Main risk considerations

- protocols for how to communicate, who communicates and what is communicated
- whether personnel are trained in the communication system
- whether the plan includes a communication loop from workers being withdrawn and the control station.

4.10. Monitoring of the location of workers

4.10.1. Required outcome

Each mine should have procedures to monitor:

- workers entering and exiting the mine
- the general location of workers while underground.

The procedures should provide an ability to check that all affected workers have moved to the required place of safety.

4.10.2. Main risks

- people are not contacted because it is not known they are in the affected area
- time is wasted trying to contact workers mistakenly thought to be in the affected area
- failing to recognise that workers have not reached the place of safety.

4.10.3. Main risk considerations

- whether the monitoring system provides adequate detail of location of all people underground
- whether all identified places of safety have a system of communication with surface control.

4.11. Re-entry following withdrawal

This section relates to the process of re-entry after withdrawal where a TARP has been reached but no incident has occurred. This section does not relate to re-entry after an emergency incident. This will be detailed in the emergency control plan and with reference to the NSW Emergency planning for mines Code of Practice. Re-entry after emergency will be coordinated through the Emergency Plan and is not addressed by this technical reference guide.

4.11.1. Required outcome

Re-entry into areas where a TARP has been reached, but no incident has occurred, is undertaken in a planned manner that:

- minimises risk to workers and complies with relevant regulatory requirements
- does not cause further adverse events when rehabilitating compromised areas
- does not reactivate the adverse event that caused the TARP.

A re-entry plan should be developed using risk assessment and risk management methods to determine appropriate operational procedures and technical standards. A re-entry plan should be designed to implement, control, and monitor the re-entry and recommencement of operations of a mine or part of a mine. A re-entry plan should identify the outcomes which indicate that normal conditions exist in the mine.

Re-entry must only occur after safety issues have been resolved. Re-entry is conducted under the rules associated with normal work and not the procedures established for emergency response.

Regardless of the size of the recovery and re-entry operation, the chances of a successful outcome are improved if the process has been planned and correctly resourced. The time taken to undertake re-entry planning will reduce the chances of reactivating the residual hazards and risks and should include:

- consultation with all key stakeholders
- risk management must be undertaken using the hierarchy of controls
- procedures and standards of engineering practice
- information and instruction
- training and competence
- supervision
- monitor system of work
- review the operation
- revise, as necessary.

Re-entry plans should:

- ensure that re-entry processes and procedures are comprehensive
- identify and deal with all technical matters adequately
- ensure that the requirements of the mine operator, the NSW Resources Regulator (the Regulator) and Mines Rescue are met.

A group assembled to undertake a re-entry should:

- develop the re-entry plan
- direct operations in accordance with the re-entry plan
- monitor conditions to ensure that they are consistent with the re-entry plan
- monitor and receive feedback
- monitor and respond to changed conditions
- maintain a complete log on decisions taken, directions given, and communications made.

4.11.2. Main risks

- workers re-entering a hazardous environment with inadequate knowledge of the potential risk and without adequate procedures, standards, and equipment
- workers re-entering a hazardous environment without adequate backup
- workers re-entering a hazardous environment without adequate communication to a control centre
- workers re-entering a hazardous environment without an adequate escape strategy
- unrecognised hazard exists because of the initial withdrawal condition
- workers re-entering in response to a transient dip below withdrawal trigger level
- re-entry triggers are not developed for each withdrawal condition
- consideration not given to inspections/remote monitoring prior to general re-entry.

4.11.3. Main risk considerations

The following points are common to most coal mine re-entry operations, regardless of the size of the area, the size of the recovery group or the nature of the event that resulted in a withdrawal of workers:

- remaining hazards or conditions that would allow a hazard to be triggered by the re-entry process
- contingency retreat plans
- physical and environmental conditions to be encountered underground
  - state of roof and ribs, which are the physical stability of the mine
- isolation of affected areas
- ventilation; including:
  - composition of the atmosphere
  - re-ventilation method
  - progressive re-entry
  - condition of ventilation appliances
- monitoring and control of atmosphere and dilution of gases

- radio and/or telephone communication between control centres, fresh air bases and operational teams
- electricity, including:
  - explosion-protected equipment
  - cables
  - conditions to enable restoration of power
- water
- access.

These guidelines do not propose that workers engaged in a re-entry process should remain in areas where statutory threshold limits are exceeded. Mine operators must comply with the statutory limits with respect to flammable and noxious gases.

5. Emergency escape management system

5.1. Introduction

Management systems for emergency escape should be integrated with the mine safety systems developed and implemented under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013.*

Development of the Emergency Escape System is to be undertaken in a manner that:

- complies with Work Health and Safety legislative framework
- complies with the Work Health and Safety (Mines and Petroleum Sites) legislative framework
- is consistent with the NSW Emergency Planning for mines Code of Practice and Safety Management Systems in Mines Code of Practice.

Risk assessment must be used to identify and quantify circumstances likely to trigger the need for emergency escape and to identify controls and barriers. Conduct of risk assessments and development of systems and procedures must be undertaken in consultation with workers and their representatives in accordance with the Work Health and Safety Act and Regulation and the NSW Code of Practice – Work Health and Safety Consultation, cooperation and coordination. In addition, the WHS(MPS) Regulation requires operators to consult with workers on the preparation, testing and review of Emergency Plans.

The references listed at the start of this document form a body of work that contain “known risks” and “known controls.” Some of these may be relevant to the considerations of any group undertaking a risk assessment with a view to forming an Emergency escape system. The risk assessment report should contain references to the treatment of this information within the risk assessment.

Mine operators should develop procedures for evaluating and reviewing the entire Emergency escape system as part of the emergency escape strategy.

Mine operators should conduct simulated emergency exercises at each mine at least every 12 months.

Isolated work needs to be considered when selecting location. Isolated work includes work carried out in an area that is remote from others or isolated from the assistance of others because of time, location, or the nature of the work.

5.2. Risk identification and assessment

The following pages list key system component outcomes associated risks and main risk considerations.

For more information on how to conduct a risk assessment refer to NSW Code of Practice – How to manage work health and safety risks, NSW Code of Practice – Emergency planning for mines and ISO 31000 Risk Management.

5.3. Monitoring, systems audit, and review

The underground emergency escape system should be monitored to ensure all required facilities are present and in a state of readiness. The Emergency escape system should be part of the continuous improvement process for Mine safety management systems. This includes action to:

- verify the state of readiness
- monitor record-keeping
- analyse results, both routinely and after simulation exercises, special occurrences, or problems
- feed results of the analysis back into future planning and operations.

A copy of the mine's report into the exercise of escape from an underground working panel to a place of safety should be available on request by the Regulator and the Industry Safety and Health Representative (IHSR).

5.4. Training

All underground coal mine workers must be sufficiently trained to be made familiar with the exits from the mine.

Training is important to successful escape and is required under the WHS(MPS) Regulation. Mine operators must identify the training needed to achieve the required competencies within the Emergency escape system and develop and deliver appropriate training modules.

Competencies to be achieved include:

- For all workers at the mine, knowledge of:
  - the Emergency Plan and Emergency escape system
  - their role and duties under those systems
  - the withdrawal conditions of the mine
  - the location and condition of material and infrastructure they will need to fulfil their duty under the Emergency escape system
  - emergency communication arrangements and emergency phone numbers
  - the non-verbal communication system in use at a mine, where at least one person is wearing breathing protection.
- For workers who go underground, knowledge of:
  - muster areas
  - ventilation system
  - the location of caches of self-rescuers
  - the escape routes from the mine
  - the preferred means of rapid escape using the mine's transport system
  - how to put on, use and change-over each type of self-rescuer
  - the limitations of self-rescuers
  - how to put on and use breathing apparatus (e.g., compressed air breathing apparatus (CABA) if supplied for self-rescue
  - the limitations of breathing apparatus
  - the attributes of a place of safety.

- For supervisors and controllers, knowledge of:
  - management structure for the mine
  - any alternative emergency command structures
  - documentation and document control systems
  - backup personnel
  - external service providers
  - trigger points to call external services
  - supervisory control and location of workers underground and working places
  - duty card system
  - sealing mine or part of a mine
  - site access security.

Section 19 of the *Work Health and Safety Act 2011* (WHS Act) places a responsibility on the person conducting a business or undertaking to, as far as reasonably practicable, provide a place of work that is without risk to the health and safety of workers and other workers while they are at that place of work.

Section 28 of the WHS Act places a responsibility on workers to take reasonable care for the health and safety of themselves and other workers and to cooperate with any reasonable directions and cooperate with any reasonable policy or procedure relating to health or safety at the workplace.

It is not enough for workers to have only passive involvement in Emergency escape systems and the development of competencies from the training provided by the mine operator. All workers, while at work, must actively engage in understanding, developing, and maintaining the Emergency escape system and in developing the required competencies under the system. Any worker may be called upon to assist in the escape of another. There is a positive duty for each worker at the mine to make reasonable effort to learn and understand the Emergency escape system. All workers at the mine should monitor the system and its elements when the opportunity arises and must report any deficiencies encountered.

Mine operators are required to ensure that mine workers are trained and competent in the use of provided self-rescuers.

Training must include:

- information, training, and instruction in relation to the emergency plan
- sufficient training and instruction to be made familiar with exits from the mine
- training in a simulated work environment in donning and change-over of each self-rescuer type before initially commencing work at the mine and then every six months
- operating an oxygen-generating self-contained self-rescuer while undertaking physical effort similar to an evacuation situation before initially commencing work at the mine and then every three years.

Note: A live trainer or simulator may be used in place of the oxygen-generating self-contained self-rescuer provided that:

- the simulator delivers oxygen
- oxygen delivery is affected in a similar way to the self-rescuer, by the person's breathing rate and work effort, and the environmental temperature
- the simulator is worn and operates in a similar way to the self-rescuer.

Visitors and all workers should receive suitable induction training with regards to the relevant elements in the Emergency escape system.

All exercises should include the debriefing of participants and the recording of outcomes.

5.5. Record keeping and documentation

Record keeping should be integrated with the Safety Management System (SMS) record system. Records should accurately reflect current serviceability of equipment, competency of workers and responsibilities that are associated with the Emergency escape system, and the outcomes from simulation exercises.

6. Emergency escape system – elements and considerations

6.1. Early warning

6.1.1. Required outcome

Conditions of potential or imminent emergency requiring escape from a mine or any part of a mine are identified at an early stage. The appropriate alarm is communicated to workers who may be endangered to expedite their escape.

6.1.2. Main risks

- monitoring equipment does not survive event
- monitoring equipment is not reliable and/or not accurate
- alarms fail or are damaged in event
- alarms are not activated in time to allow response.

6.1.3. Main risk considerations

- monitoring equipment is adequately designed, maintained, and calibrated
- detection points positioned and alarms initiated in appropriate locations
- alarm settings linked to a graded response plan
- early warning and associated decision-making protocols are included in competency-based training scheme
- the definition of TARP levels and the specificity, measurability, achievability and timing of TARP responses
- which gases should be monitored, and which TARP levels and alarms need to be set
- the integrity and protection of the system during an event
- contingencies in the event of a failure of the primary monitoring system
- availability of competent people to operate systems and analyse results.

6.2. Communication

6.2.1. Required outcome

Mine operators should effectively communicate with all workers required to work or travel underground on the paths of egress from each part of the mine. An adequate communications system makes possible the co-ordination of all other systems. It also provides the key to early notification of an emergency event and coordination of response.

When specifying the design, construction and installation of hardware associated with the emergency communication apparatus, the integrity of the system needs to be assured during any event that causes an emergency. Essential communication systems should not be left exposed in

the mine and vulnerable to easy or casual damage. The risk assessment and risk management systems must aim to preserve the functionality of the system through a catastrophic event.

The mine must have an emergency telephone number to access the emergency phone system and set off the alarms.

The mine operator must establish a non-verbal communication protocol for digital to analogue converters and telephones so that people wearing self-rescuers can communicate without removing the mouthpiece.

A process should be in place to ensure that current information is effectively communicated to those who need it and that processes are implemented to maintain objective evidence of those information transfers. Current information must be available at all locations where operations dependent on that information are conducted and obsolete information must be promptly removed from all points of issue or use.

The mine must be able to assemble a communication system, in a timely manner, at an incident control centre to co-ordinate required communication between various parts of the mine and with external agencies. The aim is to guarantee external communication capability.

Hardware critical to the communication system needs to be marked on a mine plan available to workers responding to an incident.

The communication process should include both systems hardware and procedures.

6.2.1.1. Communication - system hardware

Mine operators, should provide fixed communication systems to the surface control at the following locations:

- underground
  - working places
  - crib rooms
  - air splits at the entrance of panels
  - first withdrawal response muster areas and places of safety
  - subsequent, higher level withdrawal response muster areas and places of safety
  - main headings
  - pit bottom.
- surface
  - surface control
  - incident control centres
  - control centres for the removal and restoration of power
  - control centres for gas monitoring, for example, the tube bundle hut
  - control centres for the starting and stopping of fans.
- maintenance and inspections as required in the WHS(MPS) Regulation.

These locations should be provided with fixed communication means to enable contact with other areas of the mine and surface, independent of underground power.

The fixed communication systems should be augmented by a minimum of one secondary communication system. At least one of these will be independent of the underground power.

Mine operators should provide for the communication systems of external agencies to be quickly connected to the mine's system.

6.2.1.2. Communication – system procedures

The mine operator should develop procedures and protocols for the transfer of information and messages during a withdrawal and an emergency.

Once an emergency response is enacted, mine operators should prioritise messaging relevant to the overall implementation of the emergency response. Communication not relevant to the emergency response should be delayed until after the immediate crisis is resolved and the safety of all personnel is assured.

Mine operators should consider a system of verification for internal and external emergency calls.

The communication protocols and procedures should be supported by appropriate sign posting at all fixed communication installations and the person receiving the communication.

Structured communication messages could include:

- the nature of the emergency, such as:
  - ignition
  - explosion
  - spontaneous combustion
  - fire
  - fall of roof or rib
  - entrapment
  - outburst
  - inrush
  - medical
- severity, including:
  - type of injuries
  - number injured
  - extent of damage.
- intensity, such as:
  - blast damage
  - colour/extent of smoke
  - visible flame
  - type and level of gases.
- status, including:
  - location and condition of workers
  - state of transport
  - state of ventilation
  - workers missing.

The probable location of workers required to move away from areas of fixed communications should be monitored to enable them to be found quickly.

6.2.2. Main risks

- all underground workers are not notified of the need to escape and details of the incident and safest route of escape

- escaping workers cannot locate or use communication system
- workers do not respond to the incident control centre
- the communication system does not survive the incident
- the communication system is not reliable
- communication transmissions interfere with gas detection equipment.

6.2.3. Main risk considerations

- whether management plans adequately direct how to communicate, who communicates and what is communicated in an emergency
- whether a communication system can operate in the absence of underground power
- whether breathing apparatus provides the wearer the ability to verbally communicate or whether a non-verbal communication protocol has been developed
- whether there is a testing regime for the communication system
- whether contingency plans are in place should the communication system fail.

6.3. Surface control rooms

All operating underground coal mines should be equipped with a surface control room to provide emergency response functions when an emergency occurs. Surface control room operators should have core competencies that assist them in identifying and instigating the need for a controlled withdrawal or escape.

This guideline utilises the surface control room model to provide information regarding the actions taken on the surface of a mine to manage an emergency. It is recognised that alternative systems can be implemented.

6.3.1. Required outcome

A core function of a surface control room is to receive and transmit data and information.

A core function of a surface control room operator is to initiate a response to information received and to maintain a log of the information received and transmitted.

Control room operators must be able to initiate a full emergency response and initiate and monitor the withdrawal of workers to a place of safety. Standing instructions must be in place regarding the initiation of the emergency procedure. Standing instructions may be in the form of a duty card system.

The control room operators are not the only workers who will have standing instructions in the event of an emergency. Statutory function holders will also have their own duty cards. During an emergency, the control room can become remarkably busy and congested. It is therefore important to locate the duty cards of other workers away from the control room. If there is an incident room, then duty cards not relating to the controllers could be located there. Access to the control room must be regulated once an emergency has been declared.

Duty cards or standing instructions should be simple procedures or control documents that lead operators through the management of the emergency. Examples of instruction that might be contained within duty cards include:

- the activation of alarm systems
- the activation and/or support of withdrawal of workers under withdrawal conditions
- those required to be notified:
  - statutory function holders
  - company officials

  - the regulator
  - police
  - ambulance
  - Mines Rescue
  - other designated workers and organisations.

Other functions of a control room could include:

- monitoring communications
- monitoring the main fan, the main return air stream and other mine atmospheric systems
- monitoring and tracking the location and circumstances of workers underground
- identification of missing workers
- providing plans
- monitoring and recording the progress of the emergency (event log).

6.3.2. Main risks

- the control room is damaged by the event or loses power
- the control room operator becomes overloaded and overwhelmed
- insufficient resources are provided to enable the control room operator to undertake their functions and meet their responsibilities
- during an emergency, the control room operator gets interrupted by people looking for their duty cards, which may prevent the control room operator from performing their functions
- during an emergency, the control room becomes congested.

6.3.3. Main risk considerations

- the surface control room location (i.e., it should operate from a separate location to the Incident Management Team)
- whether TARPs have been set to assist control room operators to manage multiple functions
- whether a procedure is in place to immediately notify competent surface personnel when a gas TARP has been triggered, prompt required actions to be taken at the surface and acknowledge that the actions have been undertaken (for example, gas monitoring alarms being activated)
- whether the control room is integrated into mine and external communication systems
- the availability of back up external communication, e.g., by mobile phones
- the availability of critical information such as relevant telephone numbers
- access to the monitoring systems, such as:
  - gas
  - ventilation
  - cameras
  - fire fighting
  - water
- whether clear and precise instructions are available to the control room operator for the onset of an emergency and for its ongoing management
- whether the only duty cards that need to be in the control room are those for the control room operator (duty cards for others need to be located elsewhere. For example, the incident room)

- whether the minimum requirements for a control room are met:
  - control room operator duty card
  - communications log
  - mine escape and rescue plan
  - TARPs
  - emergency communication to mine and outside services
  - atmospheric monitoring system
  - ventilation monitoring system
  - mine services monitoring system
  - location and movement of personnel monitoring system (for example, tag systems).
- the minimum competency requirements for a control room operator should include training and assessment in:
  - emergency management system
  - responsibilities under duty card system
  - actioning control room TARP
  - recording information received and transmitted
  - monitoring the movement of workers underground
  - mine escape and rescue plan
  - ventilation system
  - atmospheric monitoring system
  - communication system
  - mine services system.

6.4. Emergency operations room

It is recommended that a room be provided that has access to the necessary communications and resources for use by the Incident Management Team. The mine is not required to keep a room empty for this purpose; however, it must be available when called upon.

6.5. Emergency escape to the surface

The Work Health and Safety (Mines and Petroleum Sites) legislative framework requires the mine operator of an underground coal mine to, in conjunction with providing an adequate means of escape, ensure that an overall emergency escape to the surface strategy is developed for the mine that considers the following:

- the distance, grade and conditions workers will need to travel to reach the surface
- the rate at which workers will need to travel to reach the surface safely
- the location and size of each refill station, cache or changeover station and air shower
- the provision of water and communications at refill stations and changeover stations
- procedures, as far as is reasonably practicable, for rehydration and communication in an irrespirable atmosphere
- provisions for monitoring the respirable air both within and outside a changeover station
- the escape apparatus and cache or refill station capacity that is required to allow the safe escape of all workers from the mine.

6.5.1. Escapeways and transport aided escape

6.5.1.1. Required outcome

At least two escape routes are provided from each part of the mine to the surface so that in the event one becomes impassable another is always available for travel. There are sufficient types and numbers of transport or alternate escape means, in combination with escape equipment, to allow the safe evacuation of workers.

Provision of vehicle-aided escape or equivalent must always be a primary objective of any Emergency escape system. The escape functions of all vehicles must be considered in their selection and configuration.

Systems that rely on long walks through difficult conditions need to be remedied.

The WHS(MPS) Regulation requires provision for exits to be marked, signposted and accessible and for appropriate transportation during an emergency evacuation.

Mine operators should maintain a primary and secondary means of egress, that is trafficable on foot if vehicle aided escape or other transport methods fail. These must be to a standard that they can be negotiated in poor visibility and smoke.

Mines should consider providing segregated intake and second means of egress in main headings. It is preferable that the second means of egress can be driven, at least in the main headings.

6.5.1.2. Main risks

- escapeways are not trafficable
- fire or explosion destroys stoppings between segregated escapeways
- fire occurs on equipment located in escapeway
- the environmental conditions during and/or after the incident preclude the use of transport vehicle
- available transport does not cater for the maximum number of workers in the area
- transports used as part of escape strategy collide in poor-visibility conditions
- lifelines, caches of breathing apparatus and charging stations are not found or not properly understood
- escape route has reduced visibility, irrespirable air, or unsafe atmospheres
- workers escaping on foot are hit by vehicles being used during the evacuation due to poor visibility or integrated vehicle and walking routes.

6.5.1.3. Main risk considerations

- whether there is a primary (intake) and alternate escapeway nominated from all districts to the surface or a place of safety
- whether the primary escapeway maintained in good, trafficable condition
- whether escapeways are segregated by substantial, fire-resistant stoppings
- whether fire sources in escapeways have been identified and controlled
- where transports form part of escape strategy, whether they cater for the maximum number of workers likely to be in the area
- where transports form part of escape strategy, whether a guidance system is implemented together with an effective signalling system or control mechanism to address the hazard of collision
- whether a competency-based training scheme is in place that addresses choice of escape routes, access to escapeways, conditions in escapeways and location of equipment within escapeways

- where new hazards are introduced to the escapeway, whether a reassessment of the escape strategy is triggered.

6.5.2. Self-rescuer apparatus

6.5.2.1. Required outcome

Underground workers are provided with respiratory protection apparatus to allow safe egress from the mine through any irrespirable or irritant atmospheres that may be encountered. Mine operators should conduct a risk assessment to identify the best respiratory protection apparatus for various specific situations.

6.5.2.2. Main risks

- the limitations of the selected self-rescuer apparatus are not understood
- the self-rescuer apparatus does not suit the purpose for which it will be used
- cache spacings do not allow an escaping person to reach and don a new self-rescuer before the self-rescuer they are wearing expires
- caches do not contain enough self-rescuers
- underground personnel are not medically fit to wear the self-rescuer and escape on foot
- the integrity of the self-rescuer apparatus deteriorates and does not provide any or enough protection
- degradation of self-rescuer due to vibration
- appropriate rehydration facilities are not provided.

6.5.2.3. Main risk considerations

- whether self-rescuer apparatus is approved for underground use
- whether cached self-rescuers are stored in an easily accessible, appropriately designed and located container
- whether the use of the selected self-rescuer apparatus is supported by a competency-based training scheme given by accredited trainers and includes training on how to change over a self-rescuer in a potentially irrespirable atmosphere, a low-visibility environment, or a smoke-filled environment
- whether a system is in place to manage the issue and return, inspection and maintenance of person-worn self-rescuers
- whether selected self-rescuer apparatuses are serviced in accordance with the requirements specified in the design registration and with reference to Technical reference guide: Escape breathing apparatus for underground mining applications (standards for design and ongoing monitoring)
- whether there is a monitoring program for self-rescuer integrity over the service life of the self-rescuers
- whether there is a record of self-rescuers on site, including their location, batch number, in-service details and maintenance history.
- where the self-rescuer worn at the belt is a CO-filter type, whether caches with enough self-rescuer apparatus, capable of providing oxygen, are available at changeover points
  - the first cache needs to be located near the hazardous zone and be close to working faces
  - the locations of subsequent caches should be determined through “walk-out trials”
  - the rated duration of the self-rescuer should be considered
  - the manufacturer’s recommendations and the results of any credible published trial of the equipment should be considered

- temperature and environmental conditions in which self-rescuers are stored, both on the surface and in caches
- correct disposal of self-rescuers.

6.5.3. Guidance systems / lifelines

6.5.3.1. Required outcome

A system is provided to aid personnel in their escape through conditions of reduced visibility. Paths of egress are marked so that workers who are not familiar with a route can safely travel it in conditions of poor visibility. The primary egress should have markings that will assist transport drivers in low visibility. Further information is available in the Mines Rescue Gas Detection and Emergency Preparedness Manual.

6.5.3.2. Main risks

- workers cannot find the guidance system
- caches and/or changeover stations cannot be in conditions of poor visibility
- guidance system does not survive the incident
- guidance system does not indicate the direction of travel in conditions of poor visibility.

The incidence of contractors and the high mobility of the workforce leads to confusion as to what constitutes the lifeline system. For this reason, it is important that escape guidance systems are developed consistently, based on the design and methods outlined in the Mines Rescue Gas Detection and Emergency Preparedness Manual.

6.5.3.3. Main risk considerations

- guidance system is readily accessible
- clearly identifiable access points to escapeways
- easy access to, or a documented means of reaching, the start of the guidance system
- the guidance system provides continuous directions to a place of safety, such as lifelines fitted with directional cones
- the guidance system leads the escaping person along a path unhindered by obstacles
- the guidance system is included in the competency-based training scheme.

6.5.4. Guidance system attributes

- exercises have repeatedly shown the effectiveness of the lifeline where visibility is impaired
- all means of egress, not just the second means of egress, could be fitted with lifelines
- exercises have shown that a tactile system is more reliable in a smoke-filled atmosphere than visual or audible cues, although visual and audible cues are useful and warranted
- lifelines need to penetrate as close to the working area as possible
- starting the lifeline at a point in another known reference line can be advantageous
  - for example, starting the lifeline at the auxiliary fan, as the fan is connected to the working face by the vent tube which can be closely followed out
  - other examples include cables and pipelines and if used, these could be given identifying features.

6.5.5. Changeover stations and refill stations

6.5.5.1. Required outcome

Safe storage/caches of self-rescuer units placed along escapeways where efficient changeover of self-rescuers is facilitated. At least the first changeover station from a production unit should facilitate safe assembly of escaping workers and communication.

Changeover stations should generally be located between intakes and returns with trap doors to both intake and return.

The Work Health and Safety (Mines and Petroleum Sites) legislative framework requires the following matters to be addressed:

- travel expectations by vehicle and foot
- spacing of changeover stations
- ensuring changeover station survives a blast
- accessibility for all
- hydration
- communication system
- if CABA, have refill facility and hydration options.

6.5.5.2. Main risks

- changeover station not located within the duration of supplied self-rescuer apparatus
- unsuccessful changeover of self-rescuer apparatus in irrespirable atmosphere
- damage to changeover station prevents escaping workers acquiring replacement self-rescuer apparatus
- system supplying air to Respirable Air Changeover Station (RACOS) does not survive the incident
- ingress of toxic gases into RACOS
- RACOS does not allow access for stretcher
- RACOS does not cater for the maximum number of workers likely to use it
- dehydration because RACOS does not provide drinking water.

6.5.5.3. Main risk considerations

- changeover stations are located and constructed such that they will resist damage during normal operations and emergency use
- where RACOS are supplied, there is a maintenance and inspection program
- monitoring device is available to indicate air quality inside RACOS is safe
- where RACOS are provided the competency-based training scheme includes access to RACOS and the requirements of their use
- all training should assume an irrespirable atmosphere for self-rescuer apparatus change over.

6.5.6. Boreholes

6.5.6.1. Required outcome

Boreholes have a potential role in communications and supply of air to respirable air changeover stations, and in the recovery of personnel from underground workings.

6.5.6.2. Main risks

- a suitable drill rig (and escape equipment, if required) is not available within an appropriate timeframe
- drilling takes longer than planned
- surface and underground sites are not compatible
- access to surface is not available or suitable for drill site
- borehole location and condition are unknown.

6.5.6.3. Main risk considerations

- a suitable rig is available within appropriate timeframe or borehole is pre-drilled
- where a borehole is part of planned rescue strategy the surface location is available, secure, surveyed, cleared, consolidated and provided with all-weather access
- where a borehole is part of planned rescue strategy the underground target site is surveyed, suitably supported, cleared and marked
- where a borehole is part of planned rescue strategy the depth, stratigraphy, hole stability and drillability should be known.

6.6. Competency and Training

6.6.1. Required outcome

Required competencies for each worker or class of worker should be specifically defined within the Emergency Control Plan. Records of the workers who are assessed as competent within a specified class of workers are to be maintained.

Workers must not go underground if they have not:

- undertaken specified training to the set schedule
- been assessed as competent.

This provision does not apply to statutory officials who have power of entry.

6.6.2. Main risks

- all workers, including contractors and visitors, do not receive induction and ongoing training appropriate to their risk, role and responsibility
- appropriate training is not conducted before implementation of significant changes to the Emergency escape system
- workers are unfamiliar with escape route alternatives, cache locations, etc
- incident occurs when a worker/s with specific responsibility under Emergency escape system is uncontactable.

6.6.3. Main risk considerations

- training includes all relevant aspects for all underground personnel
- training includes additional modules for supervisors
- training includes personnel (and their alternates) who have specific roles in the Emergency escape system
- training includes exercises of a practical and desk-top nature
- training includes exercises which include external emergency services
- training covers visitors and contractors
- trainers are competent to provide the necessary training.