



MAUK
The Mining Association of the United Kingdom

Guidance on Escape and Rescue from Mines

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Part 1 - Introduction

General Information

1. The mine operator must ensure that they have considered the risks as required by Regulation (3) of the Management of Health and Safety at Work Regulations, this includes the provisions for escape and rescue; as a minimum, the Mine operator must consider:
 - a. **Primary**, the arrangements for self-escape to a place of safety (For example, the risk assessment may designate the surface as the place of safety.)
 - b. **Secondary**, the arrangements for a place of safety underground, in the event that it is not possible to self-escape to the surface (or other designated place of safety)
 - c. **Auxiliary**, the arrangements for the rescue of persons below ground, or for carrying out work to secure the health and safety of persons below ground in the event of an emergency.
2. The guidance is based on the application of technologies that have proven to work in underground emergencies, which have resulted in the need for self-escape and / or mines rescue. The reader should recognise and consider technologies continually emerging that may enhance their current arrangements for escape and rescue. Where new technologies are introduced, there should be an assessment made to ensure that the reliance placed on that technology as part of the escape and rescue plan is not negatively impacted by the reliability, and resilience of that technology.

Who should read this guidance?

3. This document is aimed primarily at mine operators with a statutory responsibility under the Mines Regulations 2014 for ensuring effective arrangements for escape and rescue and the other elements of effective emergency planning. Others in the mine management structure, safety representatives and members of the mines rescue services may also find this information useful.
4. The guidance may also be useful to organisations that may be considering future emergency response requirements as part of the requirements of mine design. This could be extended to those that are planning underground visitor centers as part of redeveloping historical mine sites.

Legal provisions

5. The Mines Regulations 2014 (L149) (Regulation 48, Guidance Points 260-

262) places a duty on the mine operator (as far as is reasonably practicable) to have two separate exits to the surface of the mine. Additionally, Regulation 49 (Guidance Points 263 to 269) requires that there normally be two ways out from a place of work, unless that place is a heading or other place that it is not practicable to provide at least two ways out. In the case of it not being practicable, other provisions to satisfy the requirements of the regulations must be in place. The relevant regulations are included within **Appendix 1**. *(The term heading can be applied to a tunnel in development or a shaft without a connection at the bottom.)*

6. The Mines Regulations 2014 (L149) place duties on the mine operator to ensure that persons can reach a place of safety promptly in the event of an emergency. The relevant regulations are included within **Appendix 1**.
7. The Mines Regulations 2014 (L149) (Regulation 53, Guidance Points 272-303) state that a mine may not be worked unless the mine operator has made suitable arrangements for the rescue of persons, and the carrying out of work necessary to secure the health and safety of persons below ground in an emergency. The relevant regulations are included within **Appendix 1**.
8. The Mines Regulations 2014 (L149) (Regulation 7, Guidance Points 19-22 and 25-27) require that the mine operator assess the major hazards using a suitable system of risk assessment (for example, bow tie, failure mode analysis etc.) As part of any such assessment the mine operator should consider major hazard controls and mitigation measures, including the use of Safety Performance Indicators (SPI's). Those mitigation measures must include a provision for self-escape and mines rescue.
9. The Mines Regulations 2014 (Reg 7, Guidance point 23) requires that a mine operator has an effective Safety Management System (SMS). As such, the operators should produce rules, standards, and procedures for their emergency arrangements.
10. The Management of Health and Safety at Work Regulations 1999 (Regulation 3) requires a suitable and sufficient assessment of the risks to health and safety to which employees and "others" are exposed whilst at work.

Arrangements for Escape

11. It is essential to have effective arrangements in place for the safe and prompt evacuation of people from mines, as well as to take measures to

control the risk from fires, outbursts (gas) and explosions.

12. The primary focus of any emergency plan put in place by the mine operator is to discharge their responsibilities in relation to the requirements of Regulation 53 of the Mines Regulations 2014, and the emergency plan should place emphasis on the requirements of self-escape.
13. See **Part 3** of this Guidance in relation to arrangements for self escape.

Arrangements for Rescue

14. The mine operator may not operate the mine unless they have made suitable arrangements for:
 - a. The rescue of persons from the mine; and
 - b. For carrying out necessary work to secure the health and safety of persons below ground in an emergency.
15. The requirement of **(14)** above is an absolute and exists regardless of the extent or number of measures that a mine operator has implemented to remove or mitigate the major mining hazards.
16. There is no legal responsibility for the fire and rescue service to rescue people trapped below ground, and any assessment made concerning the provision of rescue services should take the availability and suitability of the fire and rescue service into account.
17. The mine operator will need to make suitable arrangements for rescue. This may be achieved by:
 - a. Providing their own arrangements; or
 - b. Working with other mine operators; or
 - c. Working with a specialist rescue provider; or
 - d. Any combination of the above.
18. Mines rescue arrangements must be suitable for the type of mine.
19. The mine operator must have in place a suitable provision for rescue, and that provision must extend beyond employees to include contractors, tour guides and members of the public.
20. See **Part 4** of this Guidance in relation to arrangements for mines rescue

Part 2 – Considerations for the Mine Emergency Planning

Assessing the hazards and risks associated with an emergency

21. The mine operator must prepare a written plan, which is referred to as the 'escape and rescue plan' within the Mines Regulations 2014.
22. The mine operator should carry out a suitable and sufficient risk assessment that considers potential hazards within the operation which may present the need for a person to:
 - a. Respond to an emergency
 - b. Evacuate the mine or area of the mine
 - c. Initiate a plan for rescue
 - d. Initiate a plan to make an area safe to allow self-escape or rescue.
23. When considering the hazards and risk, the mine operator must not only consider risks that are inherent to the mining process, but risks that are introduced to support that process, these for example could include:
 - a. Mineral oils
 - b. Diesel fuel
 - c. Wood
 - d. Chemicals
 - e. Mineral conveying systems
 - f. Vehicles
 - g. Electrical equipment
 - h. Explosives
 - i. Hot works
 - j. The efficiency of the ventilation system, and the impact of potential failures.

(This list is not exhaustive, and is provided for guidance only)
24. It is important that the site maintain an inventory of the hazards that are present or imported to the site, and that inventory of hazards is periodically reviewed to ensure that the emergency planning remain adequate.
25. Risks that may be considered inherent to the mining process, could include the following:
 - a. Oxygen deficiency, due to an inrush of gas that displace oxygen in the atmosphere

- b. A depletion of oxygen in the atmosphere due to a fire (or, where applicable, explosion)
- c. The presence of toxic gases due to fire (or, where applicable, explosion)
- d. An inrush of material that could flow
- e. Entrapment by falls of ground.

(This list is not exhaustive, and is provided for guidance only)

- 26.** Where the escape and rescue plan are contingent on the availability of shafts, or winding equipment (or other such equipment in unwalkable outlets), the mine operator must consider the availability of alternate arrangements should there be a failure that renders the shaft or winding system inoperable.
- 27.** It may be beneficial for mine operators to consider potential failure modes, and failure escalation that could potentially lead to a situation defined in (29) above.
- 28.** The escape and rescue plan must also consider areas with enhanced risks, these include:
- a. Single entry headings (which would include tunnels and/ or shafts under construction)
 - b. Hot and humid roadways
 - c. Steep roadways
 - d. Mines that have large volumes of imported flammable material (for example storage mines)
 - e. Mines that have fire suppression systems that displace oxygen to depress fires
 - f. Mines that have production areas (such as longwall faces) that have long access roadways, typically greater than 1000m in length.
- (This list is not exhaustive, and is provided for guidance only)*
- 29.** The approach to the assessment should assist the mine operator in establishing:
- a. The risks associated with each hazard
 - b. The number of people at risk
 - c. Any measures already in place to control the risks.
 - d. Additional measures needed to eliminate or further minimise the risk.
 - e. The escalation potential should the identified controls fail.
- 30.** Whilst it is important that the risk assessments fully consider the events that may require lead to the implementation of the emergency plan, consideration should also be given to the application of systems and technologies that may allow for a situation to be descaled. Such systems

could include:

- a. The design and evaluation of equipment being deployed into mine operations to ensure that it is suitable for the purpose for which it will be used.
- b. The use of purpose designed fire suppression systems as part of the operation of underground plant and equipment.
- c. The use of detection systems that provide early identification and action plans in the event of early alarms
- d. The use devices to automatically seal off affected areas of the mine, noting that such devices must not interfere with the self escape or rescue of persons

(This list is not exhaustive, and is provided for guidance only)

Who should the plan consider

31. The plan should consider everyone at work in the mine and any “others” who may enter the mine.
32. If there is more than one employer at the mine, they will need to fully co-operate to ensure that the mine operator can fulfil their obligations.
33. Each employer is obligated to consider the risks that exist for their employees and any other persons.

Development of the emergency plan

34. The emergency plan should be based on identified risks.
35. The mine emergency plan should be written in an easily understood format. Ideally, it should be modular and capable of being used in a way that allows the mine to be segregated into affected and unaffected zones. For example, an incident close to the working area may not impact those working further away, so initial communication and responses can be more targeted and efficient.
36. Designing the emergency plan to be modular may also assist in the requirement to periodically review; places situated away from main production areas are less likely to change.
37. The mine operator is responsible for developing the emergency plan. However, there is a potential benefit from involving any contractor in circumstances where there is more than one employer, as the contractor may be more familiar with the work area and work process.

- 38. The emergency plan must adequately consider the requirements for self-escape **(See Part 3 to this document)**.
- 39. The emergency plan must adequately consider the arrangements for mines rescue **(See Part 4 to this document)**.
- 40. The emergency plan should also consider the arrangements for standing down the emergency, and ultimately the process required to verify the safety of the mine, and the persons employed prior to returning to normal operations.

Provision of Mine Plans

- 41. The mine operator should ensure that a plan showing the extent of the mine workings is available on a scale of not less than 1:2500. However, a smaller scale may be more appropriate to ensure enough detail is shown (e.g. 1:500).
- 42. The mine operator should ensure the availability of a plan showing the mine ventilation systems. The plan will indicate the direction of airflow, the quantities at key locations/splits, the location and type of any device used to regulate the flow of ventilation, and the location of safe havens or changeover stations.
- 43. Plans should be readily available for use in an emergency, with copies available in incident control and other key areas involved in managing an emergency response.
- 44. The plans should be periodically reviewed and updated, to keep them current and reflective of the extent of the workings and mine ventilation systems.
- 45. Where there are multiple seams, a separate plan must be available for the mine workings, and ventilation for each seam.
- 46. Where the plans show underground stope working, they need to be three-dimensional to make clear where mineral has been or is being excavated.
- 47. Plans for stope working should also make it clear for, the purpose of mines rescue, the areas where access has been maintained or access has been prohibited.

48. There are potential benefits to digitise the mine plans and make them available through portable devices. This makes the mine plans readily available to those with a responsibility for managing and coordinating the emergency response.

Incident management and control

49. It is critical in an emergency that those in control of the emergency have the information available that allows them to clearly identify and account for:
- a. The total number of people on site.
 - b. The total number of people that are employed underground at the time of the emergency.
 - c. Ideally the number of persons that are employed in the area of the mine affected (assuming that this is not the whole mine)
50. The emergency plan should be made as simple to follow as possible (in the event of an incident occurring “out of normal working hours”, the plan may need to be instigated by a person that may not normally sit within the mine management structure).
51. The emergency plan should designate a single person to take charge of the incident. However, substitutes should also be identified should the designated person be unavailable, or the incident is likely to extend for a significant period of time.
52. The emergency plan should identify other key roles and designate appropriate persons within the mine structure to fulfil them.
53. Essential functions within the incident management and control structure could include the following roles and responsibilities:
- a. Alerting and coordinating a mines rescue response
 - b. Accounting for persons underground at the time of the incident (this may be extended to include a responsibility for recording those going underground in response to the incident)
 - c. Coordinating the emergency response underground (sometimes referred to as the underground controller)
 - d. Technical services persons providing information and plans
 - e. Provisioning of equipment and supplies
 - f. Provisioning of people resources to support the emergency response
 - g. Provision of food and refreshments that may be required to sustain an ongoing emergency response
 - h. Engineering to advise on electrical and mechanical matters or

- prepare equipment for use
- i. Ensuring the security of the site.

- 54.** As part of the emergency plan, the mine operator should consider designated areas and office space, such places should include:
- a. Incident control
 - b. Underground control
 - c. Inbye Control (fresh air base)
 - d. Rescue room
 - e. Briefing and debriefing areas
 - f. Morgue (medical station)

(This list is not exhaustive, and is provided for guidance only)

- 55.** The mine operator should also consider functions which may be externally facing, these may include:
- a. Coordinating between other emergency services
 - b. Managing the press and social media
 - c. Liaising between friends and family of those caught up in the emergency.
- 56.** If the layout of the surface allows, considerations should be given to how active participants in managing the emergency response, and passive participants that need to be informed. Ideally there will be separate accommodation for passive participants (such as the press and families) that allow the communication and messaging to be controlled.

Training for effective incident management response

- 57.** The mine operator should ensure that all persons with a role under the emergency response plan are trained and competent in their roles and responsibilities.
- 58.** Where there is a potential for any person to substitute into an alternative role, the mine operator should ensure they are trained in the roles and responsibilities of those alternative positions.
- 59.** The mine operator should arrange for those responsible for the escape and rescue plan to have the opportunity to practice through simulated emergency exercises in both desktop and live drills/mocks.
- 60.** The training should be reviewed periodically or when there have been significant changes in the mine's operation; the provisions within the escape and rescue plan; or new approaches to mines rescue.

Equipment to Support an Emergency Response

61. The mine operator should consider the type and quantity of equipment that may be required to support an emergency response underground (Guidance on the type of equipment that may be required is outlined in **Appendix 2** of this document)
62. The mine operator should ensure that there are adequate supplies of breathing apparatus. (Details of the potential quantities that may be required are outlined in **parts 120-124** of this guidance.)
63. In order to make the equipment readily available in the event of an emergency underground, the mine operator should give consideration to where the equipment will be stored.
64. The mine operator should consider how any equipment that may be required for an emergency response would be transported. It may be necessary as part of the emergency planning process to consider alternative transport routes to those normally used as part of normal mine operations.

Part 3 - Considerations for Self-Escape

Situations Where People May Need to Self-Escape

- 65. Emergencies that may require people to self-escape may include:
 - a. Fires
 - b. Explosions
 - c. Major rock falls (and consequential entrapment)
 - d. Inrushes of gas, water or material that flows when wet
 - e. Outburst of suffocating or harmful gasses from the strata.

Raising the Alarm

- 66. There should be appropriate means of warning people in the event of an emergency.
- 67. Consideration should be given to the type of communications systems installed, and ensure that there are adequate numbers of telephones, intercom, pagers, or radios to support effective communication in an emergency.
- 68. Under certain emergency situations, the power supplies and/or cable infrastructure may be compromised. The mine operator should consider these risks and ensure that redundancy and resilience is designed into the system (for example, battery backed systems or having communications systems routed in different roadways).
- 69. The mine operator should consider if there are locations that would benefit from the installation of additional communication equipment, which, whilst not normally required to support operations, would enhance communication in an emergency.
- 70. It may be possible to install monitoring systems that automatically raise the alarm and issue visual or audible (or both) alarms for localised emergencies.
- 71. A developing underground emergency is most likely to be identified by those in the immediate vicinity. Mine operators must ensure that all persons below ground have the knowledge and training on operating the communications system and, in addition, the type of information they may be asked to provide.
- 72. Should an alarm be raised the mine operator should consider the surface arrangements in place to ensure that information is cascaded and, where necessary, the emergency plan is activated.

73. For smaller operations, it is possible that no persons may be present on the surface. In these circumstances, the mine operator should consider alternative arrangements (for example, having persons below ground contact someone away from the mine at predetermined times and have a protocol for reacting under various circumstances).

Finding the Way to a Place of Safety

74. The emergency plan must consider potential scenarios that may require people to self-escape. As part of those considerations the mine operator must evaluate and designate potential places of safety.
75. In the event of self-escape, the safest place to evacuate to is generally the surface of the mine.
76. There may be emergency scenarios which impede the ability to reach the surface. The mine operator must therefore consider the provision of safe havens (See MAUK **Guidance and Information on the Role and Design of Safe Havens in Arrangements for Escape from Mines**).
77. Designated escape routes should be high enough to allow people to walk and they should be kept free from obstruction.
78. Designated escape routes should be adequately inspected, and arrangements made to ensure that they are adequately maintained.
79. Safety evacuation routes must be clearly identified. Where multiple evacuation routes exist, the mine operator should consider using signage (or other systems) which clearly identify the route to be taken.
80. In certain emergency situations it is likely that the visibility may be compromised by smoke, the mine operator should consider whether the probability for self-escape is improved by the installation of wayfinding systems.
81. Types of wayfinding systems include the following:
- a. **Signs and Reflective Route Markers**, these have limited use where visibility is an issue. To remain effective, a regime must be in place to ensure they are periodically inspected and cleaned.
 - b. **Illuminated Signs**, may provide a useful indication of the location. However, consideration needs to be given to a failure of the power supply and there must be a regime in place to ensure that they are periodically cleaned.

- c. **Passive Guidance Systems**, these systems are typically provided by
 - I. Experienced persons relying on structures such as cables, conveyors, and other such arrangements to form a lifeline in conditions of reduced visibility
 - II. The installation of dedicated lifelines which indicate the direction of escape. The lifeline should have features that provide an unambiguous direction (when it comes to escape).

Studies completed by **Kriel et al (1995)** showed that the use of lifelines increased the walking rate to 75% of normal when using a self-rescuer. This number reduced to 40% of walking rate when other fixed structures were used.

- d. **Active Guidance Systems**, these systems employ a combination of visible and audible signals to guide personnel. The spacing of devices needs to be such that they can be seen/heard in reduced visibility. Spacing can be maximised using systems that give audible directional cues, using a synchronized stepped tone output.

Consideration should be given to how the system is to be triggered in the event of an emergency. Considerations may include:

- I. Triggered automatically in the event of power loss
 - II. Triggered automatically via the environmental monitoring systems
 - III. Triggered manually
 - IV. Combination of the above.
- e. As new technologies become available, their inclusion to enhance the arrangements for escape and rescue should be reviewed, however as part of the review process that assessment for their introduction, should consider the reliability and resilience of those technologies.

82. Where an active guidance system is employed, consideration needs to be given to the effective examination, maintenance, and testing of the system, including the methodology for triggering activation.

- 83.** Whichever system is selected, it should, as part of the assessment for use, achieve the following:
- a. Significantly increase the speed of egress
 - b. Be useful in conditions of extremely low visibility
 - c. Not present ambiguous directional information
 - d. Provide visual, audible, and tactile cues
 - e. Offer high integrity and preferably fail-safe operation; and

- f. Not rely on background or other ambient lighting being present.

Specific Considerations for Single Entries

- 84. The mine operator must consider the arrangements for self-escape from places where there is only one way in and out (this would include shafts which are in the process of construction).
- 85. Where through risk assessment, a danger such as fire is identified as a hazard, consideration must be given to using a fire detection and alarm system to automatically warn people in those areas.
- 86. The mine operator should assess the number of people required to operate in those areas. This assessment should include provision for management, supervisors and others that may have reason to enter. In all circumstances consideration must be given to how that number can be minimized.
- 87. As part of the escape and rescue plan, a means of quickly identifying people within the areas should be implemented. If this is an electronic recording system, then provision should be made to ensure that information can be recovered in the event of a power failure.

Provision and Use of Self Rescuers

- 88. Where a risk assessment identifies the potential for an irrespirable atmosphere to exist, the mine operator must arrange for the provision of self-rescuers for all persons below ground.
- 89. Where a self-rescuer is issued, the mine operator must ensure it is with the person upon mine entry and is with that person at all times while below ground.
- 90. The purpose of a self-rescuer is to protect people while they escape to a place of safety, for instance, where the mine environment may contain harmful levels of carbon monoxide (for example, following a fire), or have low levels of oxygen (for example, following an outburst or inrush of gas).
- 91. The mine operator must determine the type of self-rescuer that they will provide. This decision will be dependent on the range of identified hazards at that operation. Self-rescuers fall into two types:

- a. **Filter self-rescuer**, protects against carbon monoxide but not an oxygen deficient atmosphere, so would not be appropriate if the risk assessment indicated that an oxygen deficient atmosphere could reasonably be present
 - b. **Self-contained self-rescuer**, contain an oxygen supply and therefore provide protection in all atmospheres.
92. When selecting a self-rescuer, the mine operator should consider the duration and how an individual's physical limitations or the incident's characteristics may influence the speed at which people travel. In assessing the type and duration of a self-rescuer, consideration should be given to the following:
- a. The nature of the ground underfoot (typical maximum values based on the Naismith's rule would be 5km in one hour, however these conditions are optimal and assume smooth paths)
 - b. Any gradients (typical maximum values based on Naismith's rule would be to allow 60 minutes for every 600m of ascent)
 - c. The impact of reduced visibility on travel times
 - d. The impact of stress induced by the incident
 - e. The potential impact of wearing of a self-rescuer
 - f. Restrictive spaces, ladderways and other areas to be navigated during escape.
93. In circumstances that require the movement of casualties to a safe location, the management and transport of those casualties will further reduce the speed of travel.
94. The mine operator should never solely rely on the manufacturers information when selecting a type and duration of self-rescuer. They should arrange to test the duration under simulated emergency conditions.
95. Where evaluation of the self-rescuer (whether based on manufacturer's information or simulated test) indicates that the duration is inadequate to facilitate an escape to a place of safety, then the mine operator must consider arrangements for change-over facilities or safe havens (See MAUK **Guidance and Information on the Role and Design of Safe Havens in Arrangements for Escape from Mines**).
96. In addition to self-rescuer duration, when assessing whether safe havens, or facilities for the exchange and recharge of self-rescuers should be provided, it is important to think about:
- a. maximum distance to travel to reach a place of safety

- b. travelling conditions and visibility
 - c. physical and mental effort required to escape; and
 - d. temperature and humidity (the key considerations relating to temperature have been included in **Appendix 4**).
97. Because wearing a self-rescuer makes verbal communication impossible, consideration should be given to how to communicate in an emergency.
98. Communication is a key to the implementation and overall effectiveness of the plan covering the self-escape of persons from the mine. As new communication technologies become available, their inclusion should be considered as part of the arrangements to improve the escape and rescue plan at the mine. The review process for their introduction, should consider the reliability and resilience of those technologies under the circumstances that may exist underground at the mine during an emergency situation.
99. The mine operator must ensure that there is an adequate scheme of maintenance in place for all self-rescuers, and that the scheme of maintenance recognises manufacturers recommendations, the conditions to which they are routinely exposed or stored, and the age of the units.

Training for Self-Escape

100. The mine operator must ensure a scheme of training is in place which ensures that persons working underground are competent to:
- a. Initiate an emergency response, and provide information which is essential to establishing an appropriate response
 - b. Find their way to a place of safety. This should (where applicable) include the requirement to travel alternative routes to familiarise them with alternative escape routes
 - c. Where applicable, don a self-rescuer
 - d. Where applicable, operate and use a changeover station
 - e. Where applicable, how to activate a safe haven.
101. Training should be:
- a. Periodically repeated. For self-rescuers it is recommended that this is done annually
 - b. Repeated following any change which renders the previous training ineffective (for example, significant changes to the mine layout, a change of role meaning a person is deployed to a different location, or a change of escape arrangements and/or equipment).
102. The effectiveness of the arrangements and training should be

periodically tested using a simulated emergency exercise. The exercise should be designed to review multiple areas of the escape and rescue plan.

Part 4 – Considerations for Mine Operators and the Rescue Provisions

Requirements for mines rescue

- 103.** The mine operator may not operate the mine, unless they have made suitable arrangements for:
- a. The rescue of persons from the mine; and
 - b. Carrying out work necessary to secure the health and safety of persons below ground in an emergency.
- 104.** The requirement of (91) above is an absolute and exists regardless of the extent or number of measures that a mine operator has in place to remove or mitigate the major mining hazards.
- 105.** The mine operator as part of reviewing the requirements for mines rescue, must consider:
- a. The various circumstances where persons may not be able to self-escape to the surface or other place of safety; and
 - b. The various circumstances that may lead to an irrespirable atmosphere, and the requirement for competent persons to conduct rescue operations wearing breathing apparatus.
- 106.** The mine operator, especially at small mines, must recognise that in the event of an underground emergency, there is potential for members of their own rescue team to be caught up in those events. It is therefore essential that these small operations have considered where assistance in a mines rescue emergency may come from.
- 107.** The mine operator will need to make suitable arrangements for rescue, and this may be achieved by:
- a. Providing their own arrangements; or
 - b. Working with other mine operators; or
 - c. Working with a specialist rescue provider; or
 - d. Any combination of the above.
- 108.** The mine operator should consider the total number of people they train in mines rescue activities, consideration will need to be made of holidays, shift patterns and other potential reasons for absence as part of that assessment.
- 109.** Mine operators should consider the response times of their own rescue team members, those of other mine operators and/or a specialist rescue

provider.

Requirements for rescue (non-breathing apparatus rescue)

- 110.**At mines that have identified the potential for an irrespirable atmosphere as nil or negligible, then the most likely incident that may have a requirement for rescue is one of entrapment.
- 111.**Entrapment may be because of:
- a. A fall of ground blocking access or egress to and from a place of work; or
 - b. A person(s) becoming entangled within plant/machinery.
- 112.**In considering the number of persons required to recover situations involving falls of ground, the mine operator should consider:
- a. The skills needed to remove debris and install temporary support; and
 - b. The work environment, and how long a reasonable work rate may be sustained by those clearing debris; and
 - c. The requirements for management and supervision; and
 - d. The amount of material to be excavated, and the potential for those activities to extend over multiple shifts.
- 113.**In rescue involving plant and machinery, the requirement for a rescue team may be limited.

Requirements for rescue (breathing apparatus rescue)

- 114.**Where the mine operator has breathing apparatus on site (open circuit, or closed circuit) the decision to deploy a rescue team in breathing apparatus should be made by the incident controller and/or the specialist rescue provider.
- 115.**Small mines should consider having at least one person trained in the ability to wear breathing apparatus. This person can act as a guide where the mines rescue provision is reliant on other mine operators and/or a specialist rescue provider.
- 116.**Under normal circumstances, a rescue team will consist of five persons, one of which will be appointed to act as Team Captain.
- 117.**As part of the initial deployment, it would be preferable to have two

teams of five persons, one of which will be deployed in breathing apparatus and the second to remain on standby at a designated safe location, often referred to as the Fresh Air Base (FAB).

118. Factors such as heat and humidity, or physical effort may limit the duration that a closed-circuit breathing apparatus may be worn.
119. Often the limiting factor on open circuit breathing apparatus is the amount of compressed breathable air available. The rate at which this is used will depend on several factors.
120. Where a rescue incident requiring breathing apparatus becomes more protracted, there is potential for the number of teams required to increase, typically:
 - a. One team of five working under breathing apparatus
 - b. One team of five on standby at the FAB
 - c. One team of five travelling to the mine or to the FAB
 - d. One team of five travelling out from the mine
121. Rescue team members that have been deployed in breathing apparatus may deploy more than once in the first twenty-four hours, then there should be a rest period of 12 or more hours between further deployments.
122. In subsequent twenty-four periods, the wearing of breathing apparatus should be restricted to one occasion in each period.
123. Based on (109) and (110) above and considering two-hour deployment times in closed circuit breathing apparatus, there could be a requirement of up to 10 teams in the first twenty-four-hour period. (**Illustrated in figure 1 below**). Note there are factors that may positively and negatively influence wearing times.

Mines Rescue Deployment (Initial 24 Hours)																								
Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Deployed in BA	T1			T3				T5				T7				T9				T1				
		T2				T4				T6				T8				T10				T2		
Fresh Air Base	T2			T4				T6				T8				T10				T2				
			T3			T5				T7				T9				T1				T3		
Travelling to Site / Into the Mine	T3				T5					T7				T9				T1				T3		
				T4				T6					T8					T10			T2			T4
Travelling Out from the Mine			T1				T3					T5				T7				T9				T1
					T2					T4				T6				T8				T10		
On Rest						T1				T3				T5				T7				T9		
							T2					T4				T6				T8				T10

*for illustration - based on 2 hour cycles

Figure 1- charts showing team requirements based on 2-hour cycles

- 124.** The requirement for rescue teams in subsequent twenty-four-hour periods, based on **figure 1** would increase to a minimum of 12 teams.
- 125.** A mine operator should have the means to trigger a mines rescue response, and alert members of the mines rescue team that they are required to attend the mine.
- 126.** Any system provided under **(125)** above, should be periodically tested. These tests should be carried out randomly and the responses recorded to inform safety performance indicators relating to the suitability of the mines rescue response arrangements.

Operational Limitations of Breathing Apparatus

- 127.** For closed circuit breathing apparatus used in the UK, the limiting factor is generally considered to be the ability of the wearer to operate for prolonged period, with heat and humidity being the most significant issue. Guidance on the limitations is included within **Appendix 4**.
- 128.** Mine operators should consider routinely recording the wet and dry bulb temperatures in various parts of the mine, this will assist in developing the mines rescue response, and the number of teams required in the event of a sustained emergency.
- 129.** The duration of closed-circuit breathing apparatus can be calculated as shown in the table below (this uses data for the BG4 as the example):

Charge Pressure (bar)	Cylinder Size (litre)	Optimum oxygen capacity (litres)	Flow rate of Oxygen Dose (litre / min)	Duration at a Nominal Breathing Rate (min)	Duration Under Nominal Conditions (hours)
200	2	400	1.65*	242	4

*Oxygen flow rate is present set within the regulator

Figure 2 – Table showing the nominal capacity of the BG4 closed circuit breathing apparatus

- 130.** Closed-circuit breathing apparatus have a limited supply of oxygen, and operational time can be impacted significantly if there are leaks on the breathing system. Care must be taken to ensure that the apparatus is correctly maintained, and wearer checks are completed prior to operational deployment.
- 131.** The duration of the closed-circuit breathing apparatus can also be

impacted by the work rate, periods of extended effort may lead to the use of the bypass valve to reinflate the breathing bag, reducing the deployment time.

- 132.** Compressed air sets are generally limited by the quantity of air that can be carried. The table provides an estimate of a compressed air system using a 9l cylinder charged to 200bar and a 6.8l cylinder charged to 300bar. The quantity of air available will vary dependent on pressure and volume and the mine operator should make themselves familiar with their arrangements as part of preparing the escape and rescue plans.

Charge Pressure (bar)	Cylinder Size (litre)	Quantity of Compressed Air (litre)	Duration at a Nominal Breathing Rate (min)**	Duration Under Work Conditions (min)***
300	6.8	2,006*	50	30
200	9	1,800	45	27

*Nominal rate, this includes the 0.9 density adjustment for pressures more than 250bar

**Nominal breathing rate assumed at 40l/min

*** Breathing rate under work conditions assumed at 65l/min

Figure 3 – table showing the maximum capacity of a compressed air cylinder

- 133.** The chart above (**figure 3**) indicates the maximum duration of the cylinder in minutes, dependant on work rate. In calculating the maximum duration of the set, consideration also needs to be given to a safety factor. If the safety factor is assumed to be 55bar (whistle +/- 5 bar), then in the example above the times at a nominal breathing would reduce for a 6.8l and 9l cylinder by an estimated 9.35 minutes and 12.4 minutes respectively.

- 134.** By estimating the breathing rate, and the walking rate we can estimate the maximum distance that a rescue worker might be able to travel using an open circuit compressed air set. This is shown in **figure 4** overleaf.

Cylinder Size (litre)	Available Air in (min) when charged to capacity	Available Air (min) Including a safety factor (50bar)	Nominal walking rate (m/ min)	Walking rate under load (m/min)	Maximum travel distance (nominal) (m)***	Maximum travel distance (loaded) (m)***
6.8*	50	40	60	40	2,400	1,600
9**	45	32	60	40	1,920	1,280

*For a 6.8 litre cylinder, minimum charge pressure is 300bar

** For a 9-litre cylinder, maximum fill pressure is assumed to be 200b (300b versions are available)

***safety factor is assumed on a nominal breathing rate of 40l/m

***The total travel distance is both directions, and allows no time for searching

Figure 4 – Examples of Estimated Total Travel Distance for Compressed Air Breathing Apparatus
(organisations should consider and set their own standards)

135. The duration of open circuit breathing apparatus may be extended by adopting all or a combination of the following:

- The use of twin 6.8l cylinders
- The use of refill / recharge stations

136. Where compressed air refill / recharge stations are utilised as a method for extending the range, the mine operator must ensure that they are placed in locations that are suitable spaced and easily accessible during an emergency.

137. The mine operators should ensure that they have considered the travel distances whilst using any breathing apparatus, and factor this into the rescue plan.

Considerations for rescue when life is at stake

138. If there is life at stake, and the rapid deployment of a rescue team in breathing apparatus has a potential to make a significant difference, then consideration may be given to deploying in teams of less than five.

139. When the decision is made to deploy a rescue team of fewer than five people in breathing apparatus, the mine operator should consider additional operational controls to reduce the risk of the rescue teams becoming casualties. The considerations could include all or a combination of the following:

- Reducing the total time that a rescue team may be deployed.
- Increasing the level of reserve air/oxygen (dependent on the equipment) that the rescue team must maintain before having to return to the FAB
- Restricting the distance that the rescue team can travel from the

- FAB, and maintaining line of site of the rescue team
- d. Splitting members of the available rescue team and ensuring a standby arrangement is maintained as part of any deployment
- e. Requiring the team to return to the FAB, if communications are compromised
- f. Limiting the activities of the rescue team to one of search, and administration of immediate medical assistance.

140. Where a decision is made to deploy a team of less than five people, the quantity and type of equipment that they can transport beyond the FAB will be compromised, which may further influence the response parameters.

Arrangement at the mine site to support a mines rescue event

141. Site security should be notified that rescue teams from other organisations and/or a specialist rescue provider may be arriving on site, and that these should be directed without delay to the on-site facilities.

142. Lengthy induction process should be avoided as this can lead to unnecessary delays and be of limited value given that the circumstances cannot be considered normal.

143. Site signage should be clear, and give directions to key areas, for example the rescue room, the control room and incident control.

144. A space should be designated on site which is often referred to as the emergency accommodation or rescue room. This space should be large enough to:

- a. Hold a team of five people being briefed/carrying out equipment checks ready for deployment
- b. Hold a team of five people being debriefed, with space to isolate equipment requiring maintenance.

145. There should be space designated as the emergency accommodation or rescue room should have the following facilities:

- a. Benches that allow equipment to be laid out and checked
- b. Sinks which allow equipment to be washed and cleaned
- c. Hot water
- d. Heating
- e. Tables and seating
- f. A telephone (or other communications) that allow direct

communication with incident control/underground control and other relevant areas

- g. An internal telephone directory (or telephone numbers that are relevant to the rescue effort)
- h. A wipe board or pin board for note making or mounting plans
- i. Sets of plans on suitable scale for provision to the rescue team during deployment
- j. Supply of drinking water (with the facility to make hot drinks).

146. The mine operator should also consider making available a secondary covered area where additional rescue teams and equipment can stay until deployed.

147. The mine should make available other personnel to support the mines rescue activities, this may include people to guide the mines rescue teams or assist in transporting material, equipment to support the mines rescue teams or assisting in treating and transporting casualties from the fresh air base to the surface.

First aid considerations

148. Any mines rescue response is limited by travel time to the mine, deployment, and travel to the incident site. The mine operator should therefore consider the first aid training provided to front line supervisors (and others) to ensure that there is maintained a capability underground when dealing with trauma-type events.

149. The mine operator should consider the first aid equipment needed underground to deal with trauma level events.

Selection of persons for mines rescue activities

150. The mine operator should consider the criteria for selecting a part time mine rescue operative, which could include:

- a. Relevant underground experience, and a broad knowledge of the underground operations
- b. Physically fitness
- c. Skills which are relevant to a mines rescue situation (for example an electrician or mechanic)
- d. The aptitude and attitude displayed during normal work, including a willingness to lead and take instruction
- e. The ability to work as part of a team
- f. A willingness to train, learn new skills and commit to the desktop

- learning required
- g. Skills which complement those of existing team members.

Fitness of persons for mines rescue activities

- 151.** As part of the selection process, any perspective operative should undergo a medical which will typically include:
- a. A fitness test (various tests are available) which includes recovery time from physical activity
 - b. A test to calculate aerobic capacity (VO2 max). Aerobic capacity should ideally be 35ml/kg/min (*reference University of Bath – Occupational Fitness Standards for Mines Rescue Workers, 2012*) (Dr James Bilzon). Alternative tests may be available using treadmill and the treadmill index (TI.)
 - c. Spirometry testing
 - d. Audiometry testing
 - e. Sight (may use correction where correctly fitted to the mask)
 - f. Blood pressure.
- 152.** The medical should include conditions that can inhibit a person's ability to operate as part of a rescue team in arduous environments, these include:
- a. Epilepsy
 - b. Diabetes
 - c. Recurring headaches (or migraines)
 - d. Any condition that prevents sweating
 - e. Reliance on prescription drugs that may inhibit decision making, response times, or limit the ability for physical work
 - f. Drug or alcohol dependencies
 - g. Injury or disability that impairs the ability to carry out the required physical activities.
- 153.** Fitness tests should be repeated annually, or when reason exists to believe an individual's circumstances have changed.
- 154.** Medical tests should be recorded as Passed (meaning the candidate is fit to continue for the next twelve months), Failed (meaning the candidate is unfit to do rescue work, but may pass when retested at some point in the future), or Retired (where the candidate is permanently unfit for rescue work).
- 155.** The mine operator should have a means to prevent any person not passed as medically fit from being deployed in a mines rescue

emergency.

156. Where the rescue operative forms part of a wider mines rescue response, which is coordinated by a 3rd party, or specialist rescue provider, those parties should also be notified that the individual has not been passed as medically fit.

Equipment for mines rescue

157. The mine operator should as part of the development of the emergency plan (**see Part 2 of this document for estimates of breathing apparatus requirements**) consider the type and quantity of equipment that may be required to support a mines rescue operation.
158. Where rescue arrangements are supported by a specialist rescue provider and/or other mine operators, efforts should be made to coordinate and standardise the available equipment.

Training and competence for mines rescue operatives

159. Mines rescue operatives should complete an induction program which aligns with the National Occupational Standards covering mines rescue activities.
160. Consideration should be given by the mine operator or specialist rescue provider on how competency assessments are completed prior to the newly trained individual becoming an operational member of the team. Ideally the assessment will be completed in a mine environment.
161. The induction program should be supported by routine training which periodically refreshes core competencies. Consideration should be given as to how competency is assessed.
162. The frequency of any planned refresher events should be determined, which should ideally be spaced at intervals over a twelve-month period.
163. Training events should be developed to ensure the scenarios practiced are relevant to the mine; they may or may not involve the use of breathing apparatus.
164. At least one training event should involve a simulated mock emergency which tests multiple elements of the mines rescue response.

- 165.** Mine operators should consider the part time mines rescue operatives achieving the L2 Rescue Operative Award.
- 166.** Rescue operatives should, as a minimum, maintain at a minimum a First Aid at Work qualification. The mine operator should also evaluate scenarios which involve a potential rescue situation alongside the need for more advanced first aid techniques. Particularly where the situation might include managing traumatic bleeds, administering oxygen therapy, administering pain relief with analgesic gas and casualty triage, monitoring and prioritisation.

Training and competence for those with other responsibilities in a mines rescue situation

- 167.** Training for effective incident management is covered in Part 2 of this guidance document.

Part 5 – Considerations for Providers of Mines Rescue Services

Duties of mines rescue personnel

- 168.** The duties of the key roles and responsibilities of mines rescue personnel are identified in **Appendix 5** to this document. The appendix covers the following roles:
- a. Rescue operative
 - b. Rescue Team Captain
 - c. Mines Rescue Officer (Supervisor)
 - d. Person manning the rescue room
 - e. Person controlling the Fresh Air Base
 - f. Administration.

Availability of Equipment

- 169.** Any specialist rescue provider must ensure that they have access to adequate quantities of breathing apparatus to support a sustained rescue effort (estimated requirements are defined in paragraphs **111** and **112** of this report).
- 170.** If applicable, the specialist rescue provider should assess the potential for more than a single mine having an incident and have contingency levels of equipment that maintains support for other operations.
- 171.** Specialist rescue providers must have enough competent people to service and test the apparatus used during an emergency response.
- 172.** The specialist rescue provider must ensure that they have a suitable number of vehicles to move equipment to and from the incident.

Availability of Vehicles

- 173.** The rescue provider should ensure that there are adequate numbers of vehicles available to transport people and equipment, the requirement for transport is likely to increase over the course of a sustained mines rescue emergency.
- 174.** Consideration should be given to the use of tracked vehicles which

would support the specialist rescue provider and mine operator in coordinating any response to a mines rescue emergency.

- 175.** The primary mines rescue response vehicle(s) should be maintained in a state of readiness, with equipment that might reasonably be required in an initial response to a mines rescue emergency.
- 176.** Other equipment that might be required should be clearly labelled and readily accessible to allow it to be loaded quickly on to a response vehicle if required.
- 177.** The primary response vehicle should be of a design that allows equipment and a full team of rescue operatives and an accompanying rescue officer to be transported simultaneously.
- 178.** Consideration should be given to ensuring that primary response vehicles can be connected to an electrical supply that will maintain electrical equipment such as cap lamps and gas monitors in a required state of operational readiness.
- 179.** Vehicles should ideally be equipped with a hands-free telephone, and satellite navigation systems. The satellite navigation systems should be preloaded with the postcodes for the mine(s.)

Coordination of Equipment Type

- 180.** The specialist rescue provider should ensure that equipment on various sites, is as far practicable comparable in type, duration, and operation.
- 181.** Where there are variations in equipment specifications, the rescue provider should ensure that training incorporates that equipment.
- 182.** Specialist rescue providers should assist in coordinating the purchase of equipment to ensure that common standards are maintained as far as is practicable.

Operational Limitations

- 183.** The specialist rescue operator should consider the safety of the mines rescue teams, and consider operational limitations that may assist in managing the major hazards that could be present in a mines rescue emergency, these may include:
 - a. The presence of an explosive atmosphere

- b. The presence of flammable atmospheres
- c. The presence of irrespirable atmosphere
- d. Dealing with falls of ground

184. Where operational limitations are in place to protect the mines rescue teams, they can be reviewed and, if appropriate, altered through consultation with the specialist rescue provider and the mine operator.

185. The specialist rescue provider should evaluate situations where the Mines Rescue Team Captain may have to cut short a response; circumstances include:

- a. Where the team is in a dangerous situation and, in the opinion of the Rescue Team Captain, the team has no access to suitable control measures; or
- b. Where critical equipment (for example, breathing apparatus) develops a fault; or
- c. Where a rescue team member becomes injured or ill (this could be physically or mentally); or
- d. Any change in circumstances, where the response task or objective is beyond the team's capability; or
- e. If oxygen or compressed air within CCBA or OCBA levels fall below prescribed limits (the team must react to the lowest gauge reading); or
- f. Where limitations influenced by the mine environment (for example heat and humidity) dictate; or
- g. Loss of communication with the FAB.

186. The mines rescue team should return to the fresh air base on completion of the defined objective or task. If adequate communications systems exist, it may be possible to vary a response.

187. The mines rescue team should always return to the FAB at the agreed time. If adequate communications systems exist, it may be possible to vary the length of a response.

188. Under all circumstances the rescue team must return to the FAB if instructed to do so.

Training and competence for mines rescue operatives (specialist rescue provider)

189. The mines rescue provider must consider the prior underground experience of a rescue worker new to their organisation and ensure that

training is reflective of their previous experience.

- 190.** Training should mirror that of the section labelled 'training and competence for mines rescue operatives'

Part 6 – Appendices

Appendix 1 – Extract from the Mines Regulations 2014

Exits from the Mine Reg 48.

1. The mine operator must ensure that there are at least two shafts or outlets providing at least two separate exits to the surface.
2. The shafts or outlets required by paragraph (1) must be:
 - a. of sound construction;
 - b. readily accessible to persons below ground at the mine; and
 - c. sufficiently separated so that, so far as is reasonably practicable, anything that happens in one of them will not affect the safety of the other or others.
3. The mine operator must ensure that, so far as is reasonably practicable, two exits from the mine are available for use at any time by persons below ground at the mine.
4. The mine operator must prepare a suitable written plan of the action to be taken to secure the safety of persons when, due to an unforeseen event or planned maintenance, only one exit is available for use.
5. If only one exit is available for use, the mine operator must ensure that:
 - a. the plan required by paragraph (4) is implemented; and
 - b. the persons below ground are restricted, so far as is reasonably practicable, to those who will not be exposed to danger by reason that only one exit is available for use and who:
 - i. are needed to carry out work essential for securing the safety of the mine;
 - ii. are involved in work relating to the unforeseen event or planned maintenance;
 - iii. at the time the exit became unavailable, were already working below ground, provided they do not remain below ground after their normal period of work has ended; or
 - iv. are needed to secure the health or safety of any person.

Ways Out from Places of Work Reg 49.

1. Subject to paragraph (3), the mine operator must ensure that every place where a person works has at least two ways out.
2. At least two of the ways out required by paragraph (1) must:
 - a. be clearly identified;
 - b. be passable with reasonable convenience;
 - c. be separate from each other; and
 - d. lead to a different exit from the mine.
3. The requirements in paragraphs (1) and (2) do not apply in relation to a heading or

other place from which it is not reasonably practicable to provide at least two ways out that comply with paragraph (2), provided that the mine operator ensures that the following conditions are met:

- a. there are in place suitable procedures to ensure that all persons can leave the place safely;
- b. the activities carried out in the place are limited to those that are required to be carried out there; and
- c. the persons present at the place at any time are limited to those necessary for the activity or activities being carried out there.

Emergency routes and emergency doors Reg 50.

1. Emergency routes and exits must remain clear at all times and lead by the most direct and safe route to the open air or a safe area.
2. Doors that may form part of an emergency route or exit must be capable of being opened easily at all times.

Auxiliary equipment Reg 51.

The mine operator must ensure that suitable auxiliary equipment is available for use when any equipment that is required to be used by persons to leave the mine becomes unavailable or breaks down.

Intake airways Reg 52.

The mine operator must ensure, so far as is reasonably practicable, that the intake airways for the mine are constructed of suitable fire-resistant materials.

Duties of the mine operator with regard to escape and rescue Reg 53.

1. In the event of an emergency, the mine operator must:
 - a. Ensure that suitable arrangements are in place for persons below ground to reach a safe place promptly; and
 - b. Provide and operate the necessary warning and communication systems to facilitate assistance, escape, and to launch rescue operations immediately.
2. A mine may not be worked unless the mine operator has made suitable arrangements:
 - a. For the rescue of persons from the mine; and
 - b. For carrying out work necessary to secure the health and safety of persons below ground in the event of an emergency.

Escape and rescue plan Reg 54.

1. The mine operator must prepare and maintain a written plan (in these Regulations referred to as the “escape and rescue plan”) which sets out the actions to effect safely and promptly, the evacuation and rescue of persons to a safe place during an emergency.
2. In preparing the escape and rescue plan, the mine operator must have regard to every relevant risk assessment carried out in accordance with these Regulations, and Regulation 3 of the Management Regulations.

3. The mine operator must review the escape and rescue plan regularly at suitable intervals and whenever
 - a. there has been a significant change in the matters to which the plan relates; or
 - b. the plan has been put into use.
4. The mine operator must keep an up-to-date copy of the escape and rescue plan in a suitable place and make it available to appropriate persons promptly in the event of an emergency.

Emergency equipment and communication systems Reg 55.

1. The mine operator must ensure that suitable equipment is always available for use where it is necessary in any operation involving escape or rescue.
2. The mine operator must ensure that emergency equipment is
 - a. maintained in good condition; and
 - b. stored in easily accessible places.
3. The mine operator must ensure that in the event of an emergency the warning and other communication systems referred to in regulation 53(1)(b) are put into operation immediately.

Training and information Reg 56.

1. The mine operator must ensure that:
 - a. all persons who work at the mine are trained in the appropriate actions to be taken in the event of an emergency at the mine; and
 - b. appropriate persons are trained in the use of emergency equipment.
2. The mine operator must ensure that written instructions are prepared on:
 - a. the appropriate actions to be taken in the event of an emergency at the mine; and
 - b. the use, handling, and operation of emergency equipment.
3. The mine operator must regularly hold safety drills to ensure that persons working at the mine are familiar with the instructions specified in paragraph (2).

Self-rescuers Reg 57.

1. In any mine in which the risk assessment carried out in accordance with Regulation 3 of the Management Regulations has identified the likelihood of an irrespirable atmosphere, the mine operator must provide:
 - a. suitable self-rescuers for all persons going below ground at the mine; and
 - b. where necessary, safe havens or facilities below ground for the exchange and recharge of self-rescuers.
2. The mine operator must ensure that every person who has been issued with a self-rescuer:
 - c. has been instructed how to use it; and
 - d. does not go below ground without it.

3. The mine operator must ensure that, so far as is reasonably practicable, every person issued with a self-rescuer always keeps it within their reach when below ground.
4. The mine operator must ensure that all self-rescuers are checked regularly and stored in a suitable place at the mine (5). In this regulation, “safe haven” means a place below ground at a mine which is provided.

Appendix 2 – Guidance on Material and Equipment for an Emergency Response

The following is guidance, and should not be considered an exhaustive list, the mine operator should ensure that the bow tie analysis (or other risk assessment) consider the types of materials and equipment that may be required as part of the measures for mitigating the failure of any controls which have the potential to escalate in to and an emergency response.

Mine operators may wish to consider how materials and equipment could be shared by operations.

Communication Systems

1. The availability of additional radios that form part of the mine wide network.
2. Spare telephones (or other audio devices.)
3. Suitable cable to allow additional devices to be installed at critical locations.

Mine Monitoring Systems

1. Additional sensors that allow for the replacement of existing fixed monitors, or the installation of additional monitoring systems.
2. Higher reading instruments which may enhance capabilities in the event that levels of gasses are elevated above those normally encountered.
3. Suitable cable to allow the fixed monitoring devices to be installed.
4. Suitable devices to allow the information to be gathered, indicated and transmitted.
5. Additional handheld monitoring devices.

Mine Ventilation

1. Spare ventilating fan
2. Spare ventilation duct to allow ventilation to be established up to rockfalls/ floods etc.
3. Availability of timber to create ventilation barriers / hurdles etc.
4. Brattice cloth to create ventilation barriers / hurdles
5. Nails

Ground Control

1. Suitable timber to allow for the installation of temporary passive supports.
2. Drills and rock bolts to allow for the installation of active support.
3. Monitoring devices to allow additional movement to be identified

Pumps

1. Pumps with the capability of dealing with any anticipated water make.
2. When considering pump, it may be worth considering both electric and pneumatic types of pumps.
3. Temporary tanks
4. Pipes, couplers and valves to allow the pump to be installed into existing ranges.

Electrical Systems

1. Availability of capacity to allow for the installation of additional equipment (as outlined above.)
2. A supply of cable to allow ventilating fans / pumps etc. to be powered
3. Spares for any critical plant or equipment that may be required in an emergency.

Hand Tools

1. A suitable supply of tools that may be required in an emergency, these may include:
 - a. Hammers (all sizes)
 - b. Picks
 - c. Shovels
 - d. Crowbars
 - e. Saws
 - f. Hacksaws (blades)
 - g. Knives

First Aid Materials

1. Access to additional first aid materials (which may be more than those normally required as part of the first aid need analysis.) First aid materials may include:
 - a. Wound dressings
 - b. Devices / dressings for controlling bleeding
 - c. Burns kits
 - d. Eye wash
 - e. Blankets
 - f. Stretchers

Provision of Food and Water

1. Those that are involved in a mines rescue response, will require food and water, the mine operator should consider how this requirement may be fulfilled at their site(s)
2. For those that have to use a safe haven, then there will be a requirement to ensure welfare, including the provision of food and drink is considered (See separate guidance on the use of safe havens). The mine operator should

consider:

- a. Provision of foods that have long duration dates (for example MRE rations)
- b. Provisions of foods that are relatively high in calorific value and can be consumed without the need to heat
- c. A n adequate supply of drinking water (guidance is provided within the haven document on the quantities required)

Cementitious Materials

1. Supply of sand and sandbags
2. Other materials to build a wall

Appendix 3 – Research Report (Self Rescuers)

In 2003, the Health and Safety Executive produced 'Research Report 180 – Use of self-rescuers in hot and humid mines'- ISBN 0-7176-2788-8, prepared for HSE by Mines Rescue Service Ltd.

This report dealt with climatic chamber testing of fit mines rescue workers wearing a variety of filter self-rescuers (FSR) and self-contained self-rescuers (SCSR) in a series of medically supervised tests under hot and humid conditions. In an executive summary, the key results showed:

- In a range of fully saturated atmospheres between 27°C and 37°C all test subjects were withdrawn inside one hour of entering the chamber
- In some subjects, an increase in core body temperature of 2°C was observed after 30 minutes of exercise
- During the tests, exceeding a core body temperature limit (38.5°C) was the predominant reason for withdrawal
- Subjects self-paced themselves at between 2 to 4 km/h but in all cases, core body temperature continued to rise during periods of exercise
- Only limited cooling took place during rest periods
- The average total distance covered during the test runs was 1448m
- The maximum distance covered was 2350m
- The minimum distance covered was 590m
- Total distance covered was influenced strongly by chamber temperature
- Observed run-out times for SCSR varied (MSA SSR 30/100) from 10 to 25 minutes with equivalent distance covered of between 560m and 1400m; and
- The mean travel speed for the subject group was 3.3 km/h.

Appendix 4 – Limitation of CCBA

The following table uses wet and dry bulb temperature to allow mines rescue teams to estimate operating durations.

Mines Rescue - BG4 Self Contained Regenerative Closed Circuit Breathing Apparatus



WET BULB TEMPERATURE (°C)

DRY BULB TEMPERATURE (°C)														
24	26	28	30	32	34	36	38	40	42	44	46	48	50	
23	*	*	*	118	113	108	103	98	93	89	85	81	77	73
24	119	114	108	103	99	94	90	85	81	78	74	71	67	64
25		99	95	90	86	82	78	75	71	68	65	62	59	56
26		87	83	79	75	72	68	65	62	59	56	54	51	49
27			72	69	66	63	60	57	54	52	49	47	45	43
28			63	60	57	55	52	50	47	45	43	41	39	37
29				53	50	48	45	43	41	39	38	36	34	32
30				46	44	42	40	38	36	34	33	32	30	30
31					38	36	35	33	32	31	30	29	28	27
32					33	32	31	30	29	28	27	26	26	25
33						29	28	27	27	26	25	24	23	23
34						27	26	25	24	23	23	22	22	22
35							24	23	22	22	22	21	20	20
36							22	22	21	20	20	19	19	19
37								20	19	19	19	19	19	
38								19	19	19	19			

Appendix 5 – Typical Duties for Mines Rescue

Appendix 5(A) Mines Rescue Operative

Travelling to the Incident

1. Travel to their respective site (unless already on site) and collect a vehicle (ideally with mobile telephone hands-free and satellite navigation facility) and personal kit.
2. Contact the mines rescue providers rescue administrator before leaving site and provide an estimated time of arrival (ETA) at the mine.
3. Travel to the mine (note the mines rescue administrator will have the address and post code of the mine if required).

On arrival at the Mine

4. Confirm arrival to the mines rescue providers rescue administrator.
5. Report to Rescue Control.
6. Adhere to any specific request from the Rescue Officer.

On the Mine Surface

7. Report to the person in charge of the rescue room and prepare for deployment.
8. Carry out wearer's examinations on breathing apparatus.
9. Collect emergency checks, lamp and self-rescuer and any other relevant personal equipment.
10. Collect information relevant to the incident (location and nature, presence of people, etc).

On arrival at the Fresh Air Base

11. Carry out wearer's examinations on breathing apparatus and any pre use check on other equipment following requests of the Rescue Team Captain.

Beyond the Fresh Air Base and whilst operational

12. Carry out Dynamic Risk Assessment (DRA)C.
13. Carry out periodic checks on Breathing Apparatus.
14. Adhere to any instructions from the Rescue Team Captain.
15. Notify the Rescue Team Captain if unwell (physically or mentally) at any time.

On return to the surface

16. Return Breathing Apparatus to the Rescue Room.
17. Notify person in charge of the rescue room when leaving the mine.

Appendix 5(B) Mines Rescue Team Captain

Travelling to the Incident

1. Travel to their respective site (unless already on site) and collect a vehicle (ideally with mobile telephone hands-free and satellite navigation facility) and personal kit.
2. Contact the mines rescue providers rescue administrator before leaving site and provide estimated time of arrival (ETA) at the mine.
3. Travel to the mine (note the mines rescue administrator will have the address and post code of the mine if required).

On the Mine Surface

4. Ensure all team members have reported to the person in charge of the rescue room.
5. Lead team in checking breathing apparatus (wearers test including cylinder pressure gauge readings) and other associated equipment.
6. Have Mine Plan available and other key items (book, pen, watch, chalk, hygrometer, etc.).
7. Carry out and record required health checks and ensure team members are fit and well (physically and mentally).
8. Appoint the team Vice Captain.
9. Receive instructions/objectives from the incident controller.

On arrival at the Fresh Air Base

10. Report teams' arrival to person in charge of fresh air base.
11. Communicate with Incident Control/Rescue Officer.
12. Check Team members are fit and well (physically and mentally).
13. Check required equipment is available (including adequate communications).
14. Ensure pre use checks on Breathing Apparatus are carried out (Captains checks) and recorded.
15. Ensure team are aware of their roles (including Vice captain).
16. Understand location of back up team(s).
17. Take appropriate notes and mark planned route (Identifying search patterns) on the mine plan.
18. Synchronise watches and agree the objectives/task and the time back at the FAB.

Beyond the FAB and Whilst Operational

19. Carry out verbal Dynamic Risk Assessment (DRA) and ensure team members are safe.

20. Monitor environment (e.g., gas levels, temperature / humidity) and implement any operational time restrictions (e.g., CCBA operational wearing times).
21. Allocate tasks and supervise team.
22. Check Team members are fit and well (physically and mentally).
23. Record relevant information (e.g., team members CCBA pressure readings on BA pressure gauge cards (at intervals not more than 15 minutes), roadway conditions, environment, location of casualties, etc.).
24. Ensure routes travelled are clearly marked (chalk or light sticks).
25. Ensure Team members remain in line of sight of other team members.
26. Adhere to any instructions from Rescue Officer / Incident Control (may be communicated through FAB).
27. Ensure casualties are triaged (where there are multiple casualties).
28. Ensure any identified areas are fully swept and record areas searched on the mine plan.
29. Withdraw rescue team if it is deemed unsafe to continue rescue operations.

On return to the Fresh Air Base

30. Ensure team uncouple and oxygen cylinders are turned off.
31. Handover any casualties in preparation for them to be taken out of the mine.
32. Check team members are fit and well (physically and mentally).
33. Debrief oncoming team and Rescue Officer.
34. Complete the Record of Oxygen Pressure Cylinder Readings.

On return to surface

35. Visit Rescue Room and inform person in charge of rescue room of teams return.
36. Check and record Team members are fit and well (physically and mentally).
37. Complete the Captains Report which must cover events from going underground (or FAB if this is on the surface) to returning to surface must be:
 - a. Clear
 - b. Concise
 - c. Factual
 - d. In the order that the events occurred.
38. Retain the Record of Oxygen Pressure Readings.

Appendix 5(C) Mines Rescue Officer

Travelling to the Incident

1. Travel to MRS site to collect a mines rescue vehicle (preferably with mobile telephone hands-free and satellite navigation facility) and kit.
2. Contact the mines rescue providers rescue administrator estimated time of arrival (ETA) and then travel to the mine.

On arrival and whilst at the Mine

3. Confirm arrival to the Mansfield Administrator.
4. Report to Rescue Control.
5. Liaise with the on site rescue controller
6. Collect information relevant to the incident (location and nature, presence of people, known presence of major hazards, etc.).
7. Collect information that may impact rescue operations (e.g., isolations, heat/humidity, explosive atmospheres, transport availability).
8. Prepare for deployment (normally at the Rescue Room).
9. Ensure the Rescue Room is prepared and manned at all times.
10. Familiarise with the mine layout and ventilation system.
11. Liaise with Mine Staff to ensure any necessary isolations, ventilation changes have been made.
12. Brief and debrief Rescue Team(s).
13. Appoint the Rescue Team Captain and Vice-Captain.
14. Ensure FAB is selected and established (where necessary) in conjunction with Incident Control.
15. Liaise with Fresh Air Base / Rescue Team Captain.
16. Ensure a standby team is onsite prior to any team going beyond FAB (unless exceptional circumstances).
17. Control movements and rest periods of all rescue teams including back up teams.
18. Consider availability of Breathing Apparatus and other equipment.
19. Ensure any critical advice/instructions given are recorded along with a rationale for that decision. (This may be on the incident control log).
20. Assist in arranging additional resource (if incident is ongoing).

Prior to leaving the mine

21. Brief any oncoming Rescue Officer.
22. Provide update to the mines rescue providers rescue administrator.

Appendix 5(D) Person Taking Charge of the Rescue Room

Note: the person taking control of the rescue room may not be required to be a mines rescue officer. However, if this person is not a competent mines rescue officer, certain responsibilities will need to be fulfilled by a mines rescue officer. These requirements are identified in ***bold/italic***.

1. Ensure that the rescue room is manned at all times.
2. Maintain the rescue room log.
3. ***Assemble the rescue personnel into teams (considering mutual aid agreements and familiarisation of the mine). This may need discussion with the mine staff to ensure the correct selection is made.***
4. ***Issue the Rescue Team Captain with a copy of the mine plan.***
5. Where appropriate and in liaison with the mine, allocate someone to act as a guide, this may be the Rescue Team Captain or Vice-Captain if they are familiar with the site.
6. Consideration to be given to the use of a guide for as far as the fresh air base. This person may not need to be able to wear BA but must have a suitable escape BA (self-rescuer).
7. Allocate breathing apparatus and other equipment to each person (the Rescue Team Captain may do this if necessary).
8. Collate information for briefing and debriefing teams in conjunction with the Rescue Officer.
9. Maintain welfare requirements of the rescue room.
10. Communicate with the Rescue Officer.

Appendix 5(E) Person Taking Charge of the Fresh Air Base

1. Establish the fresh air base.
2. Ensure a communication system is set up with Incident Control.
3. Establish a communication system is agreed with the deployed Rescue Team.
4. Agree with Incident Control/Rescue Officer and Rescue Team Captain, the objectives/task and time of return to FAB for the deployed rescue team.
5. Maintain a log of:
 - a. Instructions and information received along with the time of that instruction
 - b. Names of all persons and rescue teams arriving at the fresh air base
 - c. Time that team performs standby duty
 - d. Time that team becomes operational
 - e. Time that team returns from operational duties
 - f. Time that team leave the FAB to return to the surface.
6. Establish equipment storage area and ensure appropriate equipment is available at the FAB and is tested before use.
7. Confirm with the Rescue Team Captain wearers Breathing Apparatus examinations have been carried out before the team proceeds beyond the FAB.
8. Maintain communication with the deployed Rescue Team.
9. Provide and receive key information to and from Incident Control (Noting log requirement in point 3).
10. Debrief the rescue teams on return to the FAB.
11. Ensure casualties are transported out of the mine.
12. Ensure any welfare requirements are met.

Appendix 5(F) Mines Rescue Provider – Rescue Administration

Immediately on Receipt of Any Call

1. When an emergency call is received, follow the process as described by the specialist rescue provider.
2. Complete any required forms or record relating to the mines rescue incident and the nature of the response requested.
3. Record all incoming and outgoing messages in the emergency log.
4. If the driver of the Rescue Vehicle is not arranged within 30 minutes of the initial emergency call, escalate the issue.
5. Contact the mine operator rescue workers. (it should be noted that mine operators may on occasion have their own systems to trigger an immediate local emergency response, however the provider should continue to maintain a secondary system.)
6. Arrange to contact the specialist rescue provider to ensure that teams are available to support the operation.
7. Secure technical assistance as soon as practicable.

Whilst Teams are Travelling

8. Continue to liaise with the Rescue Officer, the vehicle driver and other key personnel to ensure:
 - a. The Rescue Officer is travelling to the incident
 - b. The rescue vehicle has a designated driver and is travelling to the incident
 - c. Where necessary, the rescue operatives are identified and travelling to the incident.
9. Provide updates to the teams and personnel travelling.
10. Provide updates to the mine operator through their designated communication routes.

Appendix 6 – References

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4. *Escape and Rescue from Mines Regulations 1995 (Approved Code of Practice)*
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