Natural Resources, Mines and Water

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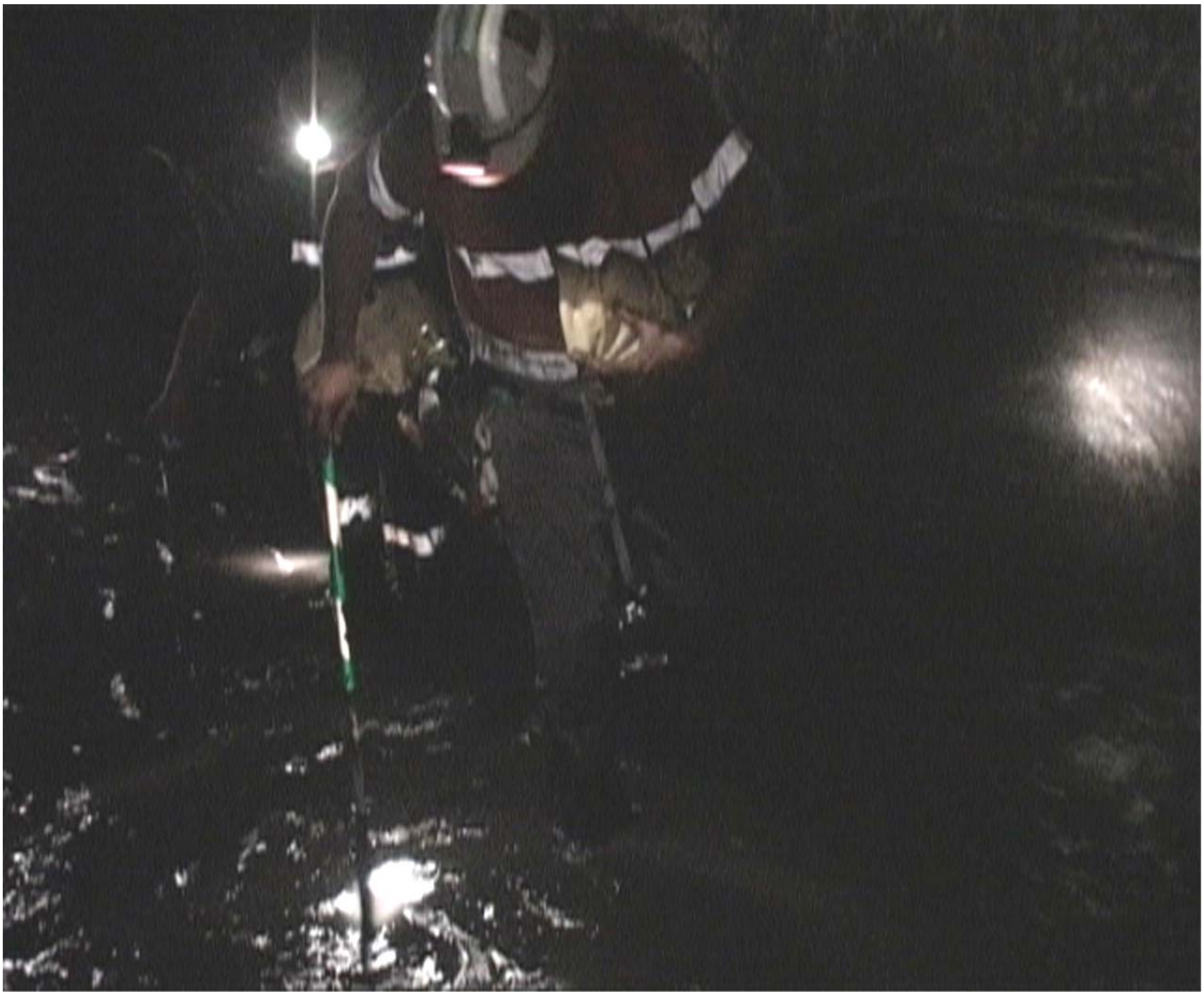
2006 Level 1 Emergency Exercise

Broadmeadow Coal Mine



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Executive Summary

Martin Watkinson

The 2006 Queensland Level 1 Emergency Exercise was initiated at Broadmeadow underground coalmine at 11:28 am on Monday, 17 July. Broadmeadow mine is a longwall punch mine located 30 km north of the Moranbah township, 190 km south west of Mackay, Central Queensland (Figure 1).

Figure 1 - Location Plan

On the date of the exercise the longwall was around 7 cut-through; some 450 m from the open cut portal. The exercise scenario was based on a fire in the intake(s). Other issues incorporated in the scenario included smoke accumulation in the open cut and recirculation into the mine workings.

Objectives

The objectives of the exercise were to test:

1. Self escape including changeover process for self contained self rescuers (SCSRs),
2. Fire fighting procedures and first response,
3. Incident management team (IMT) process,
4. Mine interaction with outside agencies particularly police and hospital,
5. Queensland Mines Rescue Services (QMRS) response, and
6. Interaction with media.

Another objective for the exercise committee was to develop a draft Recognised Standard for the Conduct of Emergency Exercises (an update of the previous Approved Standard QMD 96 7393).

Scenario

In order to create an evacuation scenario to test underground personnel a simulated fire in the intakes was coupled with a roof fall at the tailgate (T/G) end of the face preventing egress, forcing the men to evacuate inbye and undertake several changes of self contained self rescuers (SCSRs).

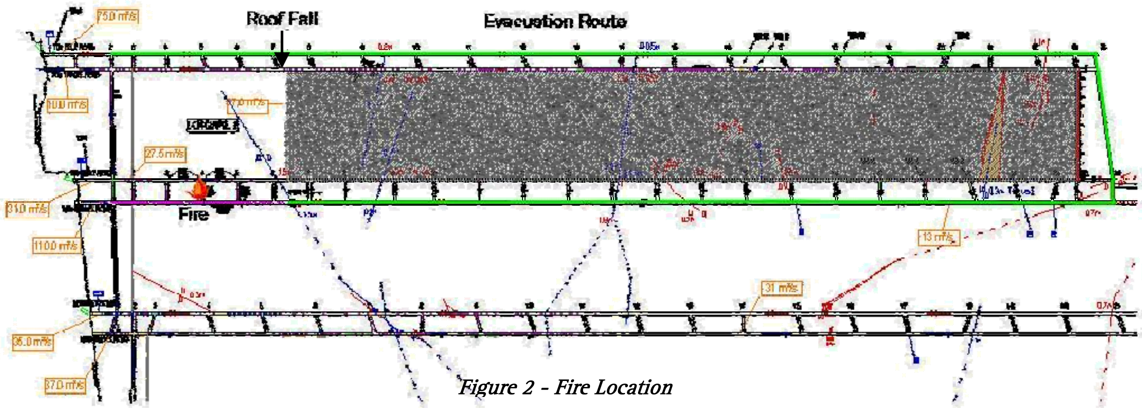

Figure 2 - Fire Location

The scenario for the exercise was based on a major fire on the hydraulic pump station and transformer in 4 cut-though in the maingate (Figure 2). The "fire" was caused by a catastrophic failure of the pumps/transformer and the burning oil and subsequent coal fire prevented egress out to the surface along the conveyor and travel road. The tailgate fall prevented egress through the longwall and along the tailgate roadway(s). Ventilation modelling was undertaken to predict the anticipated spread of smoke through the mine. The mine's Safegas (gas monitoring system) was duplicated for the exercise to enable the mine to have access to 'real time gas monitoring information' for decision making.

A total of 17 assessors were on site with representatives from Simtars, mines inspectorate (Queensland and New South Wales), Department of Natural Resources, Mines and Water (NRMW), mines rescue (Queensland and NSW), Industry Safety and Health Representative (CFMEU), Minerals Industry Safety & Health Centre (MISHC), mine staff from Queensland mines including mine managers and a ventilation officer, a mining engineer from Solid Energy (New Zealand) and two mine site representatives (moles) (Appendix 5)

The mine had an emergency response/escape system based on a primary escape route along the maingate travel road, secondary escape route along the maingate conveyor belt road and exit along the tailgate as a third route. The cache systems in these three roadways were established and fully covered all the personnel in the longwall panel. However inbye of the longwall there were limited SCSRs (7 in each cache).

The fire was deemed to have stabilised for the purposes of the exercise and all gas readings available to the mine staff indicated that the atmosphere inbye of the fire was not explosive. This was to encourage an initial fire fighting (first) response mines rescue deployment for supplementary/continued fire fighting and any search and rescue that may be required.

When the exercise commenced at 11:28 there were 10 personnel in the longwall panel. This team decided to evacuate inbye around the back of the longwall goaf where there were only caches containing 7 self rescuers.

At the conclusion of the exercise 7 personnel had successfully escaped to the surface and the other 3 were "fatalities". Underground mineworkers need to be fully aware of their escape routes and any limitations that may be placed on their possible escape in an emergency situation.

Broadmeadow mine has been under intense scrutiny by the Queensland mines inspectorate over a number of issues for the last 18 months.

The mine has made improvements in all of these areas. Positive feedback on the improvements made to date was given to the mine at the formal debrief for all parties involved in the exercise held at the mine on Tuesday, 18 July 2006.

Broadmeadow has identified areas for improvement in its emergency response systems and is actively working on refining its emergency response system.

It is disappointing to report:

- There was no first response.
- Underground personnel had major issues with changeover of SCSRs and still try to talk when wearing a SCSR.
- The mine's incident management response was ineffective.

However, this is consistent with the reports from previous Level 1 exercises (Appendix 2).

Recommendations

Three major recommendations from this report are that all mines need to focus on and address the critical issues of:

1. **First response**
   Industry needs to seriously address the issue of first response by clearly identifying what a first response team is expected to do i.e. fight a fire plus any other identified duties and what equipment they require. This will also mean that intensive fire fighting training and other associated training will be required. This should be undertaken as soon as possible, particularly as many mine sites (Broadmeadow included) do not permit the lighting of fires on site.

2. **Change over protocols and training in the use of SCSRs**
   Training in donning and use of SCSRs needs to be addressed as indicated by previous level 1 exercises, and highlighted in recent forums in the USA (see Appendix 3). It is recommended to industry that a similar competency based training regime to that proposed by the USA mining industry (at refresher intervals of 3 monthly) is implemented as well as ensuring that all mineworkers have used a real SCSR or a training rescuer that has simulated heat and resistance capabilities.

   Not only should training in the use of SCSRs be reviewed, but also the option of installing "change-over" stations, or equivalent, where escaping mineworkers can change over the SCSR in a less hazardous atmosphere, communicate with surface and also have the option of remaining in the station for a period of time.

3. **Incident management process**

In recent years the mining industry has started to adopt the Incident Control System (ICS) Training provided by the Queensland Fire and Rescue Service or the mining version called Mine Emergency Management System (MEMS). Mine sites need to clearly evaluate which system they are going to utilize to cope with emergency response (including the conventional systems already in place). Each mine must then ensure that their staff are trained, practiced and competent to fulfil their roles and responsibilities as identified in their own system.

The draft recognized standard for the conduct of emergency exercises will be available for comment in August 2006.

The 2007 Queensland Level 1 Emergency Exercise will be held at Grasstree underground coal mine.

Martin Watkinson
Chairman
Exercise Executive Committee

Major Recommendations

All of the recommendations within this report need to be evaluated to see if they are applicable at your own mine site. Simple recommendations such as the “wind chimes” to assist in locating cache’s are cheap, easy to install and can have a major impact on the evacuation process.

Training

Training in donning, use and changeover of SCSRs has been an issue raised in the outcomes of the Queensland Level 1 Emergency Exercises since the inaugural exercise at Southern Colliery in 1998, as well as in recent forums in the USA (See Appendix 3).

Each year the level 1 exercises, and presentations on such, have highlighted that a significant number of mineworkers escaping from simulated scenarios would have suffered from the effects of breathing contaminated atmosphere whilst wearing or changing SCSRs.

> “After conducting the series of studies on donning proficiency, the U.S. Bureau of Mines and the University of Kentucky researchers also concluded in 1993 that a better training system for donning SCSRs was needed (Vaught, et al., 1993). The “3 + 3” donning method improved donning proficiency, but did not eliminate the problem of skill degradation.....
>
> In this study, 88 miners were trained in the “3 + 3” method until they could proficiently don the SCSR. A week after receiving the training, 32 of these miners were randomly selected to test their SCSR donning skills. In this test, most of the miners could still put on an SCSR proficiently. After 90 days, another sample group were chosen for testing. In 90 days the proficiency rate dropped from 80 percent to about 30 percent.”
>
> “The new requirements increase the frequency of SCSR training from annually to within every 90 days and include hands-on training in the donning, use and transfer of self-rescue devices as part of the regular mine emergency drills.”

It is recommended to industry that a similar competency based training regime to that proposed by the USA mining industry (refresher intervals of 3 monthly) is implemented as well as ensuring that all mineworkers have used a real SCSR or a training rescuer that has simulated heat and resistance capabilities.

Such training MUST reinforce that talking whilst wearing SCSRs may be fatal in atmospheres containing noxious and toxic gases.

It is recommended that some of the mineworkers who wore real SCSRs assist in the development of a presentation for all other mineworkers on-site on the experience and effects of wearing a SCSR in limited vision. This could also be used industry wide.

Change-Over Stations

As described above, during a number of the previous level 1 exercises a percentage of mineworkers have failed to effectively change-over their SCSRs.

Air curtains at strategic points (simple brattice cloth tents using ring fed compressed air in the air curtain) or well-designed change-over stations similar to some current "refuge chambers", including in emergency breathing apparatus (EBA) cache areas, would have helped safeguard workers during the SCSR change-over process or facilitate refuge for those in difficulty.

Such change-over stations would allow for mineworkers to rest, change their SCSRs in fresh air, plan their method and route of escape, as well as a last resort, leave any injured persons who cannot travel to await rescue. Industry should consider whether to look at these on a mine by mine basis as part of the emergency response management plan or by legislative requirement for their installation and use.

Communication during Escape

The issue of communication once persons have donned their SCSRs has been an issue since SCSRs have been introduced into the mining industry and this was once again highlighted by "experienced" mineworkers, including rescue trained personnel attempting to use phones and talk with each other when making decisions regarding escape strategies whilst wearing a SCSR.

Serious consideration should be given to providing a SCSR (or equivalent) with a face mask that would allow communication. This does not necessarily mean for every worker, but of a sufficient number to facilitate reasonable communication.

Guides and Caches

A number of issues regarding life lines, position of SCSR caches and signage have been identified during this and previous level 1 exercises. Escape in poor visibility should be considered when developing evacuation systems.

Consideration should be given to installing a pull down lifeline (on bungee cord) with directional cones, positioned above the wheel ruts, which formed a natural track.

Consideration should also be given to supplying simple hook on ropes in each EBA cache, or training in an alternative hook on method such as using the cap lamp cables (each person hooking on the lamp of the person behind—forming a chain to minimize persons being separated whilst evacuating).

Consideration should be given to attaching some type of chime (like a wind chime) to a lifeline or similar device, which would be activated by the movement of people as they approach the cache.

People would then hear that they are in the vicinity of the cache. The device, being mechanical, is not reliant on an external power source.

A number of caches were located in the cut-through's in differing positions and, in low visibility, were difficult to find and increased angst amongst the escaping mineworkers.

It is recommended that cache layouts within the mine be standardised and lifelines provided which lead directly to the cache box.

First Response

Where mines rescue response has been called out as part of the level 1 exercises, the average time taken for teams to be on–site has been approximately 2 hours. In addition to this, in the majority of exercises, the time to deployment at the site of a simulated fire has been approximately another 3 hours, making a total of five (5) hours since the incident was initiated.

Note that first response does not need Queensland Mines Rescue Service (QMRS) approval, but, if required at a mine, the system should state the mine's standard for minimum requirements for equipment, personnel and communications.

In the scenario presented during this exercise where some persons were not able to escape through the bleeder, quick initial response to at least minimise the extent of the fire may have allowed such mineworkers to escape out the maingate 1 headings.

Initial response by persons in the immediate area who can assess the hazard and safely take some action, followed by first response by adequately trained and equipped mineworkers from the mine is a must if we are to assist persons who are inbye or have their escape ways affected by the hazard.

The Coal Training package (MNC04)[1] contains three units of competency[2] for mine emergency response training, developed as a result of Moura Taskgroup 4 Training Subcommittee.

Training and assessment packages for these units should be developed and training in at least the first response sections of these implemented as a matter of urgency across the Queensland underground coal mining industry.

1 MNC04 Coal Training Package

2 MNCU1037A Escape from hazardous situation unaided; MNCU1038A Provide aided rescue to endangered personnel; MNCU1039A Respond to inseam incident

Scope of Exercise

The scenario for the exercise was based on "major fire" on the hydraulic pump station and transformer in 4 cut-though between the travel road and the homotropal conveyor road and a roof fall in the tailgate preventing travel through the anticipated egress routes.

The only available escape route from the longwall was now around the back of the longwall through the 'bleeder' where there was a cache system based on 7 SCSRs. When the exercise was planned the mine development schedule provided indicated that longwall block 2 would be interconnected - this would have enabled an escape route out via maingate 2 travel road as well as access for mines rescue. It was planned that the normal complement of men would be on the longwall and with associated contractor staff between 20 and 30 persons would have been involved inbye of the "fire".

The mine had made a decision to not produce on dayshift and the longwall crew was on the surface involved in risk assessments in preparation for the recovery and relocation of the longwall to panel 2. This meant that on the day of the exercise the underground team trapped inbye of the fire consisted of 10 contractors involved in routine underground tasks. These 10 missing mineworkers made the decision to evacuate via the longwall bleeder and were not aware or did not recognise the issue of the limitation of caches containing 7 self rescuers.

The underground assessors did not let all 10 mine workers evacuate along this roadway as it would have compromised their safety. Only 7 mine workers evacuated along this route with 3 assessors, the other 3 mineworkers remained at the maingate crib room (meeting station) with 2 assessors. The 3 assessors travelling with the evacuees were covered by 3 additional SCSRs which had been placed at each cache in the bleeder road.

As a result of this decision made by the 10 evacuees and the fact that no effective first response/fire fighting response was made three of the evacuees were identified as casualties/fatalities.

All 10 mine workers (evacuees) wore real SCSRs and underwent at least 2 real change overs and valuable lessons and issues were identified as a result.

Video footage was taken underground covering the evacuation process and is included at the back of the report. A copy will be also be forwarded with any electronic copies of this report.

Figures 3-8 show the anticipated spread of smoke around the longwall panel as modelled in the mine ventilation simulation model. Figures 9—14 show the possible smoke accumulations in the open-cut and Figure 15 shows actual smoke accumulation in the cut from a vehicle fire incident at the mine.

Gas concentrations throughout Longwall 1 in areas affected by the fire were identified as:

CO	3400 ppm
O_2	9.5 %
CH_4	0.06 %
CO_2	1.0 %

This mix is not explosive but is toxic. Whilst in real life any fire which was not addressed would have grown to an extent that would probably require the sealing of the mine. The intent was to enable the mine to activate first response and mines rescue response.

Anticipated Smoke Spread Through Longwall Panels

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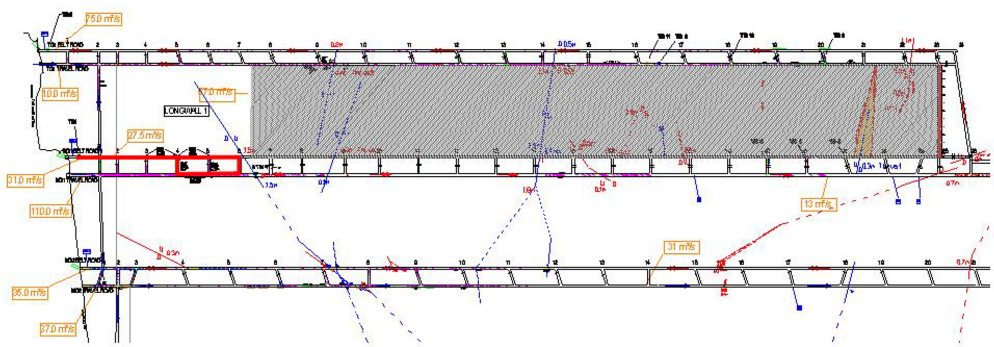

Figure 3

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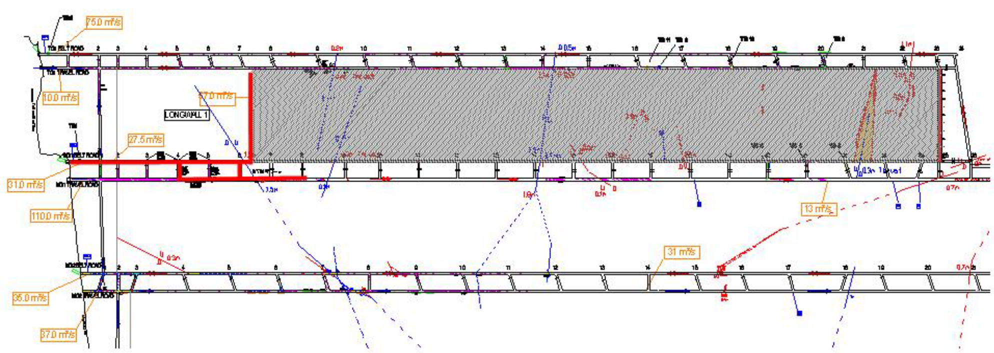

Figure 4

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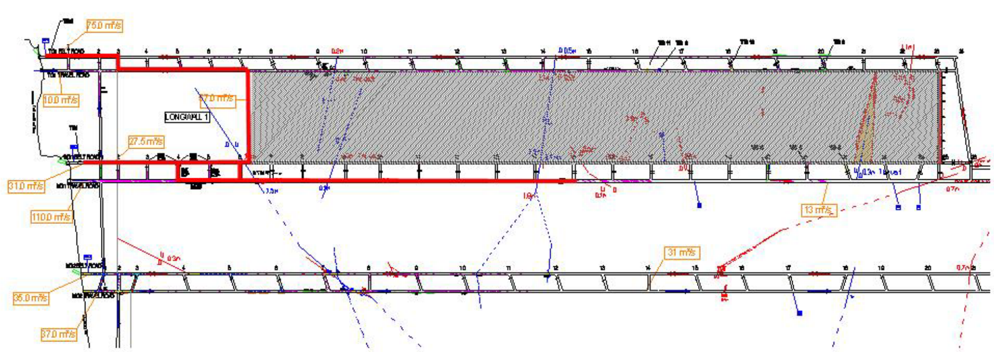

Figure 5

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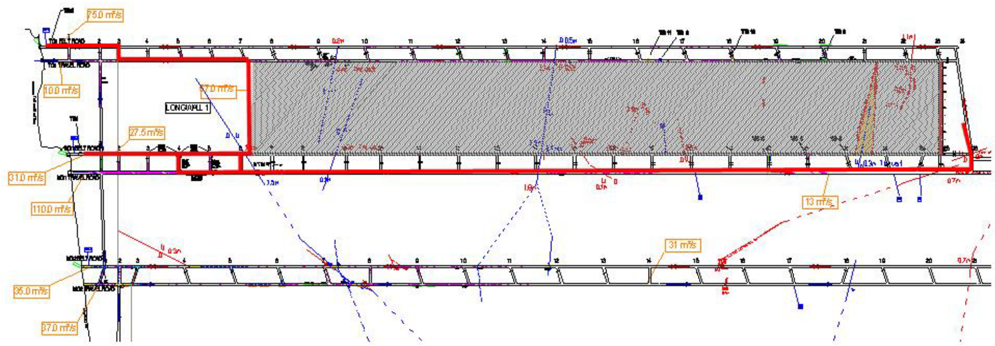

Figure 6

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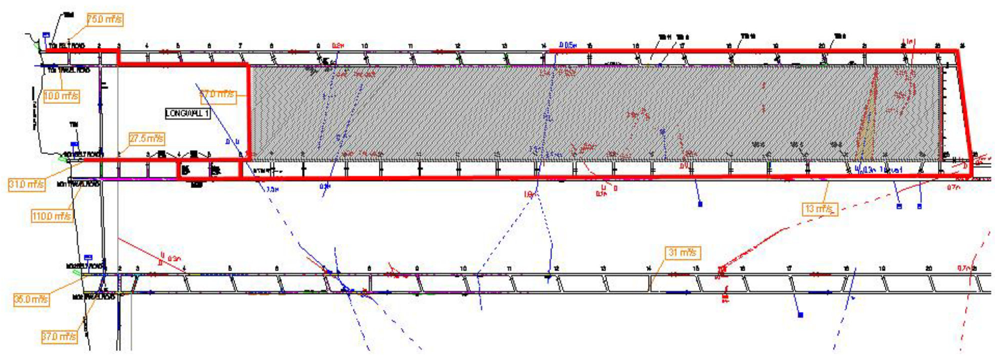

Figure 7

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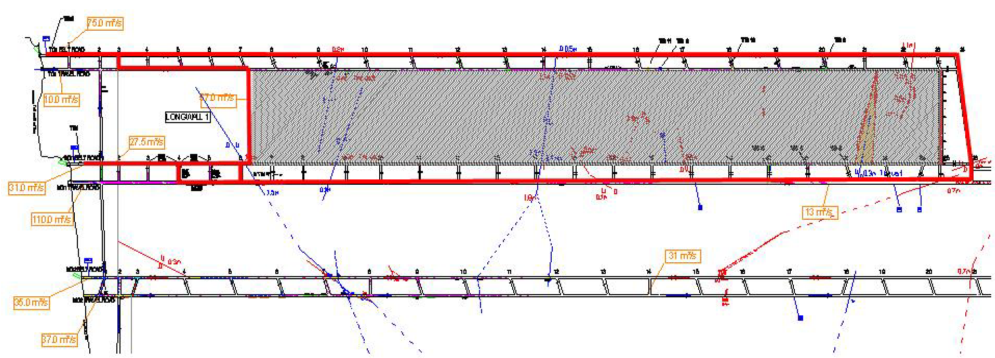

Figure 8

Smoke Accumulation

Figure 9 - Simulated smoke – incident initiation

Figure10 - Simulated smoke – 2 minutes after initiation

Figure 11 - Simulated smoke – 10 minutes after initiation

Figure 12 - Simulated smoke – 45 minutes after initiation

Figure 13 - Simulated smoke – 60 minutes after initiation

Figure 14 - Simulated smoke – 120 minutes after initiation

Figure 15 - Actual vehicle fire – Broadmeadow Coal Mine

The "Windchime"

Lachlan Cunningham

The introduction of the wind chime was in response to a suggestion from one of our newly recruited miners (so much for experience!), who took part in an internal evacuation exercise. We have a system of life lines to our change-over stations (COSs) with directional cones; we also have a flashing beacon outside each COS. Our change-over stations have a borehole to the surface positively fed by a surface compressor. There are sufficient face masks in each COS for every person underground to be fed by the compressor. We also have a cache of SCSRs at each COS for a full evacuation of the mine.

One miner could not detect the flashing beacon at the COS when wearing his smoke goggles. There was some discussion on audible alarms, which usually need some sort of power source, but this was thought to have limitations. It was then that the chime suggestion was forwarded. We bought a cheap one for trial at the $2 shop, but this got pinched after a few days. We made one up in the workshop, but the pipes were too thick and it did not resonate loudly enough, so we got some high grade steel exhaust tubing and made one up, which apparently works well. We don't attach the chime to the pull down rope directly, but from a side rope, which moves with the pull down life line.

The chime works in two ways:

1. Our COSs are in the main intake airway (primary escape route) and the ventilation velocity makes the chimes sound, so anyone in the vicinity can hear where the COSs are.
2. Should there be a shutdown or loss of ventilation, people using the lifeline cause the chime to move and resonate, indicating proximity to the COS.

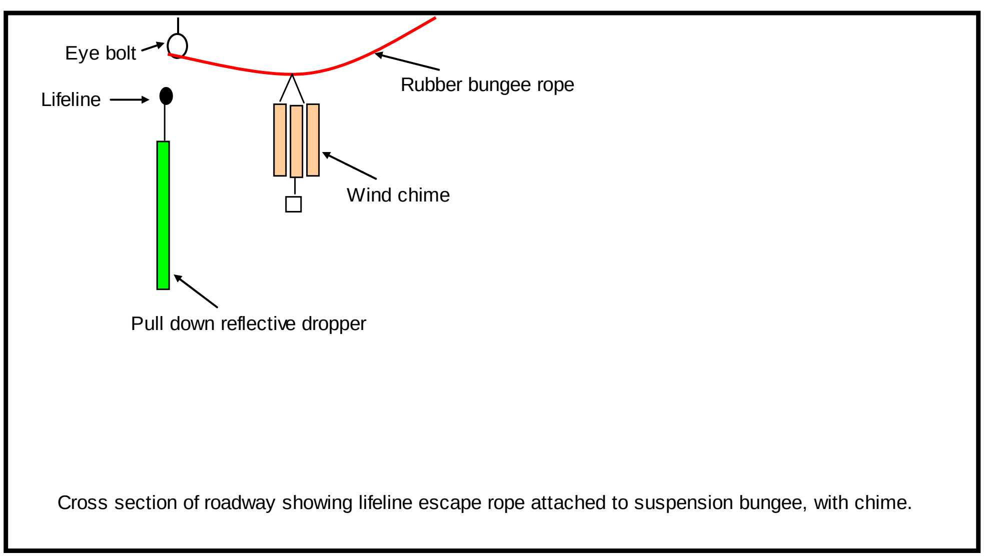

Figure 16 –Wind Chime

Underground Section

Longwall Evacuation

Greg Dalliston, Chris Gilbert, Lachlan Cunningham, Dave Macpherson & Alex Neels

This section of the report records the actions of the workers in the longwall panel, inbye of the fire area. It notes the assessors' views of the positive and negative aspects highlighted during the exercise and provides recommendations where considered appropriate.

The workers in the longwall area (2 on the face, 3 in the tailgate and 5 in the maingate) were pre-briefed that an exercise was imminent and that they were to react to the information provided and would be monitored throughout the duration of the event.

The exercise was triggered underground at 11:28am when the two men on the face were told of the fall in the tailgate. Their immediate reaction was appropriate as they went to investigate. At the closest DAC unit (communication unit) (chock 40), they informed the control room of what had happened and of their intention to investigate. At 11:30am they were informed by the assessor that light smoke had now reached them from the maingate. The two men decided to return towards the maingate and attempted to contact the control room of this latest development. They received information via the control room that smoke was also on the face. They made an appropriate decision to don SCSRs at this point. The control room official instructed them to go to the crib room. The two men made directly for the crib room, via the travelling way, to find a number of men busy donning SCSRs (they then donned SCSRs especially provided for this exercise). As they arrived after the other workers had donned their SCSRs there was no communication. They followed the other workers as they made their way through to the belt road. An attempt was made to count the numbers in the group. They came up with (variously) one or two short. There was no effort to check if all people from the area were together, and also no knowledge of how many people were in the area.

The next 30 minutes was characterised by total confusion as there was no clear leadership established at the outset. Communication was very poor, with a number of workers trying to speak with the SCSR mouthpieces in, and people at the back of the evacuation line were unaware of what was happening at the front. No attempt was made to get everyone into a circle and communicate using notes or alternative methods.

It was noted that a number of attempts were made to exit via the belt road and the travelling way, even though they had been made well aware that these routes were impassable due to heat. The workers had been made to don smoke goggles after donning their SCSRs, which made visibility difficult.

The deputy (ERZ controller/supervisor), who was one of the late arrivals, and thus not privy to all the initial information, suggested exiting via the face to the tailgate. This was countered by one of the men from the face who indicated that the route was closed by a fall.

At this point it was clear that the workers were trying to talk with their mouthpieces in and would have been seriously affected by noxious gases if this was a real incident. An assessor had to instruct them not to talk with their mouthpieces in. The muffled talking did not cease completely, but reduced significantly.

To assist in determining if mine workers were experiencing any leakage at the nose or mouth whilst wearing SCSRs the assessors used an orange fragrant natural based spray. A number of mineworkers who had been wearing a SCSR admitted to experiencing tasting this.

A suggestion was made to use a vehicle to drive to the double ventilation doors, between 7 and 8 cut-through. The assessors at this point reduced visibility further (simulating increased smoke density) by making all but 1 worker turn their cap lamps off. The lone lamp was turned to dim. At this point the decision was made by the group to abandon using the vehicle and walk inbye to the doors. The workers all collected a spare SCSR from the cache at 5 cut-through, collected a 'blind mans stick' and formed a human chain. This chain was erratic with a couple of people not 'hooking on'.

One person 15 metres in front, 8 joined by placing one hand on the shoulder of the person in front, then two individuals 5 metres apart at the rear.

It is recommended that whenever possible mine workers utilize underground transport for evacuation purposes.

Approximately 30 minutes had elapsed since the exercise was triggered. This was the first indication of an organized and singular plan of escape. It was strongly felt that the inability to communicate was paramount in this initial period of confusion and lack of direction. Serious consideration should be given to providing a SCSR (or equivalent) with a face mask that would allow communication. This does not necessarily mean for every worker, but of sufficient numbers to facilitate reasonable communication.

The group started towards the ventilation doors, behind the face in the travelling road bleeder. The last man in the group, after passing cut-through 6, became completely disorientated (due to a change in the feel of the ventilation) left the group and proceeded in the opposite direction, only to stop again 20 metres outbye and turn back inbye. He later stated that he thought the change in ventilation flow (cut-through 6 was the closest to the face line) was because he had walked into a cut-through. At this point he decided to change over his SCSR. This change over was confused, with the 2nd unit being donned before removing the straps of the first. He had to take the 2nd unit off before removing his initial unit, and then put the 2nd unit back on. This required removing the mouthpiece a number of times. This complicated change could have had serious consequences. Consideration should be given to providing an air curtain at strategic points for changing SCSRs (using ring fed compressed air in the air curtain).

Training in the donning and use of SCSRs needs to be addressed as indicated by previous level 1 exercises and as highlighted in recent forums in the USA (Appendix 3). It is recommended to industry that a similar competency-based training regime to that proposed by the USA mining industry is implemented (refresher intervals of 3 monthly) as well as ensuring that all mineworkers have used a real SCSR or a training rescuer that has simulated heat and resistance capabilities.

At this point the evacuees split into two groups as it was not possible to allow all 10 to travel inbye of the airdoors due to the limited number of SCSRs (7) in the caches. The section of the report titled Longwall Bleeder Evacuation follows the evacuation process of the 7 evacuees who travelled out to the surface via the bleeder road, with the remaining 3 evacuees detailed in the Additional Longwall Evacuees part.

Strengths

- Non-verbal communications with control room was good.
- Housekeeping was generally good.
- Blind man's sticks were a major benefit and important in low visibility.
- Mines rescue procedures were well handled during the checking of the men in the crib room and the report to control room operator.
- Human chain between crew members to assist with egress worked well.

Opportunities to Improve

- Changeover from MSA Lifesaver 60 was extremely poor.
- Issues with donning of the rescuer, implying lack of familiarity with process.
- The quality of rescuers was variable, e.g.
  - Issues with nose clips e.g. slipped off (incorrect tension?)
  - Issues with neck and waist straps e.g. entanglement, unable to adjust
  - Issues with mouthpieces e.g. sharp edges, poor shape
  - Issues with goggles e.g. round shape fit better than oval, some had poor visibility.
- No general pit call to evacuate.
- Several PEDs were not working (blank screens, half screens).
- No non-verbal communication was attempted – all communication between team members was by talking through the rescuer.
- No defined leader – crew was a mixture of contractors and BMA maintenance tradesmen.
- No accurate account of people made – count varied less 1-2 people of actual numbers.
- Transport was not used.
- Instructions to carry six self rescuers and evacuate via the bleeders was impractical.
- Some specific DAC questions from control room were poorly phrased e.g. "Do you know if the transformer is on fire?" yes/no? "no" answer led control room operator to think that the transformer was not on fire.

Recommendations

- Protocols for donning and changeover of SCSRs to be reviewed and appropriate training given to all personnel.
- SCSR training to include information on non-verbal communication and the dangers of talking through rescuers.
- Workforce to review footage of self-rescuer changeovers from the exercise as a learning tool.
- Review time frame for removal of MSA Lifesaver 60.
- Review maintenance of PEDs and remove faulty PEDs from service.
- Review control room operator evacuation procedures to include a general PED message to all personnel required to evacuate.
- Review training of statutory officials (and other personnel that may be required to lead in an emergency e.g. rescue personnel, leading hands) to include decision-making, leadership, communication and accounting for personnel.
- Develop a standard evacuation protocol that includes:
  - Use of transport
  - When to change rescuers
  - Non-verbal communication
  - Route of travel

Longwall Bleeder Evacuation

Greg Dalliston, Chris Gilbert, Lachlan Cunningham

The main group changed over SCSR units between the ventilation doors. This was apparently an arbitrary decision by the first man through the doors, with other members of the group following his lead. The group was only one cut-through away from the next EBA cache for change over.

The change over was done in darkness with the effectiveness of change ranging from good to very average. A couple of mineworkers let mouthpieces fall out and others were slow to replace nose clips. Almost half the group would have been affected by the simulated atmosphere of 3400 ppm CO.

On later discussion with the 7 evacuees regarding the decision to change when they did, they believed because of the heat that their SCSRs were nearly extinct. Assessors informed them that they were at approximately 20 minutes and still had approximately that duration left.

The evacuation group was followed inbye by the assessors and it was noted that when the assessors dimmed their lights the pace slowed considerably and the group lost contact with the rib side when passing cut-throughs and wandered towards the centre of the road. Confusion was obvious. Consideration should be given to installing a pull down lifeline (on bungee cord) with directional cones, positioned above the wheel ruts, which formed a natural track.

It was observed that on one occasion the group all but missed an EBA cache as some of the dropper markers were missing and signage was visual, which does not help in poor or zero visibility. Consideration should be given to attaching some type of chime (like a wind chime) to a lifeline or similar device, which would be activated by the movement of people as they approach the cache. People would then hear that they are in the vicinity of the cache. The device, being mechanical, is not reliant on an external power source.

The evacuees were offered the opportunity to work their activated SCSRs right to the end so they could gain this experience. Very positively, the majority of workers chose to continue wearing the units till they were completely used or until it became very uncomfortable. In reality they would have donned a spare unit.

It is recommended that some of this group assist in the development of a presentation for all other mineworkers on site on the experience and effects of wearing a SCSR in limited vision. This could also be used industry wide.

On reaching the bleeder road at the rear of the longwall panel the group were allowed to turn on their lamps for safety reasons. The thick mud in this area was a hazard. The main group stayed together, hands on shoulders, but one member of the group refused to enter this roadway, thinking it was a stub heading. It took approximately 20 minutes for everyone to traverse this road. In zero visibility this would have been virtually impossible.

The mud and water was well above knee level and it was noted from tide marks on the rib that the water had been dropped by approximately one metre. We were informed that this roadway had been pumped down recently and that a small boat, observed in the mud, was used for people controlling the pumping efforts in this area. This road would have been virtually impassable under the simulated conditions with potentially drastic outcomes.

Cleaning and pumping in escape travel routes has been identified as an issue in previous exercise reports, primarily in the 1998 Southern Colliery report. It is recommended that all mines conduct an audit of their evacuation routes to identify and rectify any defects that may be found.

The progress up the tailgate road was done using smoke goggles only as all the SCSRs had expired. The roadway conditions were reasonable, with a few areas of rib requiring attention. The EBA caches were well spaced, but lacked a systematic layout, so finding the boxes containing the SCSR would have been confusing.

It is recommended that cache layouts should be standardised and lifelines provided which lead directly to the cache box.

PED messages were received by a number of the workers in the tailgate area. This was a positive feature and prompted one of the group to contact the control room using the DAC unit on reaching the tailgate portal.

A signal system was suggested by the control room official, which although not perfected, was a very positive action. This action allowed limited communication between the workers and control. The workers communicated once further, using a DAC unit on the surface belt, before deciding to use a vehicle found at the maingate area to exit the pit.

The group was then marshalled to a number of people tasked with debriefing. They were also given a limited medical visual examination and questioned as to their well-being. No up-date on the current emergency status was given to the evacuees. No clear and coordinated briefing was given to this group of what the following expectations were—they were individually briefed and shown to a room where they were checked on from time to time. They were allowed to shower and re-group in a designated room. After the debrief by a psychologist from the EAP programme the group were allowed to leave site. The last phase of dealing with this group seemed disjointed and no-one from authority addressed the group.

General Comments

After the group donned their SCSRs there was no longer an effective method of communicating with surface. The group were no longer under the advice of surface control and were effectively at the mercy of their own training, decision making, facilities and equipment put in place by the mine. As was seen, the first 30 minutes were wasted in confused activity before an escape route was decided on. During this initial period the fire would have been accelerating and the options for escape would be becoming more difficult. One clear means of assisting those workers trapped inbye of the fire would be to limit the extent of the fire (first response), as immediate rescue was impossible. This focus would have been of great benefit. The group would have, in all probability, made it to the inbye end of the longwall panel, approximately 1 hour 30 minutes after the initial incident.

If the fire had been contained within this period, the problems experienced traversing the area of thick mud behind the face may not have been such an issue. This is considered to be a critical element in assisting those in the process of a difficult evacuation to succeed.

The only real influence rescuers would have had on the group was in changing the environment (smoke and fumes) to which the workers were exposed, and the time period of such exposure.

A lifeline system would have been of great benefit as the roadways were generally in good condition, and a speedier and easier escape may have been facilitated. Direction into the EBA caches would have also been improved with a lifeline.

Workers had collected and were carrying a 2nd SCSR unit in their hand. This was a sensible action, but made hooking on to a persons shoulder (as observed) whilst carrying the 'blind mans stick' very difficult. Consideration should be given to supplying simple hook on ropes in each EBA cache, or training in an alternative hook on method, such as using the cap lamp cables (each person hooking on the lamp of the person behind—forming a chain).

Air curtains at strategic points (simple brattice cloth tents), or well designed change-over stations similar to some current "refuge chambers", including in EBA cache areas, would have helped safeguard workers during the SCSR change-over process or facilitate refuge for those in difficulty. Such change-over stations would allow for mineworkers to rest, change SCSR in fresh air, plan their method and route of escape and, as a last resort, leave an injured person(s) who cannot travel to await rescue.

Audible signs (chimes) would have assisted workers identify their location and the proximity of key emergency infrastructure.

Additional Longwall Evacuees

Dave Macpherson & Alex Neels

Summary

Recognition of changed circumstances – the scenario was a tailgate roof fall blocking access followed by a maingate sudden intense fire. The need for rescuers was recognised very quickly. There was initially some confusion regarding the status of the tailgate as an egress and as the information was not communicated to all members and it kept getting raised as an option.

Attempt communication with surface or other crews underground – communicated information regarding the fall to the control room operator. The fact that there was fire outbye the crib room was also communicated to CRO. The people in the longwall were not in a position to communicate with other crews and this was left to CRO. Communications from the people in the longwall was spoken through the rescuers.

All crew members accounted for – an attempt was made to count the numbers in the group. They came up with (variously) one or two short. There was no effort to check if all people from the area were together, and also no knowledge of how many people were in the area.

Crew marshalled together – crew came together at the crib room, this occurred due to the scenario – there was no active attempt to marshal (see comments re accounting for crew members).

Location of other underground workers considered – there was no active consideration. The layout of the mine reduced the chance of impact in other areas. There was no consideration of the potential for other persons in the same area.

Recognition of expected duration – after the initial period of determining the problems and then deciding on a route the workers evacuating through the bleeders understood the distance to be travelled and took an additional rescuer to assist with the evacuation. The men in the crib room expected an early response as they were close to the surface.

Escape route determined and appropriate route taken - the initial option was to take the shortest route (out the main gate direct to surface). Once this option was deemed impractical due to fire the decision was made that the only open egress was around the bleeder. It was not recognised by the workers that there were only 7 rescuers in each cache along this route. The assessors informed the men that 3 would have to remain at the crib room/face area due to the numbers of rescuers available.

Rescuers/light numbers provided to control – there was no effort by the men to inform control as to who was in the crib room and control did not request this information.

Plan formulated and decided on – there was initial confusion and no clear leader. Not all men were aware of the tailgate fall. Men twice attempted to exit via belt road and both times were forced to retreat due to the heat. They tried to exit via the transport road and were also driven back by heat. They then decided to exit through the bleeders when the other options were eliminated. The lack of good communication amongst the team and with no clear leader the decision process was slow and laboured.

Partial/total evacuation – the decision was made to evacuate. There was no opportunity for the men to discuss actions to be taken if they got outbye the fire. The men who did evacuate reached the surface and were directed immediately to surface offices.

Recognition of deteriorating circumstances (if any) – after the initial events the conditions were stable.

Re-evaluation of escape options (if necessary) – escape options were re-evaluated with the initial choice being the shortest route with the bleeder as last choice. The men in the crib room evaluated the route and method of escape suggested by the control room operator and rejected the idea as impractical.

Re-evaluation of escape times and duration of SCSRs – the major issue was the lack of recognition of the limits imposed by the numbers of rescuers available in the bleeder caches.

Control room informed of location – team going through the bleeders did not make any contact with control. The people in the crib room made no contact with surface until control room operator initiated contact (this may have been driven by the artificial nature of the exercise). The men who escaped through the bleeders called the control room operator via the DAC on reaching the surface (initiated by PED message from control room operator).

How is communication carried out – initial communication to surface was by phone. Intra team communications were carried out by talking through self rescuers. The control room operator initiated non-verbal communications by DAC.

How were changed conditions reported – only report was through the non-verbal DAC communications.

Where was communication attempted – only communication was from the crib room.

Duration time of self rescuers recorded – no attempt was observed to record duration of rescuers.

Gas levels and associated hazards identified and recorded – no gas detection equipment was available to the men in the bleeders or in the crib room. No records were made during the escape of conditions.

Observations communicated to control room where possible – the men going through the bleeders did not see the only communication point on the route (phone at 23 cut-through).

Check off at lamp room – checked off when reached lamp cabin.

Report to ESO and incident controller – control room operator informed incident controller.

Arrange medical treatment and re-hydration – the paramedic asked the men if they were alright with no formal examination. One man was suffering from dehydration and did not receive appropriate treatment.

De-brief observations – de-brief was not well structured. The men provided a narrative and were then asked:

- Where they left from
- What time they left
- No. of rescuers used
- Water depth at bleeder road
- General travel conditions

Before they left what did they see—there were no questions regarding the missing persons and no evidence of the questions being used to obtain specific information required by the incident management team.

Self-rescuers

- The exercise highlighted many opportunities for improvements in the area of self-rescuers. Personnel had difficulties in donning the MSA Lifesaver 60 and changing over from MSA Lifesaver 60 to MSA Lifesaver 60. Problems identified during donning included getting entangled in straps and faulty neckstraps (which necessitated in one person carrying the rescuer in one arm). There was no standard method in the performance of the changeover. This resulted in people removing the first rescuer prior to having the second rescuer ready for operation, one person inflating the bag from atmosphere with his nose clip off and one person getting tangled in both rescuers, resulting in having no rescuer for over a minute.
- The people wearing the rescuers also identified quality issues such as nose clips sliding off, mouthpieces which were ill fitting, poor quality goggles and faulty straps.
- The mine continues to use the MSA Lifesaver 60 as a belt-worn unit so the issues of donning and changing from these units still exist.
- It is recommended that the mine review the donning and changeover protocols for all rescuers used on site and ensure that all personnel are trained on these procedures and retrained at an appropriate interval. The video footage taken during the exercise shows many of the issues that arose and could be used as a training tool.

First Response

- The scenario was a fire outbye of the face generating a toxic but non-explosive atmosphere inbye of the fire. At no time was there any evidence to indicate a trend towards or the presence of an explosive atmosphere. This type of fire is suitable for fighting from the intake side by fire teams under their standard procedures. These procedures are included in the Broadmeadow Emergency Response Principal Hazard Management Plan.

- The absence of any immediate first response meant that the fire would continue and "can rapidly become uncontrollable and may result in the loss of life and the mine" (Broadmeadow Emergency Response Principal Hazard Management Plan Jul 06).
- The fighting of a fire such as this should have been risk assessed and then formed the basis of the fire fighting training and the principal hazard management plan procedures.
- The absence of a rapid first response to the scenario severely impacted on the likelihood of a successful evacuation.

Escape Protocol

- There was no defined protocol for the evacuation of the mine. The men evacuating from the mine had no pre-planned non-verbal communication system. This led to the only form of communication between team members being verbal through the rescuers. The men were also unaware of the effects of side breathing and how the CO would remain in the breathing bags.
- There did not appear to be any formal protocol for use of the transport and consideration of the use of the transport in limited visibility.
- The people evacuating the mine did not have a clear understanding of procedures at caches i.e. group changeover or carry the rescuer until the worn rescuer runs out.
- Develop a formal escape protocol that includes use of transport; non-verbal communications; route of travel and when to change rescuers. It should include actions to take upon reaching a point of safety such as communication, assess problem and treat if possible.
- Consideration should be given to the provision of whiteboards at muster points to assist with non-verbal communications.

Communications

- The non-verbal communications were a good idea. The requirement for yes/no answers mean that the questions have to be simple and well directed. Several questions were posed as a negative, e.g. "So you can't get out of the maingate?" which leaves the answer open for misinterpretation. Other questions such as "Do you know if the transformer is on fire?" resulted in a "no" answer that was taken as meaning the transformer was not on fire.
- A protocol for this type of communication should be developed with sample questions. All questions asked should be read from a written copy so that the answer options can be reviewed against the exact question.
- A system for non-verbal notification of an emergency should be developed. This may be as simple as an initial triggering of the emergency button on the phone or a "non-verbal dial up code on the DAC or phone.

- It is recommended that the emergency response principal hazard management plan be reviewed. It should be based on AS4801 or similar. The review should consider as a minimum:
  - Review of the base risk assessment to ensure it covers the mines current risk profile.
  - Documented standards for cache layout and design and for egress marking.
  - Initial response to a fire.
  - Early warning of fire through the correct location and alarm levels of real time monitor, and TARPs for gas monitoring alarms that provide for a graduated response.
  - Defined review periods/triggers for the principal hazard management plan and associated TARPs and SOPs.
  - Set KPIs suitable for management review to determine the health of the principal hazard management plan such as training compliance, audit and review compliance and audit results.
  - Determine the appropriate training, assessment and retraining scheme for senior management, control room operator, mining officials and duty card holders in the PHMP and associated protocols.
  - Determine the appropriate training assessment and retraining scheme for all underground personnel in escape equipment and consider the action to be taken when persons are not in training compliance.
  - Review the duty cards. Consider the provision of a simple duty card system for the control room operator to assist in the direction of initial response and the tracking of personnel underground in an emergency. The current numbered duty cards (No. 1 to 8) should be reviewed as a result of and taking into account the results of the exercise.

Fire Site

Steve Bullough

Summary

This exercise in general brings home some interesting findings. Any exercise whether real or simulated needs to be addressed as quickly as possible.

If you give any incident five hours start and let it manifest before a response can be implemented the incident will only intensify and introduce further problems.

From the mines rescue response, no team member asked could identify who the FAB controller was, but all could indicate a back-up team was available.

To have active rescue teams communicating to the FAB controller in the mines control room only via the DAC system leads to further confusion in this room. Communications between the FAB and the active teams needs to be addressed, information passed between both parties was limited and had to be done several times to get the actuate information across.

Teams to go operational had BG4's on their backs some 90 minutes before going operational, this should not happen.

Climbing on top of belts that are not positively isolated should be discouraged immediately.

Teams confronted with changed conditions from when they left FAB should inform FAB of conditions present and work together; this was not done, neither team having full knowledge of what each team was doing. This comes back to communicating between themselves.

The Incident

The incident was activated at 11.30am 17/7/06, fire at maingate 1 longwall pump station in 4 cut-through preventing all people inbye escaping to the surface via the panel entry.

An area outbye of 3 cut-through was established to allow for a simulated fire drill to assess the responding teams' knowledge and use of the mines fire fighting equipment and mines rescue guidelines.

It should be noted that no resources where deployed to investigate the incident until the rescue teams arrived at 4.30pm, some 5 hours after the alarm was raised. Twelve men (12) plus a deputy were present at the entrance to maingate 2 at 12.10pm and instructed by control to return to the lamp room area.

Events as they unfolded:

11.36am	Two men (2) both MTS employee's exited the portal, they where installing mono rail clips in 1 cut-through and heard a DAC message to evacuate the mine.
11.40am	They notified control that they where out the mine however they did not identify themselves or indicate where they were.
4.24pm	1st rescue team at bottom of ramp.
4.29pm	2nd rescue team arrived at bottom of ramp.
	At the maingate 1 concrete pad both rescue teams were fitted with smoke goggles to simulate restricted vision, both teams were advised verbally that from this point forward that vision was limited and 34ppm carbon monoxide was present throughout the pit surface area. It was indicated that a rushing noise could be heard through all the service pipes, simulating that the service pipes into the panel were damaged.
4.45pm	Rescue team captain (Moranbah North) instructed a team member (1) to find the isolation valves on service pipes and turn them off. To achieve this the person had to access the off walk side of the conveyor belt via the belt cross over located just near the maingate 2 transfer point.
4.47pm	Rescue captain (Moranbah North) instructed team members to set up to commence applying low expansion foam onto a given target, only one man (1) responded to running out hoses, one man (1) went back to maingate 2 to get the foam making equipment. The person running out the fire hoses actually fitted a fog nozzle to the fire hose. When the second man returned with the foam making equipment both men proceeded to apply foam to the given target. Initial trouble experienced applying foam was due to a pick up tube not in the foam pail.
4.52pm	Rescue captain (Moranbah North) noticed team member sent to isolate service pipes had not returned and instructed two (2) members to look for him at last know area of activity. It should be noted that this man was by himself on the off walk side of the belt in restricted vision. He was instructed by myself to lay on the ground, unconscious until found.
4.56pm	Missing rescue member was located by search men. The captain issued a distress signal with no response from team members. Again he called for assistance, at this point four men (4) crossed the belt (it was not running but no lock out had been activated either) to respond to the unconscious team member. Vitals where checked, condition ascertained and placed on a stretcher for removal, again over the conveyor belt.
5.06pm	Captain used the DAC to inform control on the condition of his injured team member and was instructed by a QMRS official to bring both teams back to FAB, this decision appeared to be made by the limited information made available to the individual and not a joint decision from IMT. It should be noted that a QMRS official can veto an exercise at any time if he is of the belief that imminent dangers are present, however this should be discussed by the IMT team so an informed decision can be made utilising all the correct information. Further talks between the rescue captain (Moranbah North) and the QMRS official outlining all information allowed one (1) team to continue and the team with the injured team member to return to the FAB.

5.35pm Operation team captain requested replacement oxygen bottles be sent down to allow the team to continue with the exercise.

6.10pm Operation team with new oxygen bottles fitted proceeded underground.

Key Learning Opportunities

- At the pump cart installation site in 4 cut-through both the fire fighting equipment and the phone where located in the cut-through itself, had this been a real situation none of this equipment would be available for immediate use; consideration should be given to locate this outbye the cut-through so it is accessible.
- Had the service pipes been ruptured, no provision is available to actually turn off the isolation valves; consideration should be given to have a ladder or some other implement available to reach the isolation valves in an emergency.
- No initial first response from mine site personal to investigate/respond to the incident; consideration should be given to implementing a first response system at the mine to deal with emergencies until professional help arrives and can be deployed to assist—industry needs to seriously address the issue of first response by way of clearly identifying what a first response team is expected to do i.e. fight the fire plus any other identified duties and what equipment they require. This will also mean that intensive fire fighting training and other associated training will be required; particularly as many mine sites (Broadmeadow included) do not permit the lighting of fires on site.
- The two contract employees who exited the longwall portal notified control they were safe; consideration should be given to refreshing all employee's as to what to do when they exit a mine in an emergency e.g. who they are, where they are and their physical condition.
- It should be noted that any equipment that needs to be accessed, positive and effective isolation must be performed at all times - this was not the case in this incident.
- QMRS guidelines indicate that their representative can abort an exercise if danger is eminent; consideration should be given for this instruction to be made only after an agreed decision has been made by the IMT after dissecting all the correct information available.
- The mines rescue team's duties once in the pit were onerous; consideration should be given to ensuring the work load is spread among all the team not individuals pushing themselves to complete tasks leading to exhaustion.
- Consideration should be given by QMRS to review its communication methods with operational teams – this equipment is outdated.
- Consideration is to be given to review the minimum number of mines rescue trainees – with most people working 12-hour shifts this effectively reduces the number of trainees available to respond by half (fatigue related policies), also with people choosing to live remote from mining areas response times/availability of trainee's is prolonged.

Surface Section

ICS Process

Andrew Clough

Whilst the mine had implemented the ICS/MEMS system for incident control, the new emergency response plan was only put into place on the 10th July 2006. This was at the start of the exercise window of 10—24 July 2006. No effective training had been conducted in this process and mine staff had not had the opportunity to practice their roles and responsibilities. This meant that on the day of the exercise the true process was not followed, and hence, there was no effective control of the incident.

All mines must ensure that training and practice is undertaken in the planned emergency response process to ensure that all incidents can be adequately covered 365 days of the year, 24 hours a day.

The longwall crew was available on the surface and were not utilised in any of the three control groups. The longwall crew has the most experience on the conditions underground in the longwall panel, thus, valuable knowledge and experience was lost by not involving them in the ICS process.

The incident controller was the Underground Mine Manager. The initial response to the level 1 exercise was prompt and the duty cards for the ICS sub groups quickly dispatched. Control of the incident from the IMT was hampered somewhat by a lack of information on the composition of the products of combustion from the fire. This resulted in a reluctance by the IMT to make decisions to control the fire during the early stages of the exercise.

The poor location of the communication room relative to control, and the lack of telephone lines within the room necessitated the Incident Controller to keep moving around gathering and disseminating information.

In summary there was an over reliance on QMRS as an external provider to bring the fire under control. The resulting time lag would have resulted in a significant escalation of the severity of the fire in a real life situation.

Recommendations

- Incident Management Process—in recent years the mining industry has started to adopt the Incident Control System (ICS) Training provided by the Queensland Fire and Rescue Service or the mining version called Mine Emergency Management System (MEMS). Mine sites need to clearly evaluate which system they are going to utilize to cope with emergency response (including the conventional systems already in place). Each mine must then ensure that their staff is trained, practiced and competent to fulfil their roles and responsibilities as identified in their own system.
- Allocate activities based on the functional grouping of the ICS. The Incident Controller did not delegate communication activities.

He was continually moving between the communication room, the control room and the Site Senior Executive's office. On one occasion he actually personally reviewed the tag board.

- A suitable room located close to control and equipped with multiple telephones and radio communication would have allowed the Incident Controller to remain in the one location. This would also assist in delegating activities rather than personally moving around to gather information.
- Poor communication protocols were in place. Again a suitable room with multiple telephones, a radio and a real time visual display of the gas monitoring system would have assisted here. Each telephone should also be provided with a list of mine site and off site numbers. Incoming calls from off site could be captured and controlled by a switchboard to ensure the incident management process is controlled.
- No standard time clock was present in the communications room. A clock should be installed on the wall and synchronised with control.
- No evidence was observed of risk assessments being conducted against proposed action plans. Part of the planning function is to include risk assessments. This could be conducted with additional resources than the core IMT team. The process could be facilitated with the use of a data projector and a template in a separate room.
- The visual display of information in the communication room could be improved. Activities and options were listed with names of responsible persons. Established facts were not listed. Overall objectives were not displayed. A number of white boards could have been used within the communications room. It is important that all established facts are displayed to allow each participant and new IMT member the opportunity to view the current status of the incident. The established objectives of the group should also be displayed. Another white board could be used to list activities and allocated responsibilities. These white boards should be printable to ensure a record is kept of the IMT process. A terminal with a display of the gas monitoring system should also be present in the room.

Strengths

- A quick initial response to the incident occurred.
- An ICS documented system was in place.
- The names of key personnel within the IMT were well displayed on a whiteboard adjacent to control.
- The use of the PED to contact the personnel underground was an appropriate response.
- The use of the DAC to provide non verbal communication between underground and surface was effective.
- The planning group identified correctly the issue with an insufficient number of rescuers available to travel around the back of the Longwall.
- Instruction to the underground personnel to proceed to the tailgate to gather additional rescuers was appropriate.
- There was good site access control with a boom gate and security person present.

- The planning for a relief IMT was executed effectively.
- Conducting a review of progress against the duty cards was carried out at an interval of time after the incident commenced.

Improvement Opportunities

On occasions the Incident Controller allocated duties to ICS members that were not in their functional area. This included asking the Planning Coordinator to organise Mines Rescue and the Fire Team. Again indicative of the fact that there had been little or no training and practice in the ICS system.

Incident Controller Duty Card

- Most of the mandatory actions on the Incident Controller Checklist Duty Card No.1 were followed.
- However no evidence was observed that the following occurred:
  - Send a PED message to all PED units "EMERGENCY, EVACUATE THE MINE".
  - Obtain assistance to handle incoming calls and required notifications in the control room.
  - Appoint a person to make telephone calls as per the 'Emergency Telephone List', in strict order giving your name, followed by the message: "THERE HAS BEEN AN INCIDENT AT BROADMEADOW MINE. THE PRODUCTION MANAGER HAS DECLARED AN EMERGENCY. PLEASE CARRY OUT THE EMERGENCY PROCEDURE AND REPORT TO THE MINE"
  - Acknowledge alarms in control.
  - Appoint a person to remain on telephone standby in Control Room and record all incoming and outgoing calls in the Control Room telephone logbook. Appoint a second person (when available) to record all messages received and given, and assist with communications.
  - Issue Mine Entry Authorisations to any persons required to go underground (form to be issued).
  - Appoint 2 persons to service vehicles and attend to them on standby.
  - Nominate a person to maintain the phone system on site and to undertake related activities
  - As the incident controller ensure the facilitation of the Risk Management Process.

Control Room

Tony Kelly & Larry Ryan

The initial incident of a roof fall in the longwall tailgate was reported to control at 11:30am, 2 minutes after the incident was initiated. The Control Room Operator (CRO) advised the crew to proceed to the crib room and await further instructions. The mine manager was contacted and during this conversation the mines monitoring system (Safegas) reported an alarm on the Real Time (RT) Sensor at MG1 HT Return of 50ppm carbon monoxide (CO). The CRO immediately acknowledged the alarm and identified that the sensor was actually off-scale.

Two minutes later a second incident was reported to the CRO of smoke on the Longwall. The CRO advised the longwall crew to evacuate. At this time Real Time Sensor 2 located at the tailgate return also returned an off-scale alarm of 50ppm CO. The mine manager arrived at the control room and was briefed on the information to date. A broadcast DAC to evacuate the rest of the mine was given.

Following is a summary of the control room personnel's response to the incident, highlighting their understanding and abilities with the equipment and procedures used.

Communication

Information flow through control proved very effective. The control room was a calm, organised environment, and extra staff utilised during the incident all interacted well. Some limitations with the communication processes were identified through equipment failures or intermittent faults. Issues identified included that the photocopier is unreliable, as is the telephone in the tube bundle shed. This resulted in the tasks needing to be done several times over, even leaving the control room to go to another machine. There is an opportunity for improvement in this area by ensuring all vital pieces of equipment are in effective working order.

The introduction of extra staff into control seemed to work well, in particular it allowed for the screening of telephone calls to the CRO, as there were a number of external calls which were not related to the emergency exercise. Due to the control room being always manned, people call there for non core requests or information. Even though this filtering of calls took a significant load off the CRO, due to the number of unrelated calls, important calls could not get through to control. For example, the Fire Service had difficulty getting through. A manned switch board would allow for the filtering of non-core phone calls whilst allowing critical calls to be directed as required.

It appears that the PED system did not have uniform coverage to all the underground areas as numerous PEDs sent to individual assessors were not received. There also appeared to be a problem tapping into the telephone system for the QMRS to use with their radio system. All the communication between the QMRS Operations Manager and QMRS down in the box cut were therefore via the DAC system.

During the exercise, contact was made via the DAC to personal underground in the crib room. These people were wearing self rescuers and therefore unable to speak. The utilisation of non-verbal communication is applauded. Through simple questions requiring yes/no responses the control room operator was able to deduce quite quickly the situation they were facing. This technique proved to be very effective. Concerns however did arise regarding questions containing double negatives, making yes/no responses difficult. It is recommended a procedure or list of questions is written as to maximise the most of this type of interaction, and to ensure accurate information is obtained.

Mine Monitoring System

The mine utilises both a Real Time (RT) and Tube Bundle System (TBS) for gas monitoring. One of the purposes of the exercise was to highlight the limitations associated with this equipment. The limitations of the RT Carbon Monoxide (CO) sensors were identified immediately when an off scale reading of 50 ppm was obtained. This same issue was quickly identified when the TBS analyser went off scale at 999 ppm CO. This showed a thorough understanding of the equipment.

Excellent knowledge of the mine monitoring system was demonstrated with respect to lag times on the TBS. Explanations of why the TBS and RT sensors were not displaying the same data were given, and the placement of particular tube bundle points on hold was performed to expedite results.

Gas Chromatograph

The need for the utilisation of the gas chromatograph (GC) was quickly identified with the limitations of other monitoring techniques. In an incident such as this, clear, concise instructions should be given on exactly what is required from this equipment, as miscommunication happened on more than one occasion, contributing unnecessary stress to an already highly stressful situation. Furthermore, it needs to be highlighted that persons applying unnecessary pressure and panic on the situation dramatically affected the operator.

It is recommended that when unsure of analysis results the GC operator source external help from Simtars. This support could have been improved through better communication channels. It is strongly recommended that a second phone line (that supports data transfer) is installed for the GC to allow modem transfer of data, and real time support from Simtars. This modem package is the standard support service offered by Simtars and would have greatly increased the level of support received. In fact in this situation with this communication channel, Simtars could have operated the GC remotely and Broadmeadow staff would only have needed to introduce the samples to the instrument. Unfortunately in an emergency situation such as this, the most experienced GC operator (the CRO) is usually not the person operating the GC and it is left to the relief CRO, who may have had limited exposure to operate the instrument. It is recommended that all relief CROs get regular exposure to the GC, perhaps running the samples once a tour, as to keep abreast of changes with the instrument and sample introduction. The remote location of the GC to the control also inhibited peer review and support, leaving the operator isolated and without support.

The mine contacted Simtars and obtained advice on the use of the GC. They also mobilised a gas chemist to site identifying flights and estimated arrival times.

This was supplemented by the mobilisation of the Simtars mobile laboratory providing an additional GC and tube bundle capability.

Whilst the mines inspectorate were mobilised and informed the Brisbane inspectorate of the exercise, no attempt was made to mobilise a Simtars response. This mobilisation is part of the NRMW emergency response plan. It is recommended that the mines inspectorate mobilise a Simtars response in response to the exercise scenario in all future level 1 exercises. This will test the interaction and communication process between the inspectorate and Simtars.

An understanding of results generated by the GC seemed to cause confusion. Some of this confusion related to the use of the "fire method". This method was created for use with samples collected from mine fires when it is quite possible that hydrogen and carbon monoxide may be at percentage levels. A cylinder containing high concentrations of carbon monoxide, hydrogen and carbon dioxide is used to increase the accuracy of the analysis. Simtars has a cylinder in Mackay available for use. Even though this method was introduced to improve accuracy, if the standard high span or multi span method was used to analyse the same samples, the results would still give an excellent indication for the situation.

For example, all samples analysed during the exercise were very similar with approximately the following normalised concentrations:

Helium	0.001%
Hydrogen	0.35%
Oxygen	19.39%
Nitrogen	77.88%
Methane	0.01%
Carbon Monoxide	0.35%
Carbon Dioxide	1.13%
Ethylene	0.0005%
Ethane	0.0006%
Argon	0.90%

Tabulated below are results obtained when 0.3% hydrogen and 0.3% carbon monoxide are analysed utilising the three methods available to mines without using the fire span:

Gas Component	Low Span Method	High Span Method	Multi Span Method
Carbon Monoxide	0.301%	0.284%	0.285%
Hydrogen	0.306%	0.298%	0.298%

Note the flammable components in this sample type do not change considerably between methods. This demonstrates that even given errors associated with the different calibrations, the concentration of flammable components are not nearing the explosive zone. Interpretation, as given here, was available during the exercise but was not sourced.

With concerns raised over the results generated, options for confirmation of results could be sought. Even though a modem was not installed data transfer via email was achievable and requested, but not performed. The sending of samples to nearby mines for confirmation is also an option that should be considered in the future.

The relief control room operator performed well under the excessive pressure that was applied, in particular the review of results obtained and the identification of errors was excellent. The introduction of sampling directly from the TBS to the GC seemed to be relatively new and sufficient training was not evident, however in saying that, miscommunication of instructions received by referring to the samples requiring analysis as "bag samples", even though they were coming directly from the TBS caused confusion. Furthermore, the first sample analysed (not by the relief CRO) contained errors that weren't identified but the result were still accepted. This is an example of how a lack of attention to detail in a high pressure situation resulted in an error being overlooked.

Planning Group/Role of Ventilation Officer Gas Analysis & Interpretation

David Cliff

A continuing area of concern in the level 1 emergency simulation exercises is the quality of the management of information, particularly gases i.e. the collection, reporting, and analysis of information. In addition circumstances have often coincided in past exercises to reduce the ability of the ventilation officer to discharge his functions and add value to the management of the exercise.

The documentation supplied – mine emergency response principal hazard management plan, duty cards, standard operating procedure BRM SOP 37, and mine atmosphere principal hazard management plans provide limited definition for the information collection, analysis and reporting processes to be in place at the mine in the event of an emergency.

Duty Card 2 (Planning Coordinator) defines the role of the ventilation officer (VO) to include:

- Appoint a competent person to monitor the surface area (operations building, roads and portal areas) for irrespirable conditions.
- Ensure the gas monitoring equipment is operating and make a report of the status of the ventilation and gas monitoring system to the planning coordinator, which is to include the gas levels, trends and interpretation from the sampling points underground. Set up a remote computer in the IMT room to monitor Safegas.
- Make ready for the planning coordinator a current mine plan showing the status of the ventilation, location of monitoring points and gas levels.
- Appoint a person to take bag samples from the tube bundle shed when required.
- Appoint a competent person to have control of the gas chromatograph and make it ready to accept samples and analyse samples as required.
- Appoint a competent person to monitor and report on the gas levels through the monitoring system and acknowledge gas monitoring alarms.
- Contact the Simtars on-call officer to make Simtars aware of the situation and the requirement to be on standby. Consider contacting a ventilation consultant if required and place them on stand by.
- Establish reporting of environmental data every ten minutes, at any major event, or as required by the planning coordinator.
- Notify Moranbah North of the situation and request that their gas chromatograph be available on standby.
- This does not mean that these are his only functions.

Strengths

The whiteboard outside the control room identified those persons with duty cards.

- Planning Coordinator (PC) did attempt to follow ICS process. He informally attempted to follow proper decision making process.
- The VO did organise a competent person to monitor the gas concentrations between the pit and the office buildings equipped with a hand held monitoring device.
- The VO did ensure that the gas monitoring equipment was operational (see difficulties in using GC below).
- A mine plan did exist that showed the location of gas monitoring points.
- A person was appointed to collect gas samples from the tube bundle shed as required.
- A person was appointed to operate gas chromatograph (see comments below regarding operation of GC).
- The control room operator was competent to monitor and report on the gas levels through the monitoring system and acknowledge gas alarms
- Simtars were contacted and good support was provided by Simtars personnel in ensuring the operation of the GC (see below for comments on operation of GC)
- The VO did contact retained consultant and place him on standby for assistance in gas analysis and interpretation at 12:00. Additional contact was made at 14:40 to update him of the situation. Later in the afternoon (approx 16:05) he was sent gas analysis results and he promptly provided interpretation.
- The VO established a bag sampling regime for the three key monitoring locations on a 15 minute basis. This system was to be initiated once tube bundle system CO readings went off scale.
- The VO did focus mine monitoring system on the incident area to optimise frequency of gas sampling. He displayed good knowledge of how to operate Safegas and optimise its performance.
- The VO did display sound ability in the operation of Segas Pro.
- Networking the Safegas simulator worked very well.

Improvement Opportunities

Training

- ICS - The personnel need to be trained in the functions required for the ICS system to work. The planning coordinator made a valiant effort to implement system to best of his ability. It was not evident that key personnel were ICS trained. This training relates not only to the functions of an individual but also recognition of the roles and responsibilities of others and the appropriate interaction mechanisms.

- Mine site level 2 exercises should be carried out to test the practicality of personnel to carry out designated functions with available resources.
- GC - The frequency of and complexity of GC training should be reviewed. In addition the number of people available per shift competent to operate the GC needs to be reviewed. It is not appropriate to expect the control room operator to run the GC during an incident.

Duty Cards

- Personnel should consult duty cards to ensure functions required are carried out. Duty cards should reflect required functionality. By implication duty cards specify the roles of key personnel – if function is not listed it is not part of role e.g. what is role of ventilation officer? – part specified by duty card 2, but clearly the role extends beyond this.

Decision Making

- Information supply - Effective operation and decision making can only occur under calm and measured circumstances based upon adequate information. Key decision making at Broadmeadow was not effective because:
  - Lack of control of entry and egress to key areas. Interruption and distraction detracted from decision making processes and information collection.
  - No limit of membership of groups. There were times where there were up to 20 participants in the Planning group.
  - Inadequate information collection, analysis and reporting (see below).
  - Inadequate resources in key areas (see below).
  - Risk assessments were not documented. The decision making process was not recorded.
- Planning - Informal planning occurred with little or no documentation e.g. risk assessments were not documented. A number of plans were aborted part way through development due to diversion of staff to other activities e.g. when the ventilation officer was delegated responsibility to risk assess sending someone to portal to have a look at fire, he was diverted onto other activities without being able to complete this task. It is recommended that informal or non documented risk assessments should not be carried during an incident.
- Structure - It is recommended that a structure be followed for risk assessments and discussions to ensure that conclusions are reached and digression does not occur. Personnel in the planning group need to follow the discipline of the meeting process to ensure effective operation of the planning group.

Resources

- Suitability of ICS functional areas - The allocation of areas for the various functions (planning, IC, operations and logistics) and resources for those functions urgently needs review.

In particular the IC room was inadequate – often more people tried to get into the room than it would accommodate and no real record keeping or display of information was undertaken in this room. The planning room often became the de-facto IC room for IC meetings. On a number of occasions there were 20 persons in the planning room.

- Use of display/white boards - Planning made reasonable use of white boards, initially but as the incident progressed the usage became sporadic and unsystematic. No gas data was recorded or publicly displayed. Scenario information was not displayed. All information was collected together in the scribe's notes.
- Use of scribes - Each section used a scribe and a hand written log.
- Information collection needs to be systematic track the details of the incident.
- Use of suitable expertise - Mine personnel did not consult the retained ventilation consultant regarding control of the fire – this person is very experienced in actually dealing with underground coal mine fires. A lot of discussion in planning related to the deployment of mines-rescue personnel without any suitably qualified person from mines rescue being present or accessing the mines rescue guidelines.

Information Collection and Processing

- There was little systematic collection and reporting of information. Examples of this include:
  - Confusion over location of fire and type of fire e.g. vehicle fire vs. transformer fire. Five minutes into the exercise it was identified that the transformer was on fire, yet four hours later it was stated that the transformer was not on fire.
  - Whether or not there was a fall in the tailgate. This information was recorded in the logs but not recalled.
  - Discussion over mines rescue guidelines without actually consulting the guidelines or familiarity with information regarding fires and fire fighting
  - Delay in attempting to assess type and size of fire
  - Incident controller circumvented official communication channels through direct contact with ventilation officer and others he needed information from – did not stay in the incident control room.
  - Mines rescue had in great difficulty in understanding the nature and severity of the incident.
- A systematic regime should be established for reporting and displaying monitoring information. Without systematic recording of information it is impossible to effectively brief external bodies or undertake changeover of key personnel.
- The planning group began well using white boards for information display, identifying actions and options. This impetus needs to be maintained for the duration of the incident.
- Information collection and reporting standard and frequency decayed as the incident progressed.

- All information transfer into and out of the planning room was done by face to face verbal communication. There was a phone in the planning room that was not used. The computer link to Safegas and the mine network in the planning room was not utilised till well into the incident. The Duty card 2 requirement for a Safegas terminal in the IMT room did not eventuate. The reference to the IMT room may be ambiguous and actually mean the Planning room.
- There is an opportunity to improve understanding of mine fires and their effects, e.g.:
  - Types of fires and hazards created e.g. gases- toxicity, flammability and heat generated
  - Limit of potential for explosion especially in roadways with significant air flows.
  - Direction and rate of propagation of fires
  - Impact of altering ventilation flows on fire propagation and intensity
- Remote access to Safegas gas monitoring software should have been utilised in the planning room much earlier than it was.
- There is significant opportunity to improve information collection, reporting, analysis and transfer utilising modern technology e.g. smartboards, electronic documents, electronic logs, networking of data and real time display (refer ACARP project C 11031 and previous Level 1 Incident reports for examples).

Gas Analysis

- Moranbah North were not notified nor asked to place their GC on standby. This is required by duty card 2.
- Difficulties were experienced in operating the GC (see below for discussion). Despite this no attempt was made to send samples to Moranbah North for analysis.
- The ventilation officer appeared reluctant to undertake interpretation of the gas atmosphere preferring to refer this to the consultant. This reluctance may have been due to pressure and number of tasks he was attempting to do. The ventilation officer did have the tools to do this interpretation and was competent to do the interpretation.
- The operation of the GC and training of personnel needs to be improved. The VO had not received refresher training for over three years. The other available operator was not very experienced. Considerable unnecessary stress was placed upon this operator which was not conducive to effective GC operation.

Ventilation Officer Functionality

- The VO tried to undertake too many tasks and this caused him not to complete his tasks properly. Examples of this include:
  - Taking over operation of GC to try to fix calibration problems but then leaving part way through to attend to other actions

- Showing GC operator how to take bag sample from tube bundle system, but in doing so left tube bundle analysers disconnected from tubes for 45 minutes until incident assessors reset it so that real system was operating
- The VO had no real time to consider ventilation solutions to fire management and search and rescue. He did a quick VENTSIM for deployment of GAG which was adequate for this function
- Running GC analysis without reconciling peaks properly due to haste and thus got total gas of over 109% - CO_2 was 10 times too big.
- Neglecting to send bags to Moranbah North for analysis when his own GC was incorrectly calibrated and not giving meaningful results.

▪ The VO functions required during an incident need to be identified (partially identified in Duty Card 2) and sufficient resources allocated to enable these functions to be effectively carried out. PC did not check to see if VO was carrying out all functions. VO was too involved in minutia to carry out all the functions that required for this exercise.

▪ VO was communicating directly with IC rather than through PC and thus PC was not aware of all information and interpretation that was occurring. It is recommended that the reporting of the VO be constant and through the PC.

▪ VO did not have time to consider ventilation control options for fire or interpret gases adequately.

Gas Chromatograph Issues

▪ The application of the "fire method" to the GC did not work. It appears that the method was partially overwritten by site operations that rendered it unusable.

▪ There was a perception that without the "fire method" fire gases cannot be adequately analysed by GC – this is not correct. Even if this was correct a number of actions could have been taken to optimise the analysis available:

- Send samples to Moranbah North
- Combine GC and tube bundle results to check validity for CO, CO_2 CH_4 and O_2 and set limits on how much CO and H_2 could be present.

▪ The wrong phone contact procedure with Simtars was activated – Darren Brady was called directly rather than through the official support phone number. He was not available and Simtars did redirect the call.

▪ Remote control of GC by Simtars is not currently possible due to lack of communications link. This link would have enabled Simtars to rectify calibration issues rapidly.

Opportunities for Improvement of the Overall Exercise Process

- An Ezgas emulator could be developed that provides GC results in electronic format for interpretation. The emulator would take the theoretical result for an analysis and permute by the accuracy achieved by the GC analysis of the test bags. The emulator would allow Segas Pro analysis of samples analysed until the current time.
- There needs to be a printer connected to the Ezgas emulator and Safegas emulators.
- The accuracy and limitations of the various calibration methods for analysing gas samples should be reported and publicised widely.
- The use of and support of the "fire method" needs to be improved.
- Simulator or additional system should include details of other key operational parameters that may be affected by the exercise that the mine would normally monitor, as required such as:
  - Fan pressure,
  - Fan temperature, etc.

Planning

Mick Farrag

Incident Management Team

- The incident management team (IMT) structure was put in place very early on in the incident with all functional managers appearing to have an understanding of their role. Tabards were worn and names were put on boards.
- The facilities rooms were all in place although the incident controller's room was too small to conduct the IMT meetings.
- Resources in the planning room need to be reviewed as there was poor use of the information recording systems. The mine should consider the use of smartboard type technology.
- Communication equipment – the phones were not used in the planning room. Runners (including the incident controller) were used to convey information between the groups. A computer, data projector and screen were available in the room but was not utilised until very late in the incident. When this equipment was utilised the Safegas information for the mine was all it was used for.
- The planning group made reasonable use of the whiteboards initially, but as the incident progressed, the usage became sporadic and unsystematic. Scenario information was not displayed. All information was collected together in the scribes' notes.
- Use of scribes – each section used a scribe and a hand written log.
- There was no formal decision-making process evident within the planning group and the IMT.
- No formal risk assessment process was conducted in the planning group, although some hazards were identified and considered.
- A lot of discussion in the planning group related to the deployment of mines rescue personnel without any suitably qualified person from mines rescue being present or accessing the mines rescue guidelines.
- Far too much informal planning occurred with little or no documentation e.g. risk assessments were not documented. A number of plans were aborted part way through development due to the diversion of staff to other activities e.g. ventilation officer to RA sending someone to the portal to have a look at the fire.

Interaction/Briefing

- Outside agencies – no written briefing was available to the QMRS operations manager. Requests were made for gas information and mine plans.

- IMT – verbal briefing and updates were given to the IMT: an incident action planning process would facilitate this.
- When the exercise was halted, the planning group was progressing with the establishment of post-incident management procedures considering the mine employees, families, scene preservation, accident investigation and mine recovery.
- Although a change-over plan was developed and persons sent off site to be available to return and fill the functional areas, the plan lacked detail and coordination.
- A structured change-over plan is required to be developed in advance of an incident to ensure the change-over is a coordinated event and all critical information is passed onto the oncoming IMT.
- A good change-over is critical to ensure the continuity of the Incident Action Plan and not lose control over the direction of the incident.

Overall Summary

The effectiveness of the incident management team would have been greatly enhanced if all IMT members and support personnel had a better understanding of the ICS process and had attended a course that is currently available to industry. It is critical that if ICS is to be used it needs to be implemented on site in a timely manner and that all personnel are trained in the system.

The planning group's main role is to gather incident information, process the information and develop strategies to enable the incident controllers' objectives to be achieved.

The planning group is also required to maintain an information service. This is critical to ensure that we are dealing with accurate information and that all groups are dealing with the latest and validated information.

Each functional coordinator needs to have an intimate knowledge of the roles and responsibilities of the system they are operating under. Duty cards are designed to be a memory prompt, not a document that is to be read to enable a person to carry out their role.

It is critical in an exercise, such as the level 1, to not read into the incident things that are not there. Deal with the facts. Gather the information, validate that information and act on that information.

Mines Rescue

Seamus Devlin

Mines rescue response was activated by phone at 12.00 Midday. The phone call was made to the Queensland Mines Rescue Emergency Call-Out System which is managed by the Queensland Fire & Rescue Service. The system was effective – demonstrated by the return call from the QMRS Operations Manager to the affected mine being received in six minutes.

Commencement of team equipment preparation was underway on site within thirty minutes. Excellent, willing and capable response from on-site brigadesmen.

The GAG activation call was made at 12.05pm.

The planning function of the operation was impeded by the absence of mines rescue expertise – this is a problem related to the travel time from the point of response. The response time (1 hour 45 mins) of the operations manager may have been reduced if he had not been required to pick up the Dysart based response trailer.

Testing of the on-site BG4's resulted in the progressive rejection of (progressively) four suits. The rejection of the suits was based on minor non compliance's in the testing regime – this was probably the correct thing to do given that only two persons were available to test the suits and should not have allowed them-selves to become bogged down on repairs. The testing personnel were aware that a QMRS Technician was en-route – the suits were rapidly put into operational status upon his arrival.

The Planning function requested the presence of two of the Brigadesmen to attend the planning of intervention strategies – this may well be a necessity in regard to QMRS response time capability. If this is indeed an expectation then the Brigadesmen may require a greater degree of training to allow them to function in this area.

The arrival of brigadesmen on site was slow – sufficient numbers to deploy was not achieved until 3 hours 30 minutes after the initial call.

Some confusion arose as to whether the "Mutual Assistance Scheme" was to be activated. This seems to have occurred because several different people from the mine were in verbal contact with both the Duty Officer and the Operations Manager. Because the mine site situation involved an active fire and missing people should this decision rest solely with the QMRS person responsible for the response?

The capability of on site personnel to respond as mines rescue personnel, independent of QMRS attendance, is limited (prevented?) by the fact that equipment required to establish an FAB is not kept at the sub-stations.

The paperwork for deployment of rescue teams is of a high standard and should be used.

Some of the deficiencies (problems likely to be encountered) in early options for deployment of rescue teams would have become clearly evident if risk assessment principles had been employed i.e. low visibility, heat damage to strata, heat damage to mine service lines, absence of communication options.

Options to Consider

- Need for site based mines rescue personnel to be trained in mines rescue protocol(s) to provide mines rescue input into planning group/IMT before mines rescue arrive on site.
- One point of contact for QMRS activation and ongoing communication.
- Activation level to be at the discretion of the Operations Manager/person who is responding and has up-to-date information, and competency to make an informed decision.
- Review response protocols for Operations Manager.
- Review mine site rescue room equipment.
- QMRS need to consider response times to all underground mines and factors which may affect this.
- The requirement for all information being given to QMRS Operations Manager to be signed off by all contributors was tedious and time consuming – would it be sufficient to sign off the eventual briefing document.
- First response to the fire could have been effected by on site personnel. Total evacuation of a colliery can make timely intervention difficult.
- Depending on the severity of an incident what is the flexibility in deployment of teams and the number in those teams.

Strengths

1. Call out of QMRS was initiated at 11.51am.

   The need to call QMRS was initially identified by the control officer and communicated to incident controller who delegated this to planning. Planning subsequently directed the incident controller to make this call. The call to QMRS was made at 12.00pm (no major delay in initiation).

   NB: Development Contractor Site Manager was unaware that he was talking to the Fire and Rescue Call-Out service, initially assumed he was talking (directly) to QMRS.

2. On-site response to Rescue Room.

   Two on site brigadesmen (directed) opened up the mines rescue room and commenced preparation of team equipment within 30 minutes of first phone call.

3. QMRS staff.

   Confirmation call from QMRS was received at 12.06pm.

4. Planning function

Quickly recognised the need for mines rescue expertise in their area – requested status updates from the rescue room at 12.30pm and 12.54pm – subsequently (in the absence of QMRS staff) requested the presence of two experienced Brigadesmen to assist in intervention planning.

Improvement Opportunities

1. QMRS ETA

No clear ETA was communicated to Broadmeadow (either IMT or mines rescue room). At 1.02pm the rescue room personnel made phone contact to the QMRS operations manager who indicated he was 10 to 15 minute away – arrived at 1.45pm.

2. Delivery of additional equipment/operations manger

The additional equipment required for a protracted response arrived with the operations manager – is the priority for additional equipment or the presence of the operations manager? Did delivery of the above equipment delay the arrival of the operations manager?

3. Arrival of Brigadesmen

No external brigadesmen on site as at 2.10pm.

4. Brigadesmen Exposure

Visibility restrictions caused by a fire burning for a number of hours were not considered in proposed use of teams.

5. First Response

The response to the fire could have been done without the use of rescue teams – complete evacuation does not lead to early intervention- a fire left unattended from 11.30am until post 5.00pm will (could) develop into a mine closing event.

General Surface & Debrief

Michael Driscoll & Michelle Clarke

Surface

Upon commencement of the exercise, three workers on surface (working on maingate 1 belt) and one worker in crib room, were shown the scenario photograph (showing smoke and dust emanating from MG1 fan). Workers made immediate DAC contact with control. No other action/advice/questioning by control in regards to the situation etc. Instruction from control was to immediately evacuate the area. These three workers from the belt then immediately decamped the area on foot towards maingate 2 area. This was in accordance with the instructions given by the control room.

It was observed that the control room operator did not engage in any questioning of these persons at this time. Most company emergency documentation viewed provided guidance about lines of questioning to be taken by control room personnel. It is not known why this was not done. It is submitted that this denied the opportunity that may have existed for these persons to make some specific observations or investigations of the incident, to inform IMT and assist in the determination of appropriate responses. These persons were not questioned about possession of SCSRs and cap lamps, which could have guided a decision about deployment of these persons into maingate 1 travel road (in intake air) to make a further assessment of the situation and or fight any fire that may have been present.

It is recommended that all control personnel become familiar with relevant procedures.

Another contractor mentioned that other contractors working in the maingate 1 belt roadway. These persons subsequently exited, later stating that they had heard communications over the DAC. They were not aware of the exercise having started. They were not able to be briefed and instructed with the scenario prompts as they were not in the crib room/belt area on surface and exercise personnel were not aware of their presence. These persons contacted control by DAC and were also advised to evacuate area. These persons then left the area in a mine vehicle.

It was noted that the underground ambulance was not checked prior to vacating area (was checked by contractor after arrival of exercise assessors but prior to commencement of exercise).

Travelled to TG and workshop – no persons present in this area. Noted two vehicles at the exit of the maingate 2 travel portal.

Caught up with this crew (HWE development crew plus ERZ controller). They advised that they had been contacted by DAC (not PED) to evacuate the mine. They were waiting on the surface at machinery/crib room at the surface. The ERZ Controller for this area was in contact with control by DAC.

Showed scenario photographs. At this time smoke from maingate 1/tailgate 1 was rapidly filling cut from the tailgate end towards maingate 2.

ERZ controller contacted control via the DAC in the crib room. He stated that upon being advised of the emergency via DAC underground he had advised all crew members, collected them from various workings in MG2 and then exited the mine in vehicles to the surface. Noted that all personnel who had exited MG2 were in possession of cache units, which they had obtained prior to leaving their panels. There was also a head count undertaken to ensure that all personnel were accounted for. Persons from maingate 2 were assessed as having followed appropriate procedures.

ERZ controller advised that he had been contacted at approximately 11:50 am, and that it took approximately 20 minutes to gather the crews and exit the mine.

AT T+60 assessors advised the ERZ controller of the scene (showed scenario photographic prompt – which has smoke cloud filling cut). From this prompt it was apparent that smoke had filled the cut to the entry point of maingate 2 (where these persons were gathered).

ERZ controller contacted control. Control's advice was to don SCSRs and exit to lamp room/muster area. No actual SCSRs were worn.

This crew then evacuated this area, via two underground mine vehicles.

The two assessors then awaited the potential arrival of first/fire fighting response. No response was made and by 14:30 hours the assessors returned to surface.

Debriefing

Assessors then took up a temporary position in the lamp room area awaiting the arrival of evacuated (maingate 1) personnel.

At approximately 14:45 hours observed vehicles arrive and evacuated personnel from MG1 alighted from vehicles.

Observed the lamp room officer coordinate a line of persons, take names and coordinate the replacement of lamps/batteries and unused belt worn SCSRs to racks. It was later observed that these lamps/batteries and unused belt worn SCSRs items were tagged out of service in the racks.

It was observed that the control room operator questioned the lamp room attendant as to whether or not all persons were now evacuated from MG1. The initial response of the lamp room attendant indicated that all persons were evacuated.

Although the lamp room attendant was not assessed for the entire duration of the exercise, it was noted that the duty card as it existed (duty card 7) was complied with, with the exception of securing the lamp room, which is not possible due to the design and layout of the open area utilised as a lamp room. It is recommended that the need and ability to secure this area be considered and addressed.

A deficiency identified in the duty card for the lamp room attendant was that it did not require the attendant to make a physical check of the racks to accurately identify lamps/SCSRs in use, as an additional cross check to the tag board and lamps-in-use book.

It is recommended that the lamp room duty card (duty card 7) include duties relating to manually checking lamp racks to accurately identify lamps in use (out) as an additional cross check to the tag board and lamp-In-use book.

Assessors then proceeded to take a position in observation of de-briefing of evacuated personnel. This de- briefing occurred in a series of three interconnected rooms, with two persons being de-briefed in each room. There was some degree of conversational/noise interference in these rooms because of several persons speaking at once. It was noted that the duty card holder for de-brief moved between the three rooms.

Whilst the de-briefs' were occurring, the site paramedic attended these rooms and asked general questions of the evacuated workers. No objective examinations were made of these persons at this point. They were questioned as to their welfare and asked to report any symptoms they were experiencing. During this de-brief activity, other BMA personnel provided water to these workers and blankets. It is recommended that re-hydration should be identified as a key initial requirement of the debrief process.

It is recommended that medical examinations by on site medical personnel should take priority over debrief and that such examinations should include objective medical observations of these persons (e.g. pulse, blood pressure, physical examination). If absolutely necessary, debrief/gathering of critical incident information could occur whilst such examinations are occurring.

It was noted that approximately six de-briefs were occurring almost concurrently. Persons de-briefing were from a range of areas, including human resources, commercial. It was noted that some non mining personnel involved in conducting de-briefing questioning were occasionally confused by some of the specific technical descriptions provided by evacuated persons. Some of the de-brief personnel were inexperienced in regards to mining related terminology and mine layout. This confusion could be minimised by utilisation of mining personnel for de-brief or some specific training for persons used. At very least, it is recommended that the provision of a mine emergency plan for use during debrief would be advantageous.

There was also noted to be a large variation in the amount and quality of information gathered on the debrief forms. This was considered to be a function of both the experience of persons conducting the debriefs; training/instruction given to these persons and the open nature of the questions contained in the questionnaire. It should also be noted that a number of questionnaires were not completed (or were only completed in a limited capacity) on the second page. This page contained cues at the top of page in relation to topics for further questioning including "escape route; equipment locations; roof; ribs; ground; air; visibility and any other info volunteered". It is submitted that there could have potentially been cogent information upon these lines of questioning for communication to IMT, but in some cases these were seemingly not explored. Other vital information was also omitted, including for example the exact working locations of some persons. Some forms did not even identify whether the person was working in maingate 1, maingate 2 or maingate 3.

It is recommended that debriefing forms be redesigned to take into account items about which IMT requires specific advice.

It was also noted that the report pro-forma used was a two page "Debrief Report" (Broadmeadow "Duty Card 6 Debrief Report"), although a total of three debrief reports were identified in various Broadmeadow documents. It was also noted that a further five hand written questions were included on a separate document for persons who had evacuated from the area where the incident had occurred (maingate 1). It is recommended that one form be developed for use.

During de-brief it was noted that personnel were offered the opportunity of having contact made with a psychologist, although, given the layout of the de-brief area, this offer was made in the presence of other crew members, which could act to deter a person from identifying that they wish to take up the offer. Such offers should be made individually and out of hearing of other crew members.

Subsequent review of all debrief questionnaires, indicated that all persons evacuated from non-incident areas (maingate 2 and maingate 3) were individually debriefed. It is not apparent if this process delayed any report from these areas to IMT. It is possible that critical information from the non incident areas could be gathered from the team leaders and an assessment made as to the need to individually de-brief all personnel. The debrief of all non incident personnel should not unnecessarily delay the report of critical information to IMT.

Another issue identified by review of debrief questionnaires completed relates to non-incident surface personnel from the administration area being debriefed. A number of debrief questionnaire reports were located from surface personnel who had not been into the operational mine areas. If is not clear why these persons were debriefed.

Subsequent to debriefing and the opportunity to change/shower, the evacuated persons were gathered in a conference room and debriefed by Employee Assistant Program (EAP) personnel.

This debriefing was effective and well conducted.

An issue identified by EAP representatives was the need to prepare for possible fatalities, including the issue of preparation of evacuated personnel for this eventuality. This issue needs to be identified and addressed in the planning and debrief process.

This also highlighted the need to ensure that persons involved in the incident (especially those unaccounted for or deceased) are identified and contact details (next of kin, etc) are available. It is not clear that this occurred. Some personnel spoken to indicated that this task would be complicated by the fact that numbers of persons involved were contractors and some confusion existed about the exact location of these records.

It is recommended that relevant employee records be identified in the initial phases of an emergency/entrapment situation.

Site Senior Executive

Kevin Clough

Summary

The exercise commenced at approximately 11.30am with a phone call from underground on the longwall mid-face to the surface control room identifying a roof fall in the tailgate.

The emergency alarm was sounded at approximately 11.40am and turned off at 11.49am.

All personnel were evacuated from the office complex during the initial response to the emergency alarm.

The incident management team (IMT) notification board outside the surface control room was filled in with details of the personnel assigned to the various duties.

The first evacuees from the mine portal areas arrived on the surface at approximately 11.47am.

Consideration should be given to the processing of incident information and decision-making on-line so that all parties, including the SSE and QMRS have all information readily available.

General Comments

- The SSE had difficulty getting information at start of exercise. He eventually went into his office and waited on IMT to report to him on a regular basis.
- The SSE was reluctant to involve the Police at the start of the exercise and request them to come to site. He maintains that Police are only required for fatalities. District Inspector insisted that Police be called to site at 1.03pm.
- Direct access required by SSE to gas analysis and incident information on a suitable computer monitor and information being updated on line by the incident control teams would have facilitated this.
- The mine is to develop and foster good relationships with the Police Service. They are an excellent resource to have available in any emergency.
- Media update given did contain inaccuracies. The fire was mentioned on the conveyor belt, not the pump station.
- Updates to BMA corporate headquarters and to Department of Natural Resources, Mines and Water were given regularly.

Media Coverage

Anna Duffield & Mika Thuijs

Media coverage was provided by Anna Duffield, Mines Media Officer—NRMW and Mika Thuijs, Journalist—International Longwall News.

These two journalists were given a prepared list of questions but had no idea what the scenario was. The idea was to test the company's communications in relation to the level 1 exercise to see what information could be gleaned. All inquiries were handled politely and the "press" was directed to ask questions of the SSE/media liaison media manager. At no time was any information on the "incident" revealed by the parties receiving the phone calls. Both Anna and Mika were given actual phone numbers of people in the organisation, including the control room number to test mine site response.

Report by Anna Duffield

Most people were unable to provide specific details and said someone would return my call. A written statement was provided by BMA at 3:15pm. The media manager advised that all media enquiries were to come through him.

Fire evacuates underground mine

> Central Queensland's Broadmeadow Mine was evacuated late this morning (Monday 17 July) following the outbreak of an underground fire.
>
> Rescue teams continue to evacuate staff still trapped underground at the BHP Billiton Mitsubishi Alliance (BMA) mine.
>
> According to a spokesperson for BMA, rescuers have been in contact with the trapped staff.
>
> "At this stage, there is a known fire on an underground conveyor belt," the spokesperson said.
>
> "A number of people have been evacuated and rescue operations are underway.
>
> "The Queensland Mines Rescue, Department of Natural Resources and CFMEU have been notified."

Mine site officials were unable to comment on the incident, despite repeated calls to the mine manager, senior site executive and control room.

Broadmeadow Mine is an underground longwall mine located 40 kilometres north of Moranbah in Central Queensland.

Conclusions

Broadmeadow's response to the level 1 exercise scenario was professional in all aspects. Individually everyone involved performed to a good standard. The main issue is the system failures that were observed on the day. Namely:

1. There was no first response. Any fire fighting effort that had been attempted could have improved the chances of those personnel inbye of the fire to escape.
2. There are serious issues relating to the wearing and changeover of SCSRs which needs to be addressed by industry.
3. The incident control system had just been modified (to the ICS system) and had not been practiced, therefore, the information flow became chaotic and the process was not followed. This has been the same at most mines when a level 1 exercise has been conducted.
4. There are many recommendations contained within this report, some of which may only apply to Broadmeadow mine.
5. All of the recommendations within this report need to be evaluated to see if they are applicable at your own mine site.
6. Simple recommendations, such as the "wind chimes" to assist in locating cache's are cheap, easy to install and can have a major impact on the evacuation process.
7. The interaction with the media via phone calls was handled professionally and information was provided.
8. Interaction was not tested with the local hospital due to time constraints, again this is an area for attention and information from the local hospital is that mining staff do not appreciate the hospital requirements when dealing with casualties.
9. It is time for industry to learn at the hand of the emergency exercises/audits and reviews to improve all matters relating to emergency response. Emergency exercises and audits have identified several areas of concern in relation to emergency response since 1998. Some of these have not been resolved, two of which are first response and SCSR training and competency. Industry needs to take advantage of these learning opportunities and commit to developing and adopting appropriate standards.

Recommendations

Underground

1. Whenever possible mine workers utilise underground transport for evacuation purposes.
2. Serious consideration should be given to providing a SCSR (or equivalent) with a face mask that would allow communication. This does not necessarily mean to every worker, but of sufficient numbers to facilitate reasonable communication.
3. Training in donning and use of SCSRs needs to be addressed as indicated by previous level 1 exercises, and highlighted in recent forums in the USA (Appendix 3). It is recommended to industry that a similar competency based training regime to that proposed by the USA mining industry be implemented (refresher intervals of 3 monthly) as well as ensuring that all mineworkers have used a real SCSR or a training rescuer that has simulated heat and resistance capabilities.
4. SCSR training to include information on non-verbal communications and the dangers of talking through self rescuers.
5. Consideration should be given to installing a pull down lifeline (on bungee cord) with directional cones, positioned above the wheel ruts, which formed a natural track.
6. Consideration should be given to attaching some type of chime (like a wind chime) to a lifeline or similar device, which would be activated by the movement of people as they approach the cache.
7. It is recommended that some of the evacuees group assist in the development of a presentation for all other mineworkers on site on the experience and effects of wearing a SCSR in limited vision. This could also be used industry wide.
8. All mines conduct an audit of their evacuation routes to identify and rectify any defects that may be found.
9. It is recommended that cache layouts should be standardised and lifelines provided which lead directly to the cache box.
10. Consideration should be given to supplying simple hook on ropes in each EBA cache, or training in an alternative hook-on method, such as using the cap lamp cables (each person hooking on the lamp of the person behind—forming a chain).
11. Well designed change-over stations similar to some current "refuge chambers", including in EBA cache areas, would have helped safeguard workers during the SCSR change over process or facilitate refuge for those in difficulty. Such change over stations would allow for mineworkers to rest, change SCSR in fresh air, plan their method and route of escape and, as a last resort, leave an injured person(s) who cannot travel to await rescue. Audible signs (chimes) would have assisted workers identify their location and the proximity of key emergency infrastructure.

12. Review protocols for donning and changeover of SCSRs and provide appropriate training given to all personnel.
13. Review footage of self-rescuer changeovers from the exercise as a learning tool.
14. Review time frame for removal of MSA Lifesaver 60.
15. Review maintenance of PEDs and remove faulty PEDs from service.
16. Review CRO evacuation procedures to include a general PED message to all personnel required to evacuate.
17. Review training of statutory officials (and other personnel that may be required to lead in an emergency e.g. rescue personnel, leading hands) to include decision-making, leadership, communication and accounting for personnel.
18. Develop a standard evacuation protocol that includes:
    - Use of transport
    - When to change self-rescuers
    - Non-verbal communication
    - Route of travel
19. Consideration should be given to have a ladder or some other implement available to reach the isolation valves in an emergency.
20. Consideration should be given to implementing a first response system at the mine to deal with emergencies until professional help arrives and can be deployed to assist. Industry needs to seriously address the issue of first response by way of clearly identifying what a first response team is expected to do i.e. fight the fire plus any other identified duties and what equipment they require. This will also mean that intensive fire fighting training and other associated training will be required ASAP, particularly as many mine sites (Broadmeadow included) do not permit the lighting of fires on site.
21. Consideration should be given to refreshing all employees as to what to do when they exit a mine in an emergency e.g. identify who they are, where they are and their physical condition.
22. Positive and effective isolation must be performed at all times when any equipment needs to be accessed - this was not the case in this incident.
23. Consideration should be given to ensuring the work load is spread among all the team and not having individuals pushing themselves to complete tasks leading to exhaustion.
24. Consideration should be given by QMRS to review its communication methods with operational teams – this equipment is outdated.
25. Consideration should be given to the provision of whiteboards at muster points to assist with non-verbal communications.
26. Consideration is to be given to review the minimum number of mines rescue trainees – with most people working 12-hour shifts this effectively reduces the number of trainees available to respond by half (fatigue related policies), also with people choosing to live remote from mining areas response times/availability of trainee’s is prolonged.

Surface

1. Incident Management Process—in recent years the mining industry has started to adopt the Incident Control System (ICS) Training provided by the Queensland Fire and Rescue Service or the mining version called Mine Emergency Management System (MEMS). Mine sites need to clearly evaluate which system they are going to utilize to cope with emergency response (including the conventional systems already in place). Each mine must then ensure that their staff are trained, practiced and competent to fulfil their roles and responsibilities as identified in their own system.
2. Allocate activities based on the functional grouping of the ICS.
3. Risk assessments must be documented and structured for all actions and decisions being undertaken.
4. Develop a procedure or a list of questions to maximise the most of this type of interaction, and to ensure accurate information is obtained.
5. The visual display of information in the communication room could be improved. Activities and options were listed with names of responsible persons. It is important that all established facts are displayed to allow each participant and new IMT member the opportunity to view the current status of the incident. The established objectives of the group should also be displayed. Another white board could be used to list activities and allocated responsibilities. These white boards should be printable to ensure a record is kept of the IMT process. A terminal with a display of the gas monitoring system should also be present in the room.
6. Install a second phone line that supports data transfer for the GC to allow modem transfer of data, and real time support from Simtars.
7. All relief CROs must get more regular exposure to the GC, perhaps running the samples once a tour, so as to keep abreast of changes with the instrument and sample introduction.
8. ICS - The personnel need to be trained in the functions required for the ICS system to work. This training relates not only to the functions of an individual but also recognition of the roles and responsibilities of others and the appropriate interaction mechanisms.
9. The planning group is also required to maintain an information service. This is critical to ensure that we are dealing with accurate information and that all groups are dealing with the latest and validated information.
10. It is recommended that the mines inspectorate mobilise a Simtars response in response to the exercise scenario in all future level 1 exercises. This will test the interaction and communication process between the inspectorate and Simtars.
11. Mine site level 2 exercises should be carried out to test the practicality of personnel to carry out designated functions with available resources.
12. GC - The frequency of and complexity of GC training should be reviewed. In addition the number of people available per shift competent to operate the GC needs to be reviewed. It is not appropriate to expect the control room operator to run the GC during an incident.
13. Personnel should consult duty cards to ensure functions required were carried out. Duty cards should reflect required functionality.

By implication duty cards specify the roles of key personnel – if function is not listed it is not part of role – e.g. what is role of VO? – part specified by duty card 2, but clearly the role extends beyond this.

14. Do not carry out informal or non-documented risk assessments.

15. Structure - Follow a structure for risk assessments and discussions to ensure that conclusions are reached and digression does not occur. Personnel in the Planning group need to follow the discipline of the meeting process to ensure effective operation of the planning group.

16. A systematic regime should be established for reporting and displaying monitoring information. Without systematic recording of information it is impossible to effectively brief external bodies or undertake changeover of key personnel.

17. Remote access to Safegas gas monitoring software should have been utilised in the planning room much earlier than it was.

18. Reporting of the ventilation officer should be constant and through the planning coordinator.

19. Site based mines rescue personnel should be trained in mines rescue protocols to provide mines rescue input into the planning group/IMT before mines rescue arrive on site.

20. Review response protocols for QMRS.

21. QMRS need to consider response times to all underground mines and factors which may affect this.

22. Put the fire out.

23. The need and ability to secure the lamp room be considered and addressed.

24. The lamp room Duty Card (Duty Card 7) should include duties relating to manually checking lamp racks to accurately identify lamps in use (out) as an additional cross check to the tag board and Lamp-In-Use book.

25. Re-hydration should be identified as a key <u>initial</u> requirement of the debrief process.

26. Medical examinations by on-site medical personnel should take priority over debrief and that such examination should include objective medical observations of these persons (e.g. pulse, blood pressure, physical examination). If absolutely necessary, debrief/gathering of critical incident information could occur whilst such examination is occurring.

27. A mine plan should be made available for use during debrief.

28. Debrief forms should be redesigned.

29. Employee records should be identified in the initial phases of an emergency/entrapment situation.

30. A protocol for this type of communication should be developed with sample questions. All questions asked should be read from a written copy so that the answer options can be reviewed against the exact question.

31. Consideration should be given to the processing of incident information and decision making online so that all parties, including SSE and QMRS have all information readily available.

32. A system for non-verbal notification of an emergency should be developed. This may be as simple as an initial triggering of the emergency button on the phone or a non-verbal dial up code on the DAC or phone.

33. Review the Emergency Response PHMP:

- Review of the base risk assessment to ensure it covers the mine's current risk profile
- Documented standards for cache layout and design and for egress marking
- Initial response to a fire
- Early warning of fire through the correct location and alarm levels of real time monitor, and TARPs for gas monitoring alarms that provide for a graduated response
- Defined review periods/triggers for the PHMP and associated TARPs and SOPs.
- Set KPIs suitable for management review to determine the health of the PHMP such as training compliance, audit and review compliance and audit results
- Determine the appropriate training, assessment and retraining scheme for senior management, control room operator, mining officials and duty card holders in the PHMP and associated protocols.
- Determine the appropriate training assessment and retraining scheme for all underground personnel in escape equipment and consider the action to be taken when persons are not in training compliance.
- Review the duty cards. Consider the provision of a simple duty card system for the CRO to assist in the direction of initial response and the tracking of personnel underground in an emergency. The current numbered duty cards (No. 1 to 8) should be reviewed as a result of and taking into account the results of the exercise.

Appendix 1 – Exercise Timeline

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Control	Roof fall in tailgate initiated.	11:22	Persons briefed on face and 3 contractors called into tailgate onto face.	Longwall Face
		11:28	Two contractors on face at shearer feel air change and hear roof fall at tailgate and proceed to TG to investigate. Contractors stop at chock 40 and notified control of fall.	Longwall Face
Control	Fire in MG 4 cut-through initiated.	11:30	Light smoke noticed coming in from MG.	Longwall Face
Control	Fall in tailgate reported to control. Crew advised to hold in the crib room until further notice. Control contacted Mine Manager to advise of situation. During this conversation Real Time Sensor MG1 HT Return alarmed on CO.		2 on face tried to communicate with control from DAC at Chock 70, with no response	Longwall Face
			5 men at 4ct identified need to don rescuers – went to crib room.	Longwall Crib
Control	Longwall crew contacted control advising of smoke on the longwall. Longwall crew was advised of fall on tailgate. The instruction to evacuate was given by control.	11:32		
Control	Mine Manager and Tech Services Manager came to control, were briefed on the situation and gas data.			
		11:33	Contractors heard conservation on DAC at chock 60, are informed of smoke at MG1 fan (off scale), the 2 then confirmed smoke on L/wall 1 face Instructed to go to crib room Men contacted control by phone from crib room (notified 9 persons there)	Longwall Face
		11:35	Donning rescuers – checked belt road (Difficulties in donning) All communications were verbal - talking through SCSR	Longwall Crib

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Control	Contact made with MG2 and MG3 deputies and advised of situation and to evacuate to surface. Control organised vehicle transport to surface.	11:36	Rang control 2 men on face donned belt worn SCSR and proceeded to the crib room Received message across DAC looking for Deputy 9 miners who were between 4ct and crib room were donning rescuers direct from Cache @ 5ct (issued with dark smoke goggles)	Longwall Face
Control	All contractors advised to evacuate pit and leave one vehicle for longwall crew.		2 face miners change SCSR at cache @ 5ct and issued with dark smoke goggles.	Longwall Face
Control	Emergency siren started. Operations leader advised TG sensors are off-scale Full evacuation in process	11:39	Self -rescuers on Identified SCSR Cache and need to take one each Blind man sticks handed out	Longwall Crib
Control	Ramp open to light vehicles only. Security told to restrict access to the mine.	11:40	All 11 miners congregated in belt rd at 5ct.	Longwall Face
		11:41	Half group into belt road heading – 2 still putting self-rescuers on (No clear leader, no defined strategy)	Longwall Crib
Control	The Mine Manager and Operation Leader consulted mine map and determined where approximately the incident was, and the nature of the incident. A decision was made to shut down the belts. Foam, fire fighting equipment and rescue gear started to be organised Tube Bundle still showing normal results	11:44	Verbal discussion in belt road. Supervisor counted persons Proceeded down belt road until noticed increased temperatures Returned to crib room. Verbal discussion for 5mins re next action (Talking through self-rescuer. Incorrect count of persons)	Longwall Crib
Rescue	Personnel allocated to ICS roles i.e. Planning, Logistics, Incident Controller and Operations	11:46		

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Control	Advised Open Cut of situation	11:47	After discussion between deputy and contractor supervisor count of persons made and decision to go back to crib room.	Longwall Face
Control	Advised personnel from MG3 to report to muster area for debrief	11:49	Attempted to evacuate via travel road (discussion on fire) then turned back and attempted to go out belt road.	Longwall Face
		11:50	Proceeded inbye of transport road. Stopped. Verbal discussion regarding appropriate egress. (Talking through self-rescuers)	Longwall Crib
Control	Someone was advised to check the tag board	11:53	Reach crib room as group split either side of mono rail and no decision making.	Longwall Face
Control	The Operation Leader and Service Engineer discussed gas results whilst referring to mine map. It was theorised that the incident could be a fire. They identified possible locations for the fire in the MG, and it was proposed the transformer at 4ct was the likely source.	11:55	Attempt travel via travel road for the 2nd time	Longwall Face
			Returned to belt road and headed outbye until temperature increased and could not proceed (Retried failed method)	Longwall Crib
Control	Mine Manager and Operation Leader came to Control to confirm situation. 10 people unaccounted for. There was a fire underground. Confirmed foam was being organised.	11:58	Informed too hot and thick smoke, lights (turned down), turned around discussion to go out TG, informed by one of the men from the face of the fall Discussion on taking vehicle around to the bleeder road	Longwall Face
			Discussion regarding transport. Visibility was extremely poor. Decision not to use transport based on visibility.	Longwall Crib
Control	Organisation of GAG began VO advised bag samples for Tube Bundle Points 1, 6 and 11 should be taken and analysed through GC.	12:00	Lights out thick smoke, all persons took spare SCSR from EBA @ 5ct, some took a walking stick	Longwall Face

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
SSE	Ventilation Officer contacted John Brady and put him on standby. Steve Rowland contacted District Mechanical Inspector of Mines, NRMW; BMA Corporate; ISHR; QMRS; SSHR and reported that there was a fall in tailgate, smoke outbye, men inbye. Evacuating mine and development panels.		Headed back inbye in transport road. Verbal discussion.	Longwall Crib
		12:01	Headed outbye on transport road until temperature increased and could not proceed. Returned to crib room (Still attempting to exit via MG without due consideration to the nature of the event)	Longwall Crib
Control	Electrician enquired about power underground. It was stated that power had been lost to the longwall, all other underground power was intact.	12:03	Started out along lifeline in order, hands on shoulders. Came off lifeline at 5ct, Group started to split up, (1 man 15m in front, 8 together (hands on shoulders), 1 x 5m back and last man 5m further back. First man through double doors decided to change SCSR while waiting for others.	Longwall Face
		12:05	Headed inbye along transport road. 3 men at the front of group. Next 7 men formed a chain. Last man dropped away from group (Human chain worked well (used lamp cords, canes, belts) Team did not notice that 1 man had dropped behind	Longwall Crib
Rescue	QMRS returned confirmation call to Control room (as instructed by the initial caller to QMRS Emergency Call Out system). Control room requested a response based on "Fire in mine and up to ten men missing"	12:06	Last man stops, disorientated, turned around a few times and then headed to double doors.	Longwall Face
Control	First alarm on tube bundle acknowledged. CO off scale. Bag sampling initiated.	12:09	Main group through 1st of double doors at 7 - 8 CT and change over SCSR. Last person changes SCSR outbye doors	Longwall Face

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
SSE	SSE contacted Goonyella Riverside.	12:10	Commenced self-rescuer changeover at inbye double doors. All changeovers have difficulty with the worst having no self-rescuer on for over a minute. One person was inflating his bag from atmosphere (nose clip off and inflating bag) (Good location for changeover (sheltered) Changeovers were extremely poor and with no apparent changeover protocol)	Longwall Crib
		12:15	7 men proceeded inbye (limited by real-life self-rescuer cache numbers) Deputy removed from exercise. 3 men instructed to remain in crib room area, walking to consume self-rescuers.	Longwall Crib
		12:17	Reached 9 CT EBAs, took one each as spare	Longwall Face
Control	ISHR calls and is advised of situation.	12:21		
Rescue	Two on site personnel opened up the Rescue Room and started to test equipment.	12:30	Crib room area Changeover of self-rescuers for 3 men who are “walking them out” All changeovers had periods with no self-rescuer or holding breath.	Longwall Crib
Mine Manager Planning	A deputy has been sent to the low wall with gas monitoring equipment. Planning Group noted that only 7 SCSRs were available inbye the longwall and tailgate – this was not linked to the fact that it was believed that 8 people were evacuating via this route.	12:35	Self-rescuers off.	Longwall Crib
SSE	Inspection Officer contacted mine – on his way.	12:37	Reached EBAs @ 16CT, simulated a change over, and continued with spare SCSR in hand.	Longwall Face

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Control	Mineworker's tag was found on tag board, and deemed as missing.	12:41		
SSE	Notified Police Service. SSE did not request response as yet. Qld Ambulance put on standby. SSE rang Electrical Inspector, NRMW to give update.	12:46	Reached EBAs @ 23 CT, simulated a change over, continued with spare SCSR in hand	Longwall Face
SSE	SSE updated ISHR – approximately 7 people in longwall maingate when incident happened.			
Planning	Ventilation Officer discussed reducing the airflow over the fire. Planning team trying to develop a plan for mines rescue without mines rescue involvement.			
Control	Contact made with people in the crib room underground. Non-verbal communications via the DAC was used. It was determined there was 3 people in the crib room inbye 4ct. It was observed that the questions asked were sometimes a double negative and could not be answered with Yes/No answers. Some confusion/misunderstandings arose from these questions. It was determined via DAC that: – All personal on longwall were OK. – Confirmed 7 people were walking out, and identified issues with cache only containing 7 self rescuers. – It was determined that there were 36 self rescuers in the crib room, and they were advised to stay in the crib room with self rescuers. – 4. It was wrongly determined that the transformer was not on fire.	12:50 – 1:13	3 took SCSR off, 4 continued to use Reached cross panel bleeder road at the back of the panel, confusion whether this was correct road (one miner refused to follow)	Longwall Face
		12:55	PED message "Hit DAC once for u/g, twice for surface" (PED and non-verbal DAC communication was a good idea. Not all PEDs were working. Some DAC questions were poorly phrased.)	Longwall Crib

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
		12:57	DAC communication from control room to confirm location inbye 4c/t. DAC communication from control room Identified location as crib room and numbers at crib room.	Longwall Crib
SSE Planning	Requested police assistance by SSE. Group developing plans: Plan A – non-explosive: QMRS FAB at MG3 team to assess conditions and communicate to IMT then assess MG1 travel road to fight fire. Plan B – if explosive.	1:05	DAC communication from control room Determined location of remaining men, location of fire, status of men, status of TG.	Longwall Crib
Rescue	Two QMRS brigadesmen were requested to attend the Planning function meeting to advise on setting up an FAB.	1:10		
Control	North Goonyella phoned confirming 8 mines rescue personnel. It was acknowledged that the fire was at 4ct and no one was fighting the fire.	1:13	DAC communication from control room Identified if there were sufficient self-rescuers, if there were any injuries and if there was access outbye of MG	Longwall Crib
SSE Planning	ISHR on site. IMT meeting – 3 people at longwall crib room; some people have gone around the bleeder (group assumed that 8 have gone around the bleeder); fire is at 4 c/t.	1:15		
		1:27	Reached T/G side of back bleeder road (22 minutes to traverse) Continued to change over at EBA caches along bleeder A number of PED messages were received while crew travelled last 12 pillars of bleeder	Longwall Face
SSE	Police arrived on site.	1:38		
Rescue Planning	QMRS Technical Assistant arrived on site. 3 people at the longwall crib room have to go to the tailgate cache and get 6 SCSR each and evacuate via the bleeder system.	1:43		

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Rescue	QMRS Operations Manager arrived with back up trailer.	1:45		
		1:50	DAC communication from control room Instructed to get six self-rescuers each and evacuate via the bleeder road and to communicate from MG 23c/t phone/DAC (Request was impractical. Did not appear to take into account visibility, the self-rescuer they were already wearing and the weight of the six self-rescuers.)	Longwall Crib
		1:55	Communications lost Went to TG and picked up 2 self-rescuers each. Found TG DAC not working. Decided to return to crib room.	Longwall Crib
Control	Confirmed list of people still underground.	2:06		
Rescue	15 BG4s ready for team operation.	2:10	Reached crib room. Found belt DAC and crib room phone u/g.	Longwall Crib
Control	Confirmed the name of suspected missing mineworker on the list of people still underground was incorrect and his tag was left over from night shift. HR contacted him.	2:15	Determined impractical to exit via bleeder. Decision to stay at crib room	Longwall Crib
Control	Police in control room	2:17		
Control	Non-verbal DAC communication initiated from underground from seven people walking out, they were at TG DAC.	2:21	All 7 miners reached surface at TG1 and used DAC to contact control, as smoke was in the cut all kept SCSR on, communication was by way of pushing DAC buttons in response to questions by control. Control asked miners to use DAC whilst walking along surface (in pit) belt. After using first DAC on overland conveyor and on arrival at MG1 the miners decided to take the troop carrier.	Longwall Face
Rescue	Mines rescue team ready to go underground.	2:30		
Control	Non-verbal DAC communication initiated from underground from	2:32		

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
	seven people walking out, they were at the in pit transfer belt.			
Planning	IMT meeting – 7 people on the way out – not 8. There is an issue with the tag board. Decision – do we fight the fire or send a team to conduct a search? Decided to develop a plan for search and rescue and then fight the fire.	2:45	7 reached control room	Longwall Face
SSE	Mine Manager gave SSE on update on gas readings. Mine Manager said "7" people are on surface. Confirmed suspected missing mineworker – he is at home. QMRS mobilised – possibly 30 minutes to go active to fight fire or rescue men in tailgate. Defer next meeting to 3:30 pm.	2:55	Individual debrief of each miner. Whilst medic asked as to physical condition and symptoms during debrief, the actual condition and monitoring of persons was not done and re-hydration was poorly controlled.	Longwall Face
SSE	Media release given out. "This is a Qld Level 1 Emergency Training Exercise Only" An incident has occurred at Broadmeadow Mine at approximately 11:45 am. At this stage, there is a known fire on an underground conveyor belt. The Queensland Mines Rescue, Department of Natural Resources and CFMEU have been notified. The incident is currently being managed by site with rescue operations underway."	3:12		
Rescue	North Goonyella rescue team arrived.	3:30		
Control	Control advised Operation leader that the 3 people still underground should have been walking for nearly 2 hours.	3:39		
SSE	Inspection Officer, NRMW on site Fire fighting plan completed.	3:43		
Control	Reminder PED to 3 underground people to use DAC at TG.	4:00		
SSE	SSE called Crinum for mutual assistance and relief.	4:10	First man dies (CO poisoning – caused from side breathing and from poor changeover procedures)	Longwall Crib
Control	QMRS proceeding down ramp	4:22		

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
Rescue	1st rescue team at bottom of ramp	4:24		
Rescue	2nd rescue team arrived at bottom of ramp	4:29		
SSE	Mine Manager updated SSE: ▪ GAG into pit and connected – planning being reviewed. ▪ QMRS mobilising team to attack fire. Expecting people from tailgate portal. Enough foam on site for 2 hours, another 2 hours from Goonyella Riverside and Moranbah. ▪ Relief for IMT arranged. ▪ SSE requires gas readings – coal on fire in pit – estimated 30kgs of coal consumed every 30 minutes. Vent flow in place if GAG to run. ▪ Fire fighting now - mobilised at 1545. ▪ Next update at 1700.	4:32		
Control	QMRS take second vehicle with fire trailer taken to MG1 First QMRS vehicle advises visibility poor and CO is 30ppm.	4:34		
Control	QMRS advises fire has reached the portal and require back up.	4:41	Second man dies (CO poisoning – caused from side breathing and from poor changeover procedures)	Longwall Crib
		4:45	Rescue team captain instructed a team member (1) to find the isolation valves on service pipes and turn them off, to achieve this the person had to access the off walk side of the conveyor belt via the belt cross over located just near the MG2 transfer point.	Rescue
Control	QMRS underground advise they have lost one person.	4:47	Rescue captain instructed team members to set up to commence applying low expansion foam onto a given target, only one man (1) responded to running out hoses.	Rescue
Planning	Developing a plan to push dirt over the high wall. Fire now at portal with 2 teams now fighting the fire. (the 3 people still were still in the pit 3 hours after it was believed they had left)	4:52	Rescue captain noticed team member sent to isolate service pipes had not returned, instructed two (2) members to look for him on last know area of activity.	Rescue

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
		4:56	Missing rescue member located by search men, captain issued distress signal, no response from team members	Rescue
Control	QMRS advise lost person was found unconscious	4:58	Third man dies (CO poisoning – caused from side breathing and from poor changeover procedures)	Longwall Crib
Control	Fire announced as out. QMRS Team 1 will stay and Team 2 to bring unconscious person to surface	5:05	Captain used DAC to inform control of condition of team member, instructed by QMRS official to bring both teams back to FAB.	Rescue
SSE	Mine Manager updated SSE: ▪ No information on persons evacuating ▪ Attacking fire from portal. ▪ Talking to OCE re: dirt to seal portal. Sealing door damaged. IMT getting for information from QMRS. ▪ Next update 1745.	5:08		
Control	PED sent out to all "Fire is out"	5:20		
		5:25	PED message fire is out	Longwall Crib
Control	PED sent "Rescue team going into MG"	5:39		
Rescue	First team returned to surface.	6:00		
		6:35	Rescue team in area	Longwall Crib
		6:40	Rescue team entered crib room and determined that 3 men were dead Rescue team informed CRO of findings (Pertinent information was relayed, Mines Rescue acted in accordance with their parameters/procedures)	Longwall Crib

LOCATION	SURFACE	TIME	UNDERGROUND	LOCATION
SSE	3 miners – deceased Rescue to tag bodies and leave Steve briefed police Bodies in-situ Police secured scene NRMW seize site and documentation	6:42	Exercise terminated	Underground
Committee	Feedback session is given to the IMT from the assessors.	6:50		

Appendix 2 – Previous Exercise Recommendations

Control Room

1. To overcome the problems with providing paper based gas monitoring data, an on-line incident simulation was used that emulated the mine monitoring system. This system known as MEMS allows for modifications of the scenario in real time as the incident changes and site personnel attempt to control the situation, with changes able to be fed to the incident management team via secure communications.
2. Translations of information via the phone led to a number of incorrect calls/information i.e. gas concentration levels.
3. Formal procedures need to be introduced and personnel trained in the emergency procedures for site i.e. the use of the DAC system to indicate location underground to control room not recognised.
4. Key personnel need to be aware of key factors of their system such as response times and analyser ranges.
5. The supply of two-way batteries for radios for surface use is insufficient to allow long term use of the sets available.
6. IMT is to ensure that the control room operator is informed of intended actions so that he can confirm actions as required. This should be done by one of the duty card holders. This way the control room operator only gets information from one persons in contact with the IMT.
7. Limited access to the control room is imperative to stop people wandering in and out.
8. An extra phone point for personnel with duty cards is necessary so as not to use the control room as a telephone room.
9. Gas Chromatograph Operator was useful as a backup for the control room operator although he was not required to take a large number of bag samples due to the scenario.
10. Ensure that duplicate tasks are not given to duty card holders and that duty card holders stick to their duties.
11. Consider increased and more regular use of the PED to send messages to trapped personnel. Short, accurate messages can often provide a moral boost and perhaps can also be used to provide advice/directions. This should be further investigated.
12. A more autonomous/automatic mechanism to identify where personnel are location underground ad when they have returned to surface would be of great value.
13. Relief duty card operators need to be fully trained in their roles, responsibilities and functions.
14. Control room operator (or some other delegated person) should regularly continue ringing the phone.

This not only provides orientation to those people lost in poor visibility, it gives a reassurance to persons who maybe able to hear it but not respond. Regular broadcasts down the DACs could have the same effect.

Data Analysis, Interpretation and Monitoring

1. Safegas access should be extended to each key area.
2. There should be more personnel trained in the operation of the tube bundle systems and Safegas, including all its functionalities (especially from the taking of bag samples and how they could be analysed in a timely manner).
3. Consideration should be given to installing differential pressure sensors/velocity sensors to enable changes in ventilation to be accurately monitored.
4. Consideration should be given to installing further real time gas sensors – CO and O2, at more key points in the mine to allow characteristics of mine atmospheres. This would allow personnel underground who do not have personal gas monitors to be aware of the mine atmosphere at the sensor location. Locations could include: escape ways, caches, belts, transformers and intakes.
5. Computer access to the mine environment monitoring system in the IMT is essential. Ventilation simulation software should also be on this computer.
6. A mine plan in the IMT should show monitoring locations.
7. Ventilation flow sensors in key roadways would enable more accurate interpretation of makes and effects of changes in ventilation.
8. Off-scale readings on the tube bundle should trigger immediate bag sample collection. There is slow response to obtaining and analysing bag samples.
9. It is recommended that the functions inherent in current gas monitoring software be explored, particularly the facility to store and retrieve documents detailing required action response plans. Such software has much to offer control room operators and IMT personnel.
10. Review location of types of gas detection equipment underground in light of ability to detect changes in mine gas atmosphere.
11. Review tube response times and cycle time – reduce ballast volumes.
12. The maintenance of gas monitoring after an incident should be completed to include the redundancy of sensors and tubes/borehole back-up for sampling of key areas and communications.
13. There should be a designated role of a person on the incident control team to be responsible for accurate gas monitoring information.
14. The role of Simtars when assistance is called for should be known thoroughly.

15. Safegas system should be connected to the control room monitors. The absence of the Safegas system means that the trending of gases from the tube bundles and any derived indicators cannot be done except by hand.

16. Further training needs to be undertaken by control room personnel regarding AMR sensors and gas concentrations and what type of reading an unserviceable, disabled or destroyed sensor would give.

17. Monitoring station numbers and AMR sensor numbers need to be matched appropriately.

18. Personnel would benefit from increased training and awareness in the capabilities of Safegas software, particularly in trending of gases, especially Quick Trend; SPLUS; Multiple site analysis and holds on key monitoring locations; Further understanding of the separate sources of lags and delays in analysis and their cumulative effect.

19. Use “Instruction” feature of Safegas for TARP implementation and recording of actions.

20. Modify Safegas so that login time lasts for the shift duration of the control room operator. CRO had to log out whenever he left the control room. This will reduce frustration on accepting alarms.

21. A better understanding of the operation of the tube bundle sampling regime, the capabilities of the software and the computer control system is necessary to optimise the collection of relevant information.

22. It is important that samples of gas taken are labelled with the time taken and location of sample.

23. The mine monitoring system should include a facility to print a table of the latest data for all locations with date and time of all gases and be able to export to other programs or for email. This would allow error free transfer of data to other interested persons.

24. Ensure that gas chromatograph analysis of the atmosphere is undertaken as soon as practicable. Utilise Simtars or other relevant expert for additional review and verification of gas data.

25. Mine monitoring systems should ensure that trend graphs include the latest data.

26. Mine monitoring systems should include a label of tube numbers as well as locations – mine plans only refer to monitoring points by tube number when doing trending and analysis.

27. When a monitor reaches full scale, it should read “full scale”, instead of displaying a value. The value -999 can be interpreted as actual.

28. The mine monitoring system should have the ability to display trends of more than one sample point at a time.

29. Nitrogen dioxide should not be monitored via the tube bundle system. Underground personal monitors should be used instead.

Debrief

1. Debrief sessions must be structured with adequate resources, such as mine plans and question prompts sheets to facilitate accurate and complete capture of information.
2. There needs to be a formal de-briefing procedure in place, including a scribe to record all information to ensure that there is no lost information, wrong conclusions and poor recording.
3. All personnel being de-briefed need to be made comfortable, provided with adequate food and drink and tended to for any first aid needed.
4. Security needs to be placed on debriefing rooms to control who enters and exits the room.
5. It is essential that identification of any casualties be verified and accurate prior to the release of information to outside parties.
6. Review de-briefing procedures – suggest a prompt sheet be developed and/or utilised.
7. Training personnel available to debrief persons after they evacuate the mine. The knowledge evacuees have is vital to the IMT.
8. Information from debriefing sessions to be incorporated into the decision making process e.g. the operator of the vehicle may have provided useful information to assist that decision making process (the fire was relatively small, the fire was actually 20m inbye 9 cut-through). Critical witnesses should be identified and also de-briefed by IMT so that they can get a better understanding of underground conditions.

Emergency Initiation

1. The control room operator position should be a competency based position which includes the knowledge of monitoring systems and gases.
2. Refuge bays/change-over stations should include communications and gas supplies and monitoring lines.
3. A computerized system should be introduced for duty card operation and logging of actions. This should also be used to check validity of duty cards for use of back shifts and practicality of operations.
4. It is recommended that one of the training rooms be set up as an incident management room, and that a person detailed in the emergency procedures be positioned as a door guard to prevent disruptive entry to this room.
5. It is recommended that duty card sheets are made "tick and flick" style sheets, and that senior management adhere to their defined areas. This ties in with IMT as a specific team in a specific place with defined areas.
6. All personnel should be trained, including refresher training, in the location and basic content of the emergency response plan.

7. It is essential that the incident control room be complete with a number of electronic whiteboards, accurate mine plans, desktop space, communication facilities – preferably with automatic call forwarding of all incoming underground phone calls, video/audio recorders, secretarial/shorthand support and security against intrusion.

8. All persons, including managers and supervisors, must be trained in the use of self rescuers and their changeover procedures in genuine environments, including underground, after heavy work and in limited visibility.

9. Rescue room needs to have up-to-date and suitable rescue plans in the room at commencement of emergency.

10. There should be a mine surface controller function to liaise with operations base and organise any requirements e.g. task allocation for personnel.

11. When using the Macroview systems, computers in the control room to monitor tube bundles gas monitoring system, site personnel should have approval to move monitoring locations – not having to contact a Brisbane computer consultant to modify the diagram.

12. Alarm points in the Macroview system should be reviewed as all red alarms look the same and can be misinterpreted.

13. A log should be kept of active monitoring sites in the control room.

14. Utilise email system to send information between IMT and control room operator.

15. Ergonomics of control room to be reviewed e.g. location of DAC, 3 phones and 4 computers – with three people using these at once, no one can hear clearly or operate without distraction, increasing the risks of error.

16. It is recommended that in future the scenario be created with false alarms and staged introduction to allow for more realistic response from site personnel.

17. A mine must have an established, structured and comprehensive system for managing an emergency with a trained, disciplined response team. Duty cards are not a comprehensive system; they are simply a functional aid for the overstressed cognitive processes of the human brain in the early stages of an emergency.

18. All organizations should review the ICS for application in emergency incident control. Key areas of learning are – discipline in adhering to the system, limiting the span of control (i.e. no greater than five particular resources per person), clear authority in authorizing plans and actions and managing the communication flow.

Self Escape

1. Mine personnel should spend some more time brainstorming/training sessions to utilize available equipment innovatively to make air showers, barricades etc. This will improve the likelihood that panic won't set in should some personnel be unfit to facilitate self escape. It would be particularly beneficial where there is more than one person to use the airline.

2. Escape ways, and their alternatives, must be walked regularly until all personnel are familiar with them.

3. All personnel, including managers and supervisors must undertake regular genuine emergency evacuation incorporating poor visibility to best test the adequacy of the current systems and accurately determine emergency preparedness.

4. There must be an integrated approach to emergency evacuation focusing on enhancing survival covering: self rescuer change-overs to occur in safe havens; safe havens to be fitted with lighting, drinking water and mine plans of where you are and routes of travel to the next haven and explosion proof communication channels; distances between safe havens to be spaced for worst case scenarios of zero visibility; signs and arrows pointing to escape ways, oxygen caches, doors or roadways delineated by hanging lanyards from the roof must be visible and all escape ways must be maintained in good order free form excessive walking hazards.

5. It is recommended that the provision of audible call sirens be installed on the safe havens in the face areas to lead people to them. This would allow a full accounting of persons and the provision of appropriate breathing apparatus and the ability to render any necessary first aid.

6. It appears almost impossible for a changeover of self rescuers to be done under duress without the protection of a safe haven.

7. Audible signals may be the best method to guide personnel back to face area safe haven.

8. Safe havens can be used as 'hubs' from which guidelines can extend, at a reachable height, to a number of escape ways.

9. Safe havens to contain suitable compressed air breathing apparatus that may be utilized to provide 'search capability' or 'first aid' and 'fire fighting'.

10. Explosion proof communication systems such as buried telephone lines should be explored.

11. It is strongly recommended that the process for self rescuer changeover be closely investigated and through consultation with the manufacturer, a standard procedure for the change over of these sets be formulated to minimize the problems associated with the donning of self rescuers.

12. The mine should re-investigate the escape timelines and distances between cache locations in longwall returns – particularly where poor visibility may be experienced.

13. Investigate the number of SCSR in the longwall return caches. In this scenario there were sufficient numbers, but there were only six people on the face. If there had been one more person on the face, there were no spare units in the caches. The escaping crew expressed concerns during the debrief of this point. Self escape routes need to be planned and serviced by sufficient SCSRs for the maximum number of personnel in the panel in both primary and alternate routes.

14. During the refresher training for SCSRs, mines must ensure that duration times of at work and at rest are explained to wearers.

15. Communications using pens and notebooks, and not talking through mouthpieces, should be adopted as an industry standard.

16. Self rescuer training should focus on entrapped procedure i.e. walking with O_2 turned off, resulting in an extra 20 minutes of O_2 time.

17. Self rescuer manufacturers to investigate modifying units to have “fluoro” mouthpieces and breathing tubes; worn over shoulder; have harder mouthpieces; have wire reinforcing in breathing tubes to prevent their constriction when heavy breathing; be easier to open and handle with wet/slippery hands; have interchangeable mouthpieces and ladders traversing overcasts should be lined up or have guidelines joining them.

18. Walkways over overcasts should have handrails to prevent falling off, and not have raised steps or trip hazards.

19. The provision of water-proof notebooks for recording information underground should be investigated.

20. Trial the use of walking sticks in areas of excessive rib spall. The trial to consider the appropriateness of using “candy cane” shaped curve handles, or the current right angled “elbow” shaped handles.

21. Treat any person who ‘escapes’ in the hot and humid conditions as a patient to ensure they recover from the experience – particularly in the re-hydration of persons.

22. It is recommended that the ergonomics of the CABA main valves be reviewed and modified (if possible). The need to turn two valves in different directions using different hands will inevitably give rise to circumstances where both cylinders are not fully operated.

23. Access and storage of CABAs could be improved to enable easier donning of the units; review the number of CABA units and accessories (buddy masks); review pre-start checks – is the one minute high pressure leak test necessary?; training on CABAs to include oxygen cylinder use philosophy – turn one on, when warning whistle sounds turn the other on (as used in search and rescue).

24. Protocol to be developed for information transfer in an emergency – should prompt any user in the important points to be communicated.

25. Link-lines between members of the group would prevent separation of members. Link-line would need to consider distance between members e.g. buddy mask line is a limiter. A life-line would facilitate escape speed and route.

26. Indication required at cut-through’s (both sides and ribs) to identify escape facilities such as telephones, DAC and caches. Suggest that only two levels of demarcation/indication be used – one for communications and one for escape apparatus.

27. Review CABA training to ensure contingency actions are known and rehearsed. This should cater always for the unexpected. Review maintenance program to ensure that CABAs are maintained in a state of operational readiness – the program should meet, as a minimum, manufacturer’s recommendations. Back-up facilities to any escape system/apparatus are required in the event of equipment failure.

28. Review emergency escape protocols to ensure the issues of how many units to carry and when to change over are clearly outlined. It is recognized that people in a stressful situation are liable to follow their instincts.

29. Review entry barrier to Quick Fill Station – the single pogo stick hung horizontally could be split into 3 – 4 lengths to allow easier negotiation. Quick Fill Station orientation to be reviewed to enable easier and quicker access and also facilitate the use of the multiple refill points – recommend that the station be turned 90°so that the refill points are in line with the cut-through and do not face the rib. Main valve operation on refill side of the Quick Fill Station should be reviewed – is it required? Can it be arranged to turn on when any quick fill outlet is operated? Maintenance and inspection program to be reviewed in include external fittings and their operation.

30. To assist in locating phones in thick smoke, phones should give an audible beep on a regular interval.

31. When the deputy is taken away from the crew there is no gas detection capability to determine the necessity to continue wearing self rescuers. The provision of a fixed station visible display gas readings e.g. at positions in the primary escape roadway may be worth investigating. The potential for the provision of multi-gas detectors and relevant tubes in caches and training in their use should be investigated.

32. The introduction of changeover stations to the mines should be evaluated. This would allow verbal communications with the surface en-route and provide a place to leave injured persons if required. It also allows a safer environment for the changeover of SCSRs.

33. Instructing crews to discuss escape options and have a plan and nominate a leader prior to starting escape.

34. Consideration should be given to develop procedures and systems that allow:

35. Competent persons to use more than one fire extinguisher prior to it being classified as a major emergency. The SOP allows no objective way of risk assessing and managing the fire. Consequently, there is a reluctance to assess a fire and take other appropriate action. There are situations where more than one fire extinguisher is required to douse a fire. That does not necessarily increase the risk profile.

36. Competent persons (other than mines rescue trained teams) to be deployed in inspecting and/or fighting fires with water hoses (e.g. ERZ controller). In some cases it is an acceptable risk to allow persons to inspect fires. The time taken to deploy mines rescue teams allows fires to increase in intensity.

37. Personnel that have evacuated to the outbye side of a fire (subject to appropriate health and fitness checks) to inspect or participate in fighting fires under the guidance of a suitably trained person(s).

38. Resources to be used to fight fires to be identified prior to mobilizing fire fighting teams.

39. Personnel assigned fire fighting duties should be competent and adequately briefed of the risks and their duties. The fire watch team was not considered competent to perform their duties to standard.

40. Training for personnel working alone in the mine for the discovery of fires, incidents and their actions to minimize the affects to the underground environment.

41. A realistic fire gallery should be used to train mine personnel in fire fighting.

Communication and Decision-making

1. There must be established a central, clearly identifiable, decision-making process, based on risk assessment principles.

2. All underground communications should be capable to being call-forwarded to the incident control room with automatic recording devices attached.

3. Accurate information flows must be established to minimize decisions that may result in catastrophic consequences.

4. It is important that there is provision for communications out of the control room as all stakeholders must be kept regularly briefed on currency and status of events.

5. The lack of a formal recording system would be seen as a major discrepancy in a Warden's Inquiry in the process of determining true nature and cause as vital information can be lost.

6. Communication between the control room and IMT needs improvement regarding: access of people in and out of control room; phone systems installed; how information is passed on, etc.

7. There must be clear authority of exactly who is in command and how decisions will be made with a definition of the composition of the incident control team.

8. Implement a communication system to the surface from each of the main cache locations for tracking of crews escaping and one-way communications from Control for updates etc.

9. Implementing a system to ensure ALL personnel underground receive notification of an emergency as quickly as possible – some crews did not receive any notification.

10. The communications interaction between the various operation areas needs to be systematically organised such that all operational areas are provided with the necessary information and updated regularly. Consideration should be given to undertaking this electronically to minimize the disruption of phone calls.

11. Provision of at least two telephones with people assigned as scribes to take incoming calls and make outgoing calls. One telephone should be assigned for incoming calls and one telephone assigned for use by the Incident Management Team for outgoing calls only. Lines of communication need to be clearly defined so that 'closed loop' communications can be achieved, with automatic feedback. Lines of communication will curtail some telephone traffic to the Incident Management Team and allow improved operation.

12. IMT needs to have direct communications to all critical personnel and functions. This may include de-briefing of key witnesses, briefing initial team, briefing persons/teams for a critical task and getting direct updates form crucial areas underground. The more important the persons/teams task is to a successful outcome, the more direct the communications need to be with IMT.

13. There needs to be a clearly defined decision-making and validation process in place for all decisions, particularly those of the incident management team.

14. The decision-making process needs more focus and each option needs to be driven to completion before allowing digression.

15. All IMT members need to be encouraged to actively participate in the decision-making process.

16. There needs to be more urgency in decision-making when retrieving persons underground who are injured or have limited life support equipment available.

17. An automated emergency callout system should be utilized and triggered from the CROs computer, with a voice message to land lines and SMS to mobile phones.

18. Improve information flow back to the communication officer. The system needs to specifically address how communication is to flow around the site and to which particular team members or individuals.

19. Communication via the emergency button on the phones was difficult, neither the underground evacuees nor control could understand each other. An adequate means of communication needs to be implemented.

20. Consider using electronic reporting systems.

21. Incident Action Plans should be developed and documented with time and date on them to enable all persons to be briefed on current situation and for clear understanding of required actions by operational teams.

22. If the mines drift block lights are used as an additional means to stop personnel from entering the mine the underground light should remain green to enable personnel to exit to the surface. Normal controls will be needed when a mine re-entry or deployment of vehicles from the surface is undertaken.

Incident Management and Control

1. Succession plans must be developed and implemented – people were getting tired.

2. Emergency duty card systems must be reviewed to achieving objectives using realistic numbers of personnel to operate.

3. There must be a central, clearly defined incident control team.

4. An adequately resources incident control room from which to exert central control is absolutely essential.

5. Recording and logging of events is essential and must be maintained throughout an emergency.

6. Provision must be made for impounding and securing evidence i.e. deputy mini-gas instruments.

7. Gathering of experts to provide specialist advice – proximate cause, predictive analysis, options and choices, process control experts specifically to ensure essential process occur/flow.

8. It is essential to have an evacuation trigger point flow chart on the control room wall, similar to the call-out procedure flow chart.

9. There must be clearly defined goals, objectives and priorities established by the Incident Control Ream including the establishment of an action plan.

10. There must be effective recording procedures, especially by the Incident Control Team of any actions taken, decisions made or reasons/evidence supporting these decisions.

11. Operational base membership should be pre-planned and have identification vests on and have pre-designated times for reconvening for updates on situation.

12. Urgent need to improve the water collecting/dividing manifold.

13. A central point is needed where all current duty card holders are identified with name, location and contact phone number and possibly have something to identify them to outsiders that come to the site.

14. When duty card holders change, it needs to be identified formally. Handover procedures for the Incident Management Team and a range of suitable personnel to fill various roles should be defined.

15. Numbers of people in Incident Management Team room needs to be reduced, maximum should be 5 or 6, not 13 as was the case at various times. Possibly only have sufficient seating for the main players.

16. Process management (decision-making process, time wasting, verification of data, information flow in and out of the incident management room, briefings done on time, checking milestone events, interaction of members) remains a vital part of incident management and must always be at the forefront of the operations within the IMT.

17. Authorities between the Underground Management Room and the Incident Management Team need to be revisited and operational effectiveness analysed.

18. The Mine Manager should be part of the Incident Management Team.

19. Reviews and assessments of critical issues needs to be done in a coordinated manner and followed through to completion.

20. Incident Management Team members should not be going in and out of the room while the IMT is meeting.

21. Fire Officer to review quantities of low expansion foam held on site and the first response capability of people with respect to fire fighting.

22. Develop improved incident management aids for the Incident Management Team to assist the application of a disciplined system for information management, recording and decision-making. Possibly pre-designed whiteboards on the back of the day-to-day whiteboards, that is, flip them over and they are laid out ready.

23. Develop a structured 'decision' (authority) delegation tool for assisting the Incident Management Team to remain strategic.

24. Emergency incident management training is to be considered for mid and upper level management.

25. The creation of a position of "Emergency Officer" specifically to address and facilitate expertise in emergency management, fire fighting, chemical hazard management and emergency safety training and systems (not simply another hat but a specific position). The Health and Safety Officer is a different role to this position but would work with each other.

26. More and frequent simulated exercises in atmospheres of impaired vision should be conducted. Everyone in the industry should be exposed to this scenario.

27. Ensure that the number and balance of the IMT is correct. This is a question of fatigue and how long a team should remain constituted until relieved.

28. Ensure that key personnel can be contacted at all times. The location of the ventilation officer was incorrectly logged and it was only when the Underground Mine Manager was contacted that the control room officer became aware of the ventilation officer's location.

29. The system to record the names and location of personnel below ground needs improvement as when some personnel evacuated the mine their tags were not relocated on the tag board causing confusion.

30. All personnel must remove tags or replace lamps, dependent on the system of accounting for personnel when they are safely on the surface.

31. At one point the contact numbers of persons to be notified in case of emergency for the contractors still underground was discussed and how they could be acquired. If the contractor log books had been in use at the mine, as had previously been agreed to by all underground mines, the details would have been readily available.

32. Develop a card system whereby sufficiently training personnel are available to conduct the tasks required by the duty card list.

33. The impact of un-stated intrinsic objectives such as – complying with established written procedures, mitigating legal liabilities and favourable judgment of performance by peers against attaining extrinsic objectives such as – saving lives, protecting property and recovery operations as research indicates that incident management systems have little, if any, impact on the survival rates of underground personnel in the first two hours following a major event.

34. Consideration should be made towards the 'closeting' of the incident management team for the greater part of the exercise. This may mentally reduce the potential of individuals to develop independent and innovative solutions due to long periods of intense pressure and an increase in the likelihood of developing a 'group think' mentality.

35. Duty card holders need to recognize the need to remain with the IMT unless authorized to leave. This is especially true if there is an exchange of roles.

36. A systematic process for evaluating fatigue should be implemented rather than rely on the individuals to notify the incident controller of their status.

37. Calculators should be included in the duty card briefcases.

38. Suitable techniques should be used to capture ideas, generate alternatives and evaluate the different options to allow for systematic comparison.

39. The IMT members change-over should be conducted on a staggered basis with no more than 2 persons being shifted at a time. This will provide for much more cohesion in the team and limit the possibility of loss of information.

40. A written chronological record of milestone events be kept, updated and regularly referred to.

41. Consideration be given to allowing the display of this information (through windows) so that persons can update themselves without having to constantly interrupt the IMT discussions with questions.

42. A series of check sheets should be developed for IMT2 to act as memory prompts in the same way as a debriefing officer ensures capture of information. The prompt sheets could include such things as: options discussed and reasons for not doing and/or doing; current goals /actions with expected outcomes, responsibilities and timeframes; any alternative or secondary thrusts being investigated; any limits established....time, gas levels, temperatures; problems or difficulties experienced to date.

43. It is recommended that IMT is to directly brief anybody being dispatched from the surface (FAB personnel, transport drivers, mines rescue teams, etc) or at least be present during the briefing.

44. It is recommended to allocate a person as surface coordinator to oversee all of the surface tasks, movement of personnel in and out of the mine and liaison with IMT. The control, allocation and updating of the deployment and availability of resources is a vital function of a coordinated emergency response and cannot be overlooked.

45. It is recommended that whiteboards for IMT be pre-formed and ready to be filled in with information like: goals, priorities, location of men underground, known facts, assumptions or data to be confirmed (and how to confirm), gas trending, intervention activities, contingency plans (who and what), etc.

46. The control room operator cannot be the first aid attendant at the same time during an incident.

Mines Rescue

1. It is recommended that further efforts are implemented to ensure that all team members are aware of the task they have been asked to perform and each person's role in the team (there appeared to be confusion on team roles when the original team captain was reassigned to FAB control).

2. It is recommended that consideration be given to the use of 'ex-brigadesmen' in roles such as FAB officials to allow full use of "BA current" men (this is particularly relevant when rescue volunteers are few).

3. QMRS teams are to ensure all team protocols are adhered to – even in the absence of reality, it is good practice (e.g. communications and information left with FAB official, captain/team checks on equipment, etc).

4. A formal log be kept of the location and status of all rescue equipment (this task is probably best done by surface control, although it requires input from FAB officials). This becomes particularly important when two types of BA were available for use.

5. Guidelines be developed and implemented for use of vehicles in potentially poor visibility.

6. Emergency communication protocols be reviewed. The rescue efforts were hampered by a lack of effective communications between the FAB and the surface.

The solution presented by the rescue controller to cut the telephone lines at 2 cut-through and install a phone was prevented by the assessment team. In the scenario, this would have cut communications to the remaining survivors underground – and in reality, it would have severed communication to the rest of the mine (some sections of which were still operating). There should have been better options.

7. An expert working party be established to develop and implement a set of guidelines on the protocols for a combined mine-site and QMRS intervention effort (i.e. when is it okay to keep a panel crew on BA? When should mines rescue teams take over? How should these two groups interact with each other? What are the potential risks?).

8. A need exists to clarify the call out process to mines rescue mutual assistance to ensure that not every trainee is called to attend the site, only those necessary will come today.

9. The mines rescue superintendent has a responsibility to obtain information and keep his personnel fully informed of the status of events, not just wait to be told.

10. The use of home answering machines interfered with the mines rescue call out procedure.

11. A reference system needs to be introduced to ensure that only those trainees current under medical and oxygen time are placed on active duty.

12. Mines rescue superintendent vehicle should have 'hands-free' provisions to answer calls and received updates whilst in transit to an emergency.

13. Station superintendent should be part of operations based team to assist management on mines rescue, gas interpretation, ventilation, fire fighting, escape systems and intervention strategies.

14. Mines rescue key staff need to be identified and should have colour identification jackets on.

15. Mines rescue and team captains need to be present at witnesses debriefings or read their reports.

16. Mutual assistance standard needs to be looked at as call out response times were outside the one hour limit.

17. An expert working party be established to research the use of flameproof vehicles in atmospheres containing levels of flammable gases in excess of the current legislative requirements, and guidelines to be developed on how and when they may or may not be used in life threatening scenarios. The outcome of this research may result in changes in the working of legislation.

18. QMRS and mines through their mines rescue agreement should ensure that competencies are developed and persons training for the key positions of Fresh Air Base Controller and Substation Mines Rescue Controller so that in the event of QMRS staff members not being available, competent persons will be available for these key roles.

19. Whilst QMRS have developed controls to attempt to minimize the effects on mines rescue personnel deployed in hot and humid conditions, these controls (administrative controls) are low on the list of hierarchy of controls. It is recommended that QMRS investigate modern control methods to minimize this hazard. Some controls may include cooling vests, cooling of breathing tubes, etc.

20. When developing mines rescue team tasks, position, status and content of the mine's emergency equipment which may be relevant to the task being undertaken should be marked on the plan and communicated to the mines rescue tams and FAB controller.

21. The exercise clearly showed that the better the escape systems (and therefore survival systems) in place at a mine, the more likely it is that mines rescue teams will be required to enter and search for survivors some of whom may be at distances not able to be covered on foot within the time constraints placed by use of self-contained breathing apparatus – the industry as a whole needs to ensure we are ready for this.

22. It is recommended that a forum of stakeholders be urgently established to develop and implement a set of protocols covering the interactions between mine-site first response teams and external aided-rescue organizations. Each of these practices provides specialist, but separate, skills and resources and it is vital that the issues involved in their interactions be identified and coordinated. There is little doubt that CABA teams will increasingly form part of emergency response capabilities in our industry and we must be prepared.

23. It is apparent that some protocols may be hindering the ability of the QMRS to achieve its goals of search and rescue, therefore, it is recommended that a review of mines rescue protocols and procedures be undertaken to determine their continued compatibility with the industry change from traditional aided rescue to the current preferred strategy of self escape. This should specifically cover the policies on team sizes, minimum equipment, stand-by team protocols, etc.

24. There needs to be a review of the number of brigadesmen that the mine can supply at any time of the day or work roster. This could also be expanded to other mines in the mutual assistance group.

25. Consideration could be given to training more of the workforce in basic fire fighting.

26. Protocols on how mines rescue trained personnel on site are to be utilized should be developed. This can take into account the type of emergency, number available and specific duty card or other specialized needs.

27. Protocols need to be developed of what inseam personnel can and cannot do while they are still underground. This commences with a company protocol and leads to a mines rescue guideline on actions and barriers that are required for inseam intervention e.g. could the mine's three rescue trained personnel coming out of the mine have gone to the fire and put it out?

28. Greater effort and focus from key mine and mines rescue personnel needs to be given to getting the first team off the surface.

29. Whiteboards should be developed for use in the rescue room which clearly show: locations and state of critical equipment; team membership and their equipment; captains type board with basic emergency information and team deployment information and critical times.

30. Risk assessment of critical and/or hazardous activities should be undertaken e.g. when Team 1 decided to fight the fire – how many men should they have had; what BA should they have had (there was CABA on the surface also); what communications should they have had; what turnout gear and first aid equipment do they have; method of fire fighting; active times, etc.

31. The incident controller or senior IMT member should brief mines rescue teams or at least be present to ensure that all information is being passed on and that questions can be answered by somebody familiar with the mine.

32. Testing of mines rescue equipment should be continued until all of it is completed.

33. Greater concentration on getting the first team off the surface, properly debriefed and equipped is needed as this is the hardest thing to do in reality. Once the actions and limits are set by the IMT, this must become the priority.

34. The role of the QMRS within the IMT should be clearly defined e.g. formally recognized as part of the decision-making team and/or advisory and/or implementation.

35. Clearly defined instructions to be issued to rescue teams. One way of doing so could be writing the instructions on the electronic whiteboard in the IMT room and giving the printout to rescue teams.

36. The role of preparing and issuing plans during an incident should be clearly defined. Additional plans will always be required. This may be a role for the mine surveyor.

37. It is recommended to allocate a designated coordinator to the critical area underground to oversee operations and to communicate directly to IMT – this is especially critical when there are multiple groups operating in one area.

38. It is recommended that a clear decision and instruction on what BA is to be used by persons, that is, BG174 or CABA, when both are available.

39. It is recommended that the mines rescue briefing room have schematics indicating location (surface and underground), type, quantity, pressures of all breathing apparatus equipment that can be used. This schematic could include poor visibility walking times between caches and CABA locations.

40. It is recommended that the mines rescue room have a wall prompt indicating priority actions for QMRS personnel as they arrive and when allocated to rescue room duties.

41. Use QMRS cards rather than having to make up visitor's cards for rescue teams.

42. Mines rescue activities should be coordinated through the operations team with a clear communication strategy between mines rescue teams and operations centre, then onto the IMT and incident controller.

43. Mines rescue must be fully briefed on who and where people are expected to be underground.

GAG

1. Time delay for the arrival of the fuel tanker for the GAG engine (5 hours) is unacceptable.

2. Maintenance on the GAG was poor in the following areas: fuel leaks around the afterburner injectors; requirement to clean spark plug should not be performed at deployment.

3. It is essential that enough water pressure be available to safely operate the GAG unit.

4. The circumstances regarding the GAG inertisation equipment must be addressed as a matter of priority and in accordance with the current mines rescue agreement in the provision of adequate docking facilities and water supply.

5. Site provisions for use of GAG and mobile laboratory to be investigated and documented to include provision of power, communications to incident control team, parking and the ability to connect the tube bundle systems and other sample locations.

Appendix 3 – USA Emergency Temporary Standard

The Mine Safety and Health Administration (MSHA) has issued an emergency temporary standard under section 101(b) of the Federal Mine Safety and Health Act of 1977. A full copy of this document is available from www.msha.gov.

IV. Discussion of the Emergency Temporary Standard

Background

During the month of January 2006, an explosion at the Sago Mine in Tallmansville, West Virginia resulted in 12 fatalities, and a fire at the conveyor belt drive at the Aracoma Alma Mine No. 1 in Melville, West Virginia resulted in two fatalities for a total of 14 deaths of miners. While the MSHA accident investigations are not complete and accident reports have not been written, MSHA believes that the implementation of this ETS will fill a critical need to improve the ability of underground coal miners to evacuate a mine after a mine emergency occurs.

Even though the MSHA accident investigation for the Sago Mine is not yet complete, it is known that one crew successfully evacuated the mine. While the members of the second crew that survived the explosion donned SCSRs, they did not successfully evacuate the mine. Similarly, at the Alma No. 1 Mine, the MSHA accident investigation is not yet complete. While all of the twelve miners affected by the fire donned SCSRs, only ten of them successfully escaped. Two of the 12 miners in the area of the fire did not successfully evacuate the mine. It is not yet known what happened to prevent those two miners from evacuating the mine with the others. MSHA believes that the requirements implemented under this ETS would have provided the deceased miners with the tools and training needed for them to have had a better chance of completing a successful evacuation.

General Discussion
Part 48—Training and Retraining of Miners and Section 75.1502—Mine Emergency Evacuation and Firefighting Program of Instruction.

Introduction

The best technology, equipment and emergency supplies are of little use if they are misused or not used at all. Emergencies can incite disorientation and panic. Quality of judgment in how to proceed in a given emergency can be decisive for survival. Training is critical for instilling the discipline, confidence, and skill necessary to successfully escape and survive an emergency. The ETS enhances existing training requirements to help ensure that underground coal miners can effectively respond and ‘‘know the drill’’ to get out of the mine alive.

This ETS modifies various provisions in §§ 48.5, 48.6, 48.8, 48.11, and 75.1502. These modifications provide a more integrated training approach so miners will have the skills to evacuate a mine during an emergency. This enhanced training approach requires more frequent ‘‘hands-on’’ training and actual drills in evacuating the mine. In this ETS, MSHA requires that all persons, before entering an underground mine, have the skills to don and transfer all SCSRs used in that mine. This ETS includes a new provision in §§ 48.5, 48.6, 48.8, and 48.11 to provide the new miner, newly hired experienced miner, and visitors with ‘‘hands-on’’ training in the transferring of self-rescue devices in addition to the required ‘‘hands-on’’ donning training.

Once a miner starts working in a mine, this ETS requires that the actual ‘hands-on’’ training for donning and transferring of self-rescue devices becomes part of the actual evacuation drill required in § 75.1502. Because miners will now receive ‘‘hands-on’’ SCSR training at least four times a year s part of the evacuation drill required under § 75.1502, they will not be required to receive ‘‘hands-on’’ training s part of their annual refresher training under part 48.

Also, included in these evacuation drills is the training in the location and use of directional lifelines or equivalent devices, mine emergency scenarios, and stored SCSRs. This ETS requires the mine operator to have the miners walk the escapeways and to physically locate the lifelines and stored SCSRs instead of permitting a simulation drill. Further, the ETS permits the mine emergency evacuation drills in § 75.1502 to satisfy the evacuation practice drill requirements in § 75.383.

Various provisions of §§ 48.5— Training of new miners; minimum courses of instruction; hours of instruction; 48.6—Experienced miner training; 48.8—Annual refresher training of miners; minimum courses of instruction; hours of instruction; and 48.11—Hazard training are affected by this ETS.

Since 1980, each miner working in an underground coal mine has been required to have access to an SCSR that provides at least one hour of oxygen for escape from the mine during an emergency. If an emergency arises, many miners may have to escape through long and difficult underground travel ways containing irrespirable air.

MSHA has identified problems related to skill degradation in the use of SCSRs in mine emergencies (described below in the discussion of research and studies). This ETS reflects the Agency’s belief that more frequent SCSR training is necessary. There is support in the mining community for more frequent training to improve the miner’s ability to properly don the devices and retain these vital skills for longer periods of time.

For instance, MSHA sponsored a Mine Emergency Preparedness Conference in January 1995 to provide a forum for members of the mining community to share their insights and to help shape the future of mine emergency preparedness. Representatives from two major labor unions expressed some doubt that, given the existing levels of training, miners were prepared to escape with the use of SCSRs and that they were already familiar with escape routes. One of the recommendations for further action was that SCSR proficiency could be increased by integrating SCSR training with evacuation and fire drills.

To minimize problems and enhance a coal miner’s skill in handling emergency situations, this ETS includes additional training requirements. The new requirements increase the frequency of SCSR training from annually to within every 90 days and include hands-on training in the donning, use, and transfer of self-rescue devices as part of the regular mine emergency drills.

These drills also will consist of locating the continuous directional lifelines or equivalent devices and stored SCSRs. Finally, the ETS will allow a mine operator to use the drills required under new paragraph 75.1502(c) to comply with the requirements for drills specified in existing § 75.383. In addition, the ETS permits the mine emergency evacuation drills in § 75.1502 to satisfy evacuation practice drill requirements in § 75.383.

(b). Research and Studies

MSHA has identified a number of research studies that support this ETS. In 1990, researchers from the U.S. Bureau of Mines (now the Office of Mine Safety and Health Research, National Institute for Occupational Safety and Health (NIOSH)) and the University of Kentucky concluded series of studies related to SCSR donning proficiency and use in an emergency. They looked at "the procedures taught during the training, the use of any training models; the opportunity to practice donning and using the respirator; and on-the-job training." The researchers dismissed the notion that SCSRs were simple to don. They concluded that "companies should adopt a hands-on training protocol that allows them to integrate SCSR donning practice into other workplace routines such as fire [drills]" (U.S. Bureau of Mines, 1993).

Another U.S. Bureau of Mines study reported that a computer simulation showed that relative survival odds for different mines can vary by as much as 30 percent and that this difference is due to SCSR donning proficiency (Kovac, Vaught, and Brnich, 1990).

MSHA recognizes that with any "non-routine" task, such as donning and transferring of self-rescue devices, knowledge and skill diminish rapidly. The U.S. Bureau of Mines, in a review of literature related to motor skill degradation (1993 BOM Bulletin 695), found that researchers are aware of this problem.

After conducting the series of studies on donning proficiency, the U.S. Bureau of Mines and University of Kentucky researchers also concluded in 1993 that a better training system for donning SCSRs was needed (Vaught, et al., 1993). The "3+3" donning method improved donning proficiency, but did not eliminate the problem of skill degradation. In a field test for this donning method, almost all of the persons who went through the program were able to successfully complete the donning procedures. The "3+3 donning" method is a method of learning how to properly don an SCSR and was developed by MSHA and NIOSH. The first "3" steps of the method specifically train the user to begin the donning routine by concentrating on the breathing zone. Those steps include activating the oxygen supply, inserting the mouthpiece and affixing the noseclips. The second "3" steps involve adjustments to the unit's goggles and neck strap, and the miner's hardhat.

These studies further determined the effectiveness of the "3+3" donning procedures and support a need for more frequent training, such as every 90 days. In this study, 88 miners were trained in the "3+3" method until they could proficiently don the SCSR. A week after receiving the training, 32 of these miners were randomly selected to test their SCSR donning skills. In this test, most of the miners could still put on an SCSR proficiently. After 90 days, another sample group was chosen for testing. In 90 days the proficiency rate dropped from 80 percent to about 30 percent.

The U.S. Department of Labor Office of Inspector General (OIG) recommended that MSHA review the frequency and type of training required to ensure that miners will be able to effectively use SCSRs in an emergency (OIG, 1999).

Based on skills degradation research supporting additional self-rescue device training, the recommendation of the Inspector General, and past experience where improved training might have made a difference in an escape, MSHA is increasing the frequency of training on SCSRs to within every 90 days. The more frequent training, by reinforcing skills, should substantially reduce motor-skill degradation.

NIOSH has recently provided a guidance document, Informational Circular 9481 (Fire Response Preparedness for Underground Mines) to the mining industry identifying training techniques that increase skill levels of miners to deal with underground mine fires. An important element in developing skills necessary to react to emergencies is ''hands-on'' training (NIOSH, 2005). This report further identified fire drills required at 90-day intervals as an important part of the mine emergency plan that helps promote confidence in miners by showing them how to handle an emergency situation. Another benefit of the drills the report identified is a test of how effective the mine emergency plan works.

Appendix 4 – Judgement and Decision-Making Under Stress

**Judgment and Decision-making under Stress:
An Overview for Emergency Managers**

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Abstract
This paper discusses human judgment and decision-making under stress. The authors review selected recent literature across various disciplines and suggest a definition of stress within the context of decision-making during the management of emergencies. They also discuss fieldwork by the Pittsburgh Research Laboratory, NIOSH, which explores traumatic incident stress, the relationship between previous training and performance under stressful conditions, and human behavior in underground mine fires. The authors assert that stress is one of the factors that decision-makers must contend with in most life-or-death situations. They suggest that a better understanding of individual's judgment and decision-making activities while under stress would yield a better understanding of how people reach the choices they make in emergencies. This enhanced understanding would be of enormous value to emergency managers, researchers, and policymakers.

1.0 Introduction
Clearly, the effect of stressful conditions on human judgment is of importance to emergency managers. In natural or human-induced emergencies, the decisions that are made in the first minutes, hours, and days are critical to the successful mitigation, damage control, prevention of structure and human loss, control of financial costs, and ultimately the overall conclusion of the disaster. The impact of the effect of stress on professional judgment is significant. During an emergency situation, critical judgments are frequently made under conditions of temporary or prolonged stress. Emergency decision-makers are required to process massive amounts of information, which is sometimes incomplete or faulty, under severe time constraints.

1.1 Definitions

The use of the term "stress" is rooted deeply in the literature. Lazarus and Lazarus (1994, p.220) discuss the use and definition of the word "stress" and note that it was used as early as the fourteenth century to mean hardship, straits, or adversity of affliction. In the seventeenth century, a physicist-biologist, Robert Hooke, tried to help engineers design man-made structures such as bridges, which had to carry heavy loads and resist buffeting by winds, earthquakes and other natural forces that could destroy them. An important and practical engineering task, therefore, was how to design bridges to resist these loads, or stresses. Hooke's analysis greatly influenced the way stress came to be thought of in physiology, psychology, and sociology – as an environmental demand on a biological, psychological, or social system.

One popular current definition stipulates that "stress is a process by which certain work demands evoke an appraisal process in which perceived demands exceed resources and result in undesirable physiological, emotional, cognitive and social changes" (Salas et al., 1996, p.6). The authors hold this definition as one of the most appropriate for emergency management purposes, because "demand exceeding resource" is a key factor, either in the management of an emergency or in the response of an individual. The focus is on the *demand* -- which may come from numerous sources including the environment, physiological constraints and social factors -- and the human *resource*, which is dependent, again, upon numerous factors including individual perception, training, and experience.

The relationship of stress to judgment and decision-making is an aspect of human behavior that remains relatively unexplored (Hammond, 2000; Gillis, 1993). Consequently, the literature in this area is limited and not always conclusive. Gillis (1993, p. 1355) maintains that "while research on 1) the nature and consequences of stress; and 2) human judgment and decision-making are large and varied, there is virtually no overlap between the two despite the obvious practical importance of the effect of stress on judgments ..." Hammond points out that the notion of stress having an influence on judgment was only first broached during a US Congressional hearing in 1988. At issue was compensation for the victims of Iran Air Flight 655, which was shot down by the American cruiser *Vincennes* over the Persian Gulf. A second hearing was called "to examine the impact of human factors such as stress" on the crew's performance.

1.2 The Congressional Inquiry Two questions posed during the second Congressional hearing are of interest to this discussion: 1) Does the performance during the shoot-down identify elements of human behavior that are poorly understood? and (2) What have researchers uncovered to date on man's ability to make rapid and even complex decisions in high-stress environments? (Committee on Armed Services, U.S. House of Representatives, 1989). Four behavioral scientists, identified as expert witnesses, testified and wrote reports to the Defense Policy Panel of the Armed Services in 1989 concluding that we know almost nothing about the extent to which decisions are affected by stressful circumstances, much less the manner in which the decisions are influenced by high-stress environments.

The agreement among these experts was three-fold. First, stress is an area that has not been thoroughly studied and we know little about stress in group situations. Secondly, it is believed that the competence of human judgment is decreased by stress (even though the experts could not cite empirical data). Finally, the scientists concluded that stress narrows the focus of attention, implying a negative impact on judgment. In hindsight, these experts appeared to be completely correct only in their first conclusion - that stress is not a thoroughly studied area of human behavior. Conclusions two and three are discussed further in this paper, and the authors suggest the 1989 analysis was too simplistic.

One recommendation of the Committee to Congress was that stress needed to be studied further. Meanwhile, the American Psychological Association and the National Institute for Occupational Safety and Health (NIOSH) joined forces in 1990, declaring the 90's to be the "Decade of Stress." During that decade, resources and attention were focused on increasing knowledge about the human stress response and its relationship to numerous variables.

1.3 Paper Overview

Over a dozen years have passed since the Congressional hearings on Iran Flight 655, and although no conclusive data on judgment and decision-making have emerged, a number of studies have reached conclusions of interest to those who must make decisions under stress. The research is scattered throughout the social, psychological, physiological, and medical literature with varying degrees of quality and breadth. This paper presents a selection of these studies with the intention of stimulating a dialogue among those managers and others who are responsible for developing models and planning responses that require decision-making in disaster situations.

2.0 Assumptions and key issues

2.1 Stress is affected by perception. It is critical to include the concept of perception when discussing stress in relation to performance, including performance in judgment and decision-making. The reader should note that in Section 1.1, discussing the definition of stress, the key phrase "*perceived* demands" is used. Ability to cope with stress is dependent upon an individual's perception or interpretation of an event. Gillis (1993) suggests that stressful circumstances do not automatically lead to problems in judgment; it is the perceived experience of distress. One obvious implication of such a notion is that an attempt should be made whenever possible to minimize distress by psychological, pharmacological, or other means – before a subject enters the judgmental arena.

2.2 Competence *in judgment is always compromised under stress.* This particular conclusion of the experts in the 1989 Congressional hearings deserves further evaluation. It is important to note that both *improved performance and performance degradation* have been associated with increased stress (Poulton, 1976). For some individuals, heightened stress elevates their performance. Others are vulnerable to the negative impacts of stress, which results in diminished performance. A physiological example of this positive/negative dynamic of stress is athletic performance. An athlete desiring to be at an optimal performance level while competing demands an optimal stress level. The stress level should be enough to stimulate top performance, but not enough to over-stress the body, because performance declines as the body moves toward exhaustion.

Studying the effect of stress on performance and judgment, Dorner and Pfeifer (1993) subjected 40 subjects to a computerized forest firefighting game. Half of the subjects were placed under conditions of stress (a disturbing noise) and the others were left to focus on their task. The exercise involved varying levels of difficulty and lasted five hours. The researchers found that subjects under stress performed equally to those not stressed, but their problem solving patterns were different. Stressed subjects focused on the general outline of the problem, while non-stressed individuals relied on in-depth analysis. Consequently, stressed subjects made fewer errors in setting priorities while non-stressed subjects controlled their firefighting operations better.

Two Greek researchers, Kontogiannis and Kossiavelou (1999), examined the decision-making strategies and cooperation patterns used by proven, efficient teams in adapting their behavior to cope with stressful emergencies. The authors conclude that stress restricts cue sampling, decreases vigilance, reduces the capacity of working memory, causes premature closure in evaluating alternative options, and results in task shedding. A study of military commanders (Serfaty and Entin, 1993) found that teams with records of superior performance have one common critical characteristic: They are extremely adaptive to varying demands. The teams in their study could maintain performance using just one-third of the time usually available to make decisions, but the mode of communication changed. Initially, the team responded to explicit requests in communications from commanders. As time pressure increased, they stopped waiting for explicit requests and instead provided commanders with information they implicitly determined would be useful.

The authors suggest that changes from 'explicit' to 'implicit' communication can help teams maintain performance under time pressure. Implicit coordination patterns, anticipatory behavior, and redirection of the team communication strategy are evident under conditions of increased time-pressure. The authors conclude that effective changes in communication patterns may involve updating team members, regularly anticipating the needs of others offering unrequested information, minimizing interruptions, and articulating plans at a high level in order to allow flexibility in the role of front-line emergency responders. The authors found support for the main hypothesis that team coordination strategies will evolve from explicit coordination under low workload conditions to implicit coordination as work load increases.

2.3 Stress *is related to information.* In studies of escape from underground mine fires, researchers have identified several human behavioral and organizational dimensions relevant to understanding decision-making under duress. First, initial warnings in dangerous situations are often unclear, sometimes due to the way technology behaves, and sometimes due to faulty communication. This can lead to different interpretations of the problem. Second, people frequently fail to gather the right kinds of information, which prevents them from making appropriate responses. Third, once a decision is made, individuals respond well to a leader; however, if leadership is lacking people tend to become confused. Finally, apparatus (e.g., those used in mine emergencies) may not work as expected or may fail. Thus, emergency decision-makers under stress not only have the effects of their own stress response and its resulting consequences, the information they must base their judgments on is often unclear, faulty, and incomplete (NIOSH, 2000).

2.4 Stress narrows the focus of attention. A primary conclusion of the experts at the Congressional hearing was that stress narrows one's focus. Time pressure studies, where the subject is given a task and a specific, usually unreasonable, time to complete it, generally support this conclusion. Other studies, however, indicate inconclusive results for this conclusion (Hammond, 2000). *Negative information gains* become important under time pressure, because they need to be evaluated and discarded. If a situation involves *risk* (as in response to an emergency), time pressure studies show that the subject becomes more cautious and adopts risk-avoiding behavior with an importance placed on *avoiding losses* (Flanagan, 1954). These studies have shown that under time pressure the *subject adopts a simpler mode of information processing* in which alternatives are not explored fully, and certain important "cues" are used to determine the decision. From these studies, the experts conclude that stress *narrows the focus of attention*. In other words, the focus of attention shrinks, and the individual focuses just on critical issues and elements. This focused attention was assumed to be bad, but it actually may be good because it can eliminate nonessential information and highlight the most important sources.

Citing two studies reported in 1993, Gillis (1993) did not find support for the "narrowing of attention" hypothesis. Keinan et al. (1987) tested the proposition that deficient decision-making under stress is due largely to an individual's failure to fulfill adequately a most elementary requirement of the decision-making process, i.e., the systematic consideration of all relevant decision alternatives. In their study, which required participants to solve decision problems while under stress, one group was put under stress and compared to a non-stress control group. Stress was found to induce a tendency to offer solutions before all decision alternatives had been considered and to scan such alternatives in a non-systematic fashion.

2.5 Dynamic environments impact decision-making. According to Kerstholt (1994), decision-making behavior is considerably affected by the dynamics of environment, because most natural dynamic situations contain much uncertainty. He notes that a dynamic situation continually changes, and thus a decision-maker has to take temporal changes into consideration. He further notes that a decision- maker can use feedback on the effect of his/her actions on the system. In other words, as decisions are made and action is taken, the results of the decision may be taken into consideration and the information used in subsequent decisions. Additionally, in dealing with the uncertainty of a continually changing environment, the decision maker must achieve a trade-off between the cost of action versus the risk of non-action.

To test his hypothesis Kerstholt conducted a computer experiment in which subjects had to control a system that changed over time. In this experiment, the subjects had to monitor the continuously changing fitness level of a simulated athlete, and prevent him/her from collapsing. Information requests were treated as costs in the subjects' incentive system, and correct treatments were treated as benefits. The decision-making strategy remained constant. False alarms and "real" change in system parameters represented sources of deterioration in the system. Time pressure in the study was related to the development of the situation itself, and the allocation of time had to be correlated to the risk of negative consequences and the cost of delaying further information requests. The results showed a general speed-up of information processing as time pressure increased. Under high levels of time pressure, this strategy led to a significant increase in system crashes.

It is interesting to note that requests for information were not congruent with conditions – subjects tended to wait until an already deteriorating situation had further deteriorated before acting. It can be assumed that if information is expensive in time, and actions are cheap, subjects will be more inclined to use an action-oriented strategy. To the contrary, subjects did not select the most efficient strategy – they chose further information over action. Results indicated that selection of a decision strategy in dynamic tasks is less adaptive than is generally concluded from studies with static tasks.

Kidd et al (1996) linked stress and injury in another dynamic environment – farming. In a three-step secondary analysis of focus group data, one of their conclusions stated, the dimensions of workload that were particularly important included job and task complexity and lack of time. Both of these dimensions are relevant to the emergency worker. Further, as a preventative measure, the researchers suggested that a decrease in the number of roles performed exclusively by one individual could improve successful task performance.

2.6 Stress affects behavior in emergencies. There are limited studies regarding *the effects of stress* on behavior in emergencies. Researchers working with the United States mining industry have explored the issues of traumatic incident stress in mine disasters (Kowalski, 1995), burnout (Kowalski and Podlesny, 2000) stress levels related to training during a simulated escape through smoke (Vaught et al., 1997), and behaviors in underground mine fires (NIOSH, 2000). In the training study, small groups of miners were required to don self-contained self-rescuers (breathing apparatus), enter an area of an underground limestone mine that had been filled with non-toxic theatrical smoke, and travel approximately 270 meters to a door, through which they exited into fresh air. Individual subjects then provided a self-report of their experiences on questionnaires administered immediately upon completion of their walk through smoke. The general finding was that miners who had more experience or training also tended to report less stress during the exercise.

In the study of worker behaviors in underground mine fires, researchers examined eight cases in which groups of miners had escaped their workplaces through smoke. One goal was to determine whether it would be possible to model those factors that impact one's ability to make good decisions during an emergency. The researchers suggested that any person engaged in decision-making is actively involved in a process characterized by certain elements: 1) detection of a problem; 2) definition or diagnosis; 3) consideration of available options; 4) choice of what is seen to be the best option given the perceived needs; and 5) execution of the choice based on what has transpired. At any moment in this process, several factors significantly impact one's ability to solve complex problems in a limited time: 1) psychomotor skills, knowledge, and attitudes; 2) information quality and completeness; 3) stress - generated both by the problem at hand and any existing background problem; and 4) the complexity of elements that must be attended to. The resulting model posited interactions among the major components, so that heightened stress, for instance, might interfere with an accurate diagnosis, while an accurate diagnosis would lead to lowered stress levels.

3.0 Analytical vs. intuitive judgment under stress

There is an assumption that the best decisions are rational – based on logic and factual information. This assumption has implications for the discussion of judgment and decision-making under stress. Researchers have tended to look at reason and emotion separately. A value has been placed on decisions made with reason: " . . . it is a careless – but common – usage to suggest that when we make bad decisions, they are based on emotion, but when we arrive at good decisions, they are based solely on reason" (Lazarus and Lazarus, 1994, p.199). Hammond posited that different situations demand different forms of cognitive activity, some calling for increased analytical cognition, and others calling for increased reliance on intuition. Both situational analysis and people's reactions to them are key as we learn about judgment and stress.

It is instructive to examine some instances of judgment under stress in which decision-makers followed different paths but achieved successful outcomes. Hammond describes the following:

> Case 1: The USS Samuel B. Roberts, operating in the Persian Gulf, struck a mine, caught fire, and began to sink. The Roberts' captain, Commander P.X. Rinn, drawing upon his training and experience, analyzed the situation and determined a course of action directly opposed to Navy protocol. Realizing, from his knowledge of how much water the ship could take on and still stay afloat, that the Roberts would sink before his crew could extinguish the fire, Commander Rinn made a decision to focus on keeping the ship afloat and give the fire second priority. He is on record as having arrived at his decision analytically, based on available information, training, and operational experience.

> Case 2: A United DC-10, on its way from Denver to Chicago, lost its hydraulic fluid, and hence, its controllability. Captain Al Hayes and his crew had to discover an alternative way to fly the plane by using the throttles – something their training had not prepared them for – and do it with few of the cues usually available to pilots. That they were able

to land with minimal loss of life may be attributed to intuitive decision-making under stress.

The two cases cited by Hammond portray decision-making under stress within two scenarios: one where the training of the decision-maker was readily applicable, and one where the decision makers' training had not prepared them for the exigency they faced. Yet, both instances involved individuals who were highly trained. In many dynamic settings, such as mining, those who are forced to make decisions in emergency situations have little training. That is because mines, fishing boats, and logging operations, among others, are dedicated to production activities rather than to emergencies. Thus, their personnel may have had minimal drilling on how to react during crises. Their decisions must, almost of necessity, be based on intuition or fragmentary knowledge.

Considering this issue of analytical vs. intuitive judgment, a NIOSH (2000) report observed:

> "The point here is that research which focuses on judgment must include scrutiny not only of decisions that are made, but also of real-world variables that influence them. The quality of any decision may have little or no direct relationship to the eventual outcome of its execution in a given situation. This is because a decision-maker is constrained not only by the stress of the situation or personal knowledge and attitudes, but also because he or she can only weigh information that is available."

Acknowledging the complex context of concrete decision-making environments and their various sources of stress is a first step to understanding the skill of decision-making and learning to evaluate the abilities of decision-makers.

4.0 Conclusions and observations

Growing research interest has led to the question of what factors influence a person's ability to make good decisions during an emergency. There is still little agreement on how to define those basic concepts, including stress, necessary to assess the soundness of decisions from within both environmental and group contexts. The need to better understand judgment and decision-making under stress stems from high-risk occasions and emergency situations. The fundamental assumption is that, while there are untold successes, there are also notable failures resulting from decisions that can be ascribed to one or more errors in judgment. What part, then, does stress play in the commission of these errors? From a cognitive perspective, any person engaged in decision-making (either alone or in a group) is actively involved in a process characterized by certain elements. At any moment in this process, there are factors that have a large impact upon one's ability to solve complex problems in a limited time.

So what is the advice for the emergency manager based on the data? Unfortunately, the authors cannot offer a "list" of factors to consider in judgment and decision-making under stress. The present, limited data does not support such an approach. There are serious limitations to generalizing from laboratory studies to real-life emergencies. We know that there is an interaction, that human stress affects human decision-making. What we do not know is the exact nature of that interaction.

The research suggests that successful teams communicate amongst themselves and as the emergency intensifies, a flatter communication hierarchy develops with more (unsolicited) information coming from the field to the command center. Command Center personnel can facilitate and encourage this type of information. Stress is affected by perception; it is the perceived experience of stress that an individual reacts to. An implication of this notion, is that an attempt should be make to minimize distress for the responders by psychological, pharmacological or other means before entering the judgmental arena. Contrary to popular opinion, judgment is not always compromised under stress. Although stress may narrow the focus of attention (the data is inconclusive), this is not necessarily a negative consequence in decision-making, as some studies show that the individual adopts a simpler mode of information processing which may help in focusing on critical issues. Decisions can only be made based on the information available, and studies have shown that many times decisions are made with incomplete information. In addition, the issue of training plays a part in stress and decision-making.

Regarding the development of decision support systems, the authors offer several suggestions. Decision support programs should be tested under conditions of stress (time pressure is one option) to evaluate their effectiveness. Simulations should be used to replicate stress conditions in the field. New simulations should include a stress component, taking into consideration the issues presented in this paper. A simulation should also take into account the increased need, as an emergency progresses, for explicit and implicit information to be received from the field and integrated into the decision-making process.

This paper has suggested that a better understanding of the interplay between stress and an individual's judgment and decision-making activities would yield a better understanding of how people reach the choices they make in emergencies. As far as studies of judgment and decision-making are concerned, the limited literature in this area suggests a strong need for increased attention to the topic.

Stress is one of the key factors that underlies the demands on decision-makers in most life-or-death situations. Whether the individual is a naval commander, an airline pilot, a mineworker, or an emergency manager who has access to a decision support system, an emergency makes it necessary to deal with an enormous number of variables in a rather short time- frame.

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Charles Vaught, Ph.D. is a Certified Mine Safety Professional with a Ph.D. in the sociology of organizations from the University of Kentucky. His memberships include the American Sociological Association, the International Society of Mine Safety Professionals, and the United States Mine Rescue Association.

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Appendix 5 - Assessors

Steve Bullough

Steve is currently the Longwall/Services Project Coordinator for Crinum Coal Mine. He has an extensive mining background, having worked underground for 30 years in varying roles from miner through to Deputy at coal mines throughout Queensland and New South Wales. Steve is currently a board member for the Queensland Mines Rescue Service and has been an assessor for the Blackwater District mines rescue competitions for the past 10 years.

Michelle Clarke

Michelle started in the mining industry at Laleham Coal Mine, South Blackwater Coal in February 1997. Throughout the past 9 years she has worked in various mining engineering roles and has had the opportunity to work in the Bowen Basin and NSW coal fields for both underground and open-cut operations as well as gaining experience of working for both owners and contractors. Michelle has worked at Broadmeadow coal mine since June 2004 in roles including contract management and mine planning.

David Cliff

David Cliff is an Associate Professor at the Minerals Industry Safety and Health Centre at The University of Queensland. His primary role is the undertaking of applied research and consulting in health and safety in the mining industry.

Previously David was the Safety and Health Adviser to the Queensland Mining Council, and prior to that Manager of Mining Research at the Safety in Mines Testing and Research Station. In these capacities he has provided expert assistance in the areas of health and safety to the mining industry for over seventeen years. He has particular expertise in gas analysis, spontaneous combustion, fires and explosions. In recent times he has also devoted a lot of energy to fitness for duty issues and shiftwork management.

David has published widely over a range of OHS topics.

David qualified with a first class honours degree in Science majoring in chemistry from Monash in 1977, followed by a Ph D from Cambridge in 1980, a graduate diploma in environmental studies from Macquarie in 1983, a graduate diploma in outdoor education from QUT in 1986 and a graduate diploma in business administration from QUT in 1990.

He is a chartered chemist, member of the Royal Australian Chemical Institute, Australian Institute of Mining and Minerals, the Combustion Institute, the Environmental Institute of Australia, the Safety Institute of Australia and the Clean Air Society.

Andrew Clough

Andrew Clough is the production manager at the BMA Crinum Mine. Andrew has over 25 years experience in the mining industry. He commenced his career in Illawarra in 1980 in board and pillar mining. Through successive career moves Andrew worked as a rock mechanics consultant and in operational roles in the metalliferous mining industry - both within Australia and Africa. More recently Andrew was the District Mines Inspector based in Mackay before accepting his current role at Crinum Mine.

Kevin Clough

Kevin is the District Inspector of Coal Mines based in Mackay. He has over 38 years experience in coal mining both open cut and underground in Qld and NSW. He has held a variety of senior management positions at coal mines and has experience in longwall mining, bord and pillar mining as well as gas drainage and spontaneous combustion mitigation.

Lachlan Cunningham

Lachlan is currently employed as Technical Services Manager at Solid Energy's Huntly East Mine in New Zealand. Lachlan has over 21 years experience in operational coal mines in South Africa and New Zealand covering various roles in operations, technical and project management. He has experience of longwall mining, bord and pillar development and extraction systems. Lachlan is also holder of the ventilation engineers certificate from the University of NSW.

Greg Dalliston

Greg has been involved in the mining industry for 32 years, and has gained experience in numerous areas. He started his career as a Cadet Mine Manager with the Queensland Coal Association prior to working in a variety of positions within the industry, including eight years as a mine deputy.

Greg is employed as an Industry Safety and Health Representative with the CFMEU, a position that he has held for the last thirteen years.

Some of the roles pertaining to this position have included:

- Participating in tripartite industry committees to develop new safety and health legislation for the Queensland coal mining industry; member of state and national training committees for the mining industry;
- Conducting safety audits and inspections at coal mines throughout Queensland;
- Investigating serious and fatal mining accidents and assisting the mining warden as a reviewer into mining accidents;
- Conducting debriefs after incidents and providing critical incident management services; and
- Development of manager, undermanager and deputy statutory national competency standards, including risk management and emergency response.

Seamus Devlin

Seamus holds the position of Regional Manager – Newcastle Mines Rescue with the NSW Mines Rescue Service and has 30 years coal mining experience, including 27 years mines rescue experience.

Seamus has held various management positions in both the NSW and Queensland Mines Rescue Service for the past 10 years in Dysart, Blackwater, Collinsville, Hunter Valley and Newcastle and holds an Undermanager's Certificate of Competency and a Graduate Certificate in Risk Management from Monash University.

Michael Driscoll

Michael Driscoll is the NRMW Regional Compliance Manager for Central West Region which is responsible for the administration and monitoring of compliance for the various acts administered by NRMW. He has a team of 9 investigators who are available 24 hours 7 days a week. Michael has a lengthy experience in government compliance having worked in Workcover and Liquor Licensing before taking the NRMW role.

Lately Michael has assisted the Mines Inspectorate with the implementations arising from the internal review into the Mines Inspectorate.

Mick Farrag

Michael joined the industry in 1996 as a miner and subsequently deputy (ERZ controller) at Kenmare Mine. He moved to Moranbah North and undertook the roles of longwall deputy, Mines Rescue Coordinator and Statutory Fire Officer. In November 2003 Michael was appointed Manager of Operations for Queensland Mines Rescue Service. As Manager of Operations, his principal areas of responsibility include the continuation and development of Operational systems, policy, procedures, audits and standards. Michael has also been instrumental in the development and implementation of the Mine Emergency Management System.

Chris Gilbert (Griz)

Chris has worked in the coal mining industry for approximately 15 years – 5 years as a contractor on the surface and 10 years underground. Chris worked at the BMA Crinum Mine for 10 years and was the Site Safety and Health Representative for the last 2 years. Chris then transferred to BMA Broadmeadow Mine and was part of the core group during start up as a longwall face deputy. Chris is currently studying for his Ventilation Officers ticket. Chris is currently the Site Safety and Health Representative at Broadmeadow Mine.

Tony Kelly

Tony is employed as an Analytical Chemist at Simtars and has been in this role for the last 5 years. His present role involves training in spontaneous combustion and gas chromatography as well as providing technical advice on mine gas monitoring and interpretation. Tony holds a Bachelor of Applied Science in Chemistry and is currently involved in a number of research projects.

He has also been involved with numerous Level 1 and Level 2 emergency exercises with his focus being gas simulation and gas chromatography.

David Macpherson

David is the District Inspector for Coal Mines, NSW Mines Inspectorate based in Wollongong. David has held various positions within the mining industry from miner to mine manager and has over 29 years experience in the mining industry. David is a qualified auditor, has 3 years experience as a District Rescue Assessor and has recently conducted assessments on the emergency systems at all NSW underground mines.

Alex Neels

Alex graduated from university in 1999 and joined the mining industry as a Mining Engineer. Alex has worked at Grasstree coal mine since 2002, and in January 2006 she was appointed senior mining engineer and ventilation officer for the mine.

Larry Ryan

Simtars Computer System Engineer who been involved in the development of Safegas, Segas Professional, Ezgas Professional and other gas monitoring software for the coal mining fields for 7 years. During the Level 1 exercise, Larry was involved in the actual running of the software simulation on the Safegas software. Larry has developed, tested, installed and commissioned the Safegas gas monitoring software at mine sites in Queensland, NSW, New Zealand and the USA.

Kirrily Star

Kirrily has worked for Safety and Health for the past 12 years and has been the Logistics Coordinator for six of the previous emergency exercises. Kirrily was also the Technical Officer for safety management system audits for both coal and metalliferous mines throughout Queensland and the Training Officer for the Queensland Safety and Health Mining, Explosives and Petroleum & Gas Inspectors.

Martin Watkinson

Martin is the Principal Mining Engineer at Simtars. He is involved in spontaneous combustion training, testing and research, mining research and consultancy and is this year's chairman of the emergency exercise.

Martin was employed as Technical Services Manager at North Goonyella Coal Mine, Senior Mining Engineer and Ventilation Officer at Moranbah North Coal Mine during the initial mine development and longwall installation. Prior to accepting his appointment at Moranbah North, Martin worked for International Mining Consultants for seven years, undertaking assignments in China, India, Iran, Siberia, Tanzania and Vietnam.