

Abstract:

Learnings from 18 Level 1 Emergency Exercises

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Level 1 Exercises are run in Queensland as a result of a recommendation of the Queensland Mining Warden's inquiry into the explosion at the Moura No. 2 Mine in August 1994. The Warden recommended that "*Emergency procedures should be exercised at each mine on a systematic basis, the minimum requirement being on an annual basis for each mine.*" (Windridge, et al, 1996). This paper covers the learnings - in particular the need for ongoing training and assessment of mineworker's capabilities to use their self-contained self-rescuer (SCSR). Video footage will be used to illustrate some of the issues faced in the presentation at the conference.

Introduction

The inquiry into the explosion at the Moura No. 2 Mine in August 1994 recommended - "Emergency procedures should be exercised at each mine on a systematic basis, the minimum requirement being on an annual basis for each mine." (Windridge et al. 1996). In December 1996 the "Approved Standard for the Conduct of Emergency Procedures Exercises" was published and was subsequently reissued as Recognised Standard 08 Conduct of Mine Emergency Exercises. This document provides guidelines for conducting mine site emergency exercises as well as the requirement for a test of state-wide emergency response by holding a Level 1 Mine Emergency Exercise at one mine on an annual basis. Since 1998 eighteen Level 1 Mine Emergency Exercises have been held in Queensland, Australia.

The approach followed for each of the Level 1 Exercises is as follows:

- Visit to the mine to determine local site conditions and hazards.
- Determine objectives for the exercise.
- Develop of alternative scenario's to test the objectives.
- Develop ventilation modelling and prepare gas data to reflect the scenario and objectives.
- Brief all assessors at a full team meeting and arrange for site inductions.
- Conduct of exercise.
- Debrief at mine site and report preparation.
- Release a final report and distribute findings to industry.

Each of the following sections briefly outline the scenario and some of the issues identified within the reports. Copies of all reports can be obtained in PDF format from the DNRM website: <https://publications.qld.gov.au/dataset/queensland-level-1-mine-emergency-exercise-reports>

1 Southern Colliery 1998

This scenario was built around unauthorised alteration of a district regulator affecting the ventilation flow on the operating longwall. The reduced flow, plus barometer fall resulted in a fictional ignition of methane. The resulting explosion destroyed and damaged several of the mines ventilation control devices. This exercise was conducted at 12:05 am to test the call out of mines staff and responses in the early hours of the morning.

1.1 Some issues raised

- Communications between control room and Incident Management Team (IMT).
- Emergency call out procedures for staff off site.
- Duty cards impossible to follow.

- Need to conduct rapid evaluation of ventilation and gas trends.
- Need for a clearly defined IMT process.
- Need for adequately resourced IMT room.
- Need for coal mine worker (CMW) training in evacuation in zero/poor visibility.
- Escape ways to be adequately maintained.
- Safe havens for changeover of Self Contained Self Rescuers (SCSRs).

2 Kenmare Colliery 1999

This scenario was a conveyor belt fire in the intake that resulted in the whole of the mine being evacuated. The scenario was designed to test the training of contractors at the mine, however unfortunately there were very few contractors underground at the time of the exercise due to the fact that they had been previously withdrawn. This exercise was conducted at 3:43 pm to test IMT process and the issues of contractor training in emergency response.

2.1 Some issues raised

- Communications between control room and IMT.
- Need for adequately resourced IMT room.
- Need to conduct rapid evaluation of ventilation and gas trends.
- Inflexibility in the duty card systems.
- Need for training in evacuation in zero/poor visibility.
- Training required for changeover of SCSR's.
- Debriefing of evacuating personnel.

3 Newlands Southern Underground 2000

This scenario was based on a transformer fire igniting the coal ribs in the cut-through (cross cut) and was conducted at 21:00 on a Saturday night. The scenario was aimed to test the first response of personnel using Compressed Air Breathing Apparatus (CABA) as well as issues relating to call out of mine staff from Mackay on weekends

3.1 Some issues raised

- Call out of staff on a weekend when most are in Mackay.
- Successful use of CABA as a first response tool.
- Communications between control room and IMT.
- Need for CMW training in evacuation in zero/poor visibility.

4 Kestrel Mine 2001

The Kestrel scenario was based on a massive roof fall on the maingate end of the longwall some 2.5 km inbye from the mains at 21:30 on a Tuesday night. The resulting air blast injured two of the longwall personnel the remaining longwall personnel evacuated down the tailgate in an irrespirable atmosphere created by the lack of ventilation and normal seam gas make. This atmosphere was also above the 1.25% level for the operation of diesel vehicles and irrespirable due to carbon dioxide which is a constituent of the seam gas.

4.1 Some issues raised

- Need for adequately resourced IMT room.
- IMT process and data capture.
- Need for a mines rescue vehicle for deployment into non-standard atmospheres.
- Mines rescue deployment to recover injured personnel at distances of 2.5 km in an irrespirable atmosphere.
- Issues of deployment of mines rescue personnel into hot and humid conditions.
- IMT changeover process.

5 North Goonyella Coal Mine 2002

This scenario was run at 9:13 on a Monday morning with all of the mine staff present. It was designed to test the response with the mine manager and ventilation officer absent in Mackay (some 2 hours away by car) for “training”. The scenario was based on a vehicle fire which the operator could not put out. If a sufficient response was mounted the fire would have been deemed to be extinguished. There was also a simulated roof fall on the longwall, which allowed products from a spontaneous combustion deep in the goaf to report to the tailgate air stream. Unfortunately the mine staff went into emergency ‘evacuation mode’ because of the ‘exercise mentality’ and forgot to tackle the fire. An adequate response was not mounted until six hours after the commencement of the exercise.

5.1 Some issues raised

- IMT process.
- IMT changeover process.
- Need for the staff to respond to the scenario and not just evacuate the mine.
- Need for CMW training in evacuation in zero/poor visibility.
- Need for training in fire-fighting procedures.

6 Crinum Mine 2003

This scenario was designed to raise awareness of the issues relating to the transport of gas cylinders, in particular acetylene cylinders, which can be very unstable. The cylinder was “damaged” during a vehicle collision creating a vehicle fire, which subsequently developed into a coal fire. To completely pollute the intakes to the mine an air door between the intakes and the conveyor belt line was deemed to be left open for the purposes of the exercise. This again stressed the importance of conveyor belt segregation and the need for training/education to the workforce to ensure that all ventilation appliances are correctly used and any damage is reported. Without the simulation of this door being open evacuation from the mine would have been much simpler along the conveyor road. An added complication for the mine was the presence of an underground visitor. *“How readily do you think your mine would deal with an underground visitor in such a situation?”*

6.1 Some issues raised

- Communications in and out of IMT.
- Control room communications to personnel underground in the refuge bay. (The men in the refuge bay sometimes got information before IMT).
- The recognition of the fact that burning coal can liberate explosive gases in sufficient quantities to create an explosive atmosphere in a mine with no seam gas.
- The issues relating to inertisation with personnel underground.
- The need for the ventilation officer/delegate to be free to do ventilation interpretation/modelling then feed the information back into IMT.
- Safe transport of gas cylinders.
- Need for well maintained and operated ventilation control devices.

7 Oaky No 1 Mine 2004

This scenario was based on a frictional ignition in a development panel creating a “small” coal dust explosion. All the coal mine workers in the development panel were deemed to have been killed in the explosion. (These men also conducted a zero visibility evacuation to an area outbye of the explosion zone using training self-rescuers while waiting for rescue teams to be deployed). The explosion was deemed to have destroyed several ventilation structures and polluted the other development sections of the mine. A series photographs were prepared and each of the evacuating teams was briefed on what they would have seen as they travelled out of the mine.

One point of interest is that the exercise committee had made the decision that all personnel in the sandy creek area would have been killed by the initial “explosions”; however the last part of the exercise was where the mine located the “deceased”. This left the mine with a feeling of failure when in fact they had succeeded in taking the exercise to its designed fruition. This is an important part for anyone preparing industry scenarios and on reflection it would have been better if the mine staff could have at least found one survivor.

7.1 Some issues raised

- Trial of the Incident Control System/Mine Emergency Management System (ICS/MEMS).
- The need for gas analysis and interpretation.
- Debrief of personnel to get information into IMT.
- Industry to recognise the need for adequate stone-dusting to prevent coal dust ignitions.

8 Moranbah North Mine 2005

The Moranbah North scenario was based on an Eimco travelling underground with a pod of Polyurethane (PUR) turning into a cut-through hitting a transformer and causing a fire at 9:40 pm on a Sunday. The aim of the exercise was to highlight the requirements for fighting a PUR fire and the off gasses produced as well as test the callout of mine staff on a Sunday evening. The location of the scenario enabled in-seam response from an unaffected area.

8.1 Some issues raised

- The need for the mine to have a clearly defined and understood emergency response system.
- The need for quick interpretation of the mine atmosphere and ventilation assessment.
- Need for CMW training in evacuation in zero/poor visibility.
- Need for training and awareness when dealing with non-standard fires particularly PUR.
- Automated call out procedures.

9 Broadmeadow Mine 2006

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 SCSRs.

The scenario for the exercise was based on a major fire on the hydraulic pump station and transformer in 4 cut-through in the main gate. 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).

9.1 Some issues raised

- The need for mines to develop a first response capability.
- Improved training required in the donning and changeover of SCSRs.
- Mines sites to evaluate the emergency response system they are going to use in light of the development of the MEMS provided by Queensland Mines Rescue Service (QMRS).

10 Grasstree Mine 2007

Grasstree Mine has a high methane gas make on the longwall, is practicing methane drainage and utilises ventilation methods to keep the gas fringe away from the tailgate motor area of the working longwall. Nearby mines have all had frictional ignitions on both longwall and development panels. Consequently, it was decided to base the scenario for the 2007 Level 1 Mine Emergency Exercise on a frictional ignition on the longwall face. The exercise commenced at 20:00 on a Monday night to test the call out of site and other personnel.

For the purposes of the scenario it was deemed that the shearer drivers and another operator on the longwall would be seriously injured, however they would be able to make contact with the surface using non-verbal communication later in the exercise. The reason for this was to assist the decision process making for the deployment of mines rescue teams.

10.1 Some issues raised

- All mines to conduct a gap analysis on their emergency response plans to recommendations made in 2007 report as well as previous exercises.
- Improved training required in the donning and changeover of SCSRs.
- A mines inspector and industry safety and health representative should respond to and attend all Level 1 Mine Emergency Exercises.
- Non-verbal communication enabled some information to be exchanged however some information was not identified

11 Newlands Northern Underground 2008

The emergency was caused by a contractor who, on a late Friday afternoon using his heavy rigid tanker truck delivered approximately 2,000 litres of fuel to a bulk fuel storage facility located in the open cut, within 100 m of the main portal. While driving down the ramp, the truck's brakes failed causing the truck to gain speed finally colliding with some infrastructure at the bottom of the ramp. Due to the severe impact, the truck caught fire in front of the intake portal for the mine.

11.1 Some issues raised

- Wherever possible mine workers should utilise underground transport for evacuation purposes.
- Training in donning and use of SCSRs needs to be addressed as indicated by previous level 1 mine emergency exercises. Such training **MUST** reinforce that talking and not maintaining a tight seal around the mouthpiece whilst wearing SCSRs may be fatal in atmospheres containing noxious and toxic gases.
- All mines should modify their emergency response plans to contact the Queensland Mines Inspectorate via the emergency number enabling an immediate emergency response on behalf of the Department. **(07 3237 1696)**

12 Cook Colliery 2009

This scenario involved ignition of coal fines around a hot conveyor belt idler, on the main decline conveyor belt, near pit bottom. As the fire grows, combustion products are drawn into the workings and at some point the belt trips. The underground shift electrician is asked to investigate and uses the drift-runner vehicle to travel from his panel to pit bottom to investigate the source of the belt stoppage. As he drives into gradually thickening smoke, he becomes disorientated and gets lost.

Both working crews, located in different parts of the mine, start to evacuate by foot towards the secondary egress shaft. During the evacuation the crews were required to don SCSRs and changeover of SCSRs were required throughout the evacuation. One mine worker was injured during the evacuation and had to be stretchered to the shaft and put into the cage on his stretcher.

12.1 Some issues raised

- Every underground coal mine needs to be able to demonstrate their current training program is effective in donning, initiating, wearing and changeover of SCSRs.

- Emergency response and TARPs for gas monitoring to consider appropriate analysis actions (e.g. bag sampling, GC analysis) when sensors/analysers are recording gas concentrations over-range.
- The QMRS should ensure that all mine sites are provided with detailed requirements for the deployment of GAG mine inertisation system, ancillary equipment and rescue teams.
- All mines should initiate the initial Mines Inspectorate callout via the standardised emergency callout number (07 3237 1696).

13 Carborough Downs 2010

This scenario was based on what could happen at the mine if a runaway vehicle underground caused a fire and injured the operator, a severe storm caused the main ventilation fans to stop, and a mines official inspecting the mine during the emergency is reported missing.

13.1 Some issues raised

- The amount of effort required to release a CSE SCSR was not realised by coal mine workers.
- That evacuation training include a preference for using a vehicle wherever this is possible.
- Site access was restricted this added complications to getting emergency personnel on site.
- More structure required around the Incident management approach

14 Aquila Mine 2011

This scenario was that three members of a production crew were trapped in by a roof-fall. One of the miners was seriously injured so a medical emergency also existed. In addition to the roof-fall, mineworkers had to contend with the failure of the main fan (45 minutes after the roof-fall) and a surface grass fire (60 minutes after the roof-fall), which broke out when hot material from the failed transformer on the power pole fell into grass.

14.1 Some Issues Raised

- Underground coal mines review their Safety and Health Management System to identify provisions that reduce risk and support decision-making during an emergency (resources to be provided as appropriate). ie: closed-circuit video cameras at strategic locations, communication systems for duty-card holders, continuous gas monitoring at in intakes.
- Suitable resources in the emergency pod CABA as an alternative to SCSRs to improve verbal communication.

15 Oaky North 2012

A frictional ignition on Longwall 306 led to a gas explosion, which opened and damaged the doors in the tailgate and blew out the pressure release panels at the upcast shaft. The ignition injured three coal mine workers on a longwall face. Two coal mine workers in the main gate were knocked over, but remained conscious. They walked 12 km to the surface. One wore CABA all the way out and the other wore opaque goggles to simulate walking through smoke

15.1 Some issues raised

- Arrange emergency mutual assistance between mines to address the analysis of the

- large volume of technical data by appropriately qualified people.
- Develop improved debriefing techniques. This has application in incident investigations as well operational activities.
- Issues with the distances that personnel had to evacuate on foot. Use vehicles wherever possible.

16 Ensham Mine 2013

A driver of a PJB (man transport vehicle) had a heart attack, crashing the vehicle into the rib side of the man and materials drift. The passenger inside was dazed as a result of the accident. The driver collapsed outbye (up wind) of the vehicle while trying to get out. As the passenger went to raise the alarm he noticed the vehicle is on fire.

It was decided that:

- the driver would succumb to the heart attack and die.
- any reasonable fire-fighting response would put the fire out, however the pollutants within the mine would always remain above 100 ppm of carbon monoxide (CO) requiring search and recovery operation to involve the QMRS.
- during the mine evacuation, one person would be lost in the South East 2 Panel.

Some issues raised

- Consider installation of underground cameras to assist with data collection and remote monitoring of mine areas.
- Review emergency response systems to ensure that emergency hotlines such as the Mines Inspectorate Hotline are used in an emergency.
- Recognised Standard 08 Conduct of Mine Emergency Exercises identifies the need for possible press involvement, therefore all mines and mining companies should prepare adequate documentation/information resources to issue to the press during a time of crisis.
- Mines and mining companies should review the need to be able to respond to social media posts during a time of crisis.

17 Kestrel South 2014

The scenario for the exercise was based upon an underground conveyor overrunning and creating a pile up of coal at the end of the shift. A faulty conveyor belt idler was the ignition source for the coal which quickly escalated into a coal spillage fire. The pollutant from the fire quickly spread around the mine creating the requirement for an evacuation by CMWs using SCSRs and a changeover to CABA. One mineworker would be trapped underground in a fresh air circuit in contact with the surface.

It was decided that any initial fire-fighting response would not be successful so as to require the deployment of the Queensland Mines Rescue inertisation tool the GAG.

17.1 Some issues raised

- Many mines use variants of the MEMS system. Forum required to standardise what is being used.
- Forum required to consolidate of all the recommendations from 17 Level 1 Emergency exercises and act on them.
- All mines should modify their emergency procedures to ensure that the emergency activation numbers are used for the mines inspectorate, QMRS and Simtars.
- Guidance systems into SCSR/CABA locations should be standardised across all coal mines.

- Emergency winding capability including suitable capsules for extracting coal mine workers out of boreholes/shafts should be available in Queensland.

18 North Goonyella 2015

The scenario for the exercise was based on an outburst in a development heading releasing gas and coal debris that injured the development personnel and disrupted the development auxiliary fan ventilation. The gas plug (methane) travelled into the return roadway where an Eimco which had been on cleaning duties on the previous shift acted as an ignition source. The resulting explosion damaged ventilation overcasts and a stopping resulting in a short circuit of air and the gases from the explosion travelling to the longwall where the CMWs had to wear SCSRs and effect an escape.

18.1 Some issues raised

- CMWs experienced difficulty in donning and changeover of SCSRs.
- One CMW damaged the long duration SCSR during the changeover process.
- There were issues with information transfer during the IMT process in particular from the control room to the operations group.
- Non-technical issues were identified that affected decision making and information transfer during the IMT process.
- There were delays in mobilising QMRS and QMRS did not deploy underground. (Objective e. was therefore not achieved.)
- The arrival of the Industry Safety and Health Representative (ISHR) and Mines Inspector disrupted the IMT process.
- More training and practice is required in the MEMS process.
- Peabody corporate communications were provided an excellent response to the social media events. Once they knew there was an incident they established a Social Media presence and provided the correct messaging.

Discussion

The number of assessors involved in each exercise is around 20. There is a core team of assessors on the management committee who have been involved in most of the exercises. One member has been present for all eighteen. The current management committee consists of:

- Simtars (Current Chair of the committee).
- Department of Mines and Energy Inspector.
- Construction, Forestry, Mining and Energy Union (CFMEU) Industry Safety and Health Representative.
- QMRS
- Minerals Industry Safety and Health Centre University of Queensland (MISHC)
- Mine site representative "mole"

With other assessors called in for the full team briefing. Organisations represented include:

- Mine managers from Queensland coal mines
- New South Wales (NSW) Mine Rescue Service
- NSW Mines inspector
- NSW CFMEU ISHR
- Solid Energy New Zealand
- Compliance Unit, Department of Natural Resources and Mines, Queensland
- The National Institute of Safety and Health (NIOSH) in the United States

- Around four “younger” mining engineers from Queensland mines are invited to join the assessment team each year to increase their awareness of emergency response requirements.

Approximately 200 man-days of professional time are involved in the each level 1 process. That is from the initial site visit to the final printing and mailing of the report. This is a considerable investment in time and energy by coal industry professionals - but what has the industry gained by undertaking these exercises, and what are the issues that need to be addressed?

- Industry is sometimes slow to adopt or modify the emergency response plans after the running of the level 1 exercise. This can be seen by the number of times the same or similar recommendation has been made.
- All of the reports have identified issues with the training and donning of SCSR's. An issue raised in the Sago Mine Disaster Report (McAteer J.D and associates 2006)
- The amount of time taken to write and release the final report has varied from 1 month to over six months. The report often loses its impact if it is released several months after the exercise.
- The mechanism of communicating the findings to industry in general. Different approaches have been tried from road shows, to articles in the Queensland Government Mining Journal to papers given at technical conferences such as this in Australia. None have proven to be the optimum solution.
- Some mines have approached the exercise as a pass or fail test. “Fear of the exercise”. The exercise committee needs to address this to ensure that all appreciate that this is a learning experience where everyone benefits. This is also covered in the draft recognized standard.
- Once a mine has undertaken the level 1 exercise it appears that the lessons learned and information are not freely available. For example one mine where the level 1 was held and had 20 copies of the report mailed to them not one copy could be found approximately 18 months later when a new owner took over the running of the mine.

Ownership of safety management plans is required by the whole workforce, they need to realise this is a way that they can impact on their own safety and in fact a mine with a good safety system often has good productivity as well. Being systematic is what improves safety and productivity.

Summary and Conclusion

In conclusion the running of emergency exercises for 18 years in Queensland has led to many improvements in mine safety and emergency response. The exercise also tests the effectiveness and timeliness of the deployment of emergency response personnel; and equipment

The Queensland Level 1 Exercise is a learning opportunity for the mines and state services to test their response, communication systems and interactions with the aim of continual improvement of the whole system and it can be concluded that:

- Inertisation capability is readily available:- Gag in Qld and Mine Shield in NSW.
- Emergency response for gas monitoring is available in both Qld and NSW.
- Mineworkers are now more familiar with SCSR and CABA (ongoing refresher training still needed).
- Both states require emergency response training and exercises.
- When the emergency response plan is triggered a safety management plan must have

- failed.
- MEMS was developed by QMRS and has been adopted by all of the mines. (More practice is still required)
 - Mine management needs to welcome the opportunity to test their emergency response plan and no longer regard it as a pass or fail test. It is the ideal opportunity to identify improvement opportunities.
 - Industry needs to work on ways of sharing the learning with each other as mutual safety is in everyone's interest.

References

Recognised Standard 08 Conduct of mine emergency exercises. Queensland Government, Brisbane, Australia:

https://www.dnrm.qld.gov.au/_data/assets/pdf_file/0020/240374/recognised-standard-08.pdf

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McAteer, J.D and Associates, July 2006, *The Sago Mine Disaster a Preliminary report to Governor Joe Manchin III*

Level 1 Exercise Reports

Southern Colliery 1998, Kenmare Colliery 1999, Newlands Southern Underground 2000, Kestrel Coal Mine 2001, North Goonyella Coal Mine 2002, Crinum Mine 2003, Oaky No 1 Mine 2004, Moranbah North Mine 2005, Grasstree Mine 2007, Newlands Northern Underground 2008, Cook Colliery 2009, Carborough Downs 2010, Aquila Mine 2011, Oaky North 2012, Ensham Mine 2013, Kestrel South 2014, North Goonyella 2015

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