

# ***SOUTHERN DISTRICTS EMERGENCY ESCAPE SYSTEM & IT'S LINK WITH MINES RESCUE***

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## **ABSTRACT**

A new underground coal mine emergency escape system has been implemented into the coal industry in the Southern Underground Coal District of New South Wales, Australia. It has eventuated from a long process of trials and risk assessments and has involved every facet of the mining industry.

The Southern Underground Coal District consists of ten mines which are owned by five different company's. A team of over 20 people had direct input into the development of this system, as well as the countless others who have helped refine initial ideas and avail themselves to series of tests and trials. This paper is a culmination of their combined efforts.

## **BACKGROUND**

In September 1999, a new set of Coal Mines Regulation Act, Regulations was introduced in New South Wales. Part of these new Regulations specified the escape equipment that must be supplied to all underground personnel.

*"A mine manager must provide sufficient escape equipment (including adequately maintained approved types of self rescuers) to allow safe egress of persons from the mine through conditions of reduced visibility and any irrespirable or irritant atmospheres that may be encountered."*

Paul McKenzie-Wood (NSW Mines Rescue Service) had completed an ACARP study on the availability, reliability and the use of Self Rescuers world wide. The study included Australia, USA and South Africa, with a limited amount of information from Europe.

The results of the study led to two conclusions;

1. Inference that the new legislation leaves little room for the W65 Filter Self Rescuer in an escape system for potentially gassy mines, and

2. Although manufacturers are progressing through the issues, did little to allay industry concerns over the reliability and durability of Self Contained Self Rescuers that rely on the chemical technology of Potassium Superoxide.

The introduction of the proposed system has some added benefits in *responding* to underground mine emergencies and these are very much open to discussion as we strive to respond to unplanned events in a timely manner.

## **EMERGENCY ESCAPE**

The system now allows all mining companies to comply with recently introduced legislation. More importantly, it gives underground mine workers the best possible chance of detection, notification and escape in the event of a potentially devastating underground emergency, such as fire or explosion

In keeping with Department of Mineral Resources Guidelines MDG 1020, the system has a heavy focus on early warning systems such as real time gas monitoring and training of underground personnel in detecting change.

### **Communication**

Communication systems are vital at this point, and the use of DAC and telephone communications to a central control room allows rapid dissemination of critical information to all underground personnel by use of a PED system.

### **CSE 100 Self Contained Self Rescuer**

All underground personnel wear a CSE 100 self contained self rescuer unit on their belt, which can be rapidly donned to protect against any irrespirable or irritant atmospheres. The unit has a rated duration of fifty minutes which will allow outbye personnel to readily reach a changeover or refill station. It also allows the use of self contained self rescuer escape right back to a place of safety if this is the employee's preferred option.

The unit was chosen because of its history in the US market (10 years without a major recall), its duration, the fact there is a twenty five minute unit with identical donning procedure, and its 'starter' mechanism which gives the wearer oxygen immediately upon donning (considered particularly necessary in outburst prone mining areas).

### **First Response Emergency Evacuation Kit**

The use of an air shower in the changeover process minimises the risk to personnel during changeover in a potentially irrespirable atmosphere. These will be located at the

First Response Emergency Evacuation Kit (or FREEK) as well as locations where SCSR to SCSR changeovers may be necessary (eg. Longwall tailgate).

Spare SCSRs and enough CABA suits for all personnel in the district are located at the FREEK, or first response station, which will be used by the crew as a meeting point. These are located at a designated point outbye the face (within a few hundred metres) and must be accessible from both intake and return roadways. The FREEK will also contain all equipment necessary for response to an Outburst at the working face (brattice, pogo sticks, stretchers etc).

### **Compressed Air Breathing Apparatus**

At this point, the self contained self rescuer is replaced by a compressed air breathing apparatus, which will be worn by the underground personnel for the rest of their escape journey. A single cylinder, nine litre, three hundred bar Drager CABA suit is used in the whole of this mining district. The single cylinder, 9L configuration was chosen because it is the same CABA configuration that has been used in the 'outburst prone' Bulli seam, underground coal mines for over 10 years. The cylinders are Kevlar wrapped aluminium, capable of a filling pressure of 300 bar, giving an expected duration slightly greater than that of the SCSR.

The changeover technique needs to be well rehearsed, and requires the use of the positive pressure within the suit to clear any potentially fouled atmosphere from around a person's breathing zone during changeover. Crews have undertaken initial training at the SMRS, followed by a 'refresher' training on site as the equipment has been installed. Further training is planned to be conducted 'inseam', as well as an annual refresher training at the SMRS.

After securing the CABA suit to the person and turning on the air supply, it is one last breath from the self contained self rescuer and the next from the CABA face mask. A manual 'purge' button on the suit allows the compressed air from the cylinder to be used to clear any fouled atmosphere around the user's breathing zone. This of course means that at no time during the changeover are personnel exposed to the potentially lethal atmosphere.

After securing the face mask, personnel move to the ONE quick fill outlet located at the FREEK to top up their suits before proceeding outbye. It therefore doesn't matter how much air has been used from the cylinder in the changeover process. The coupling from the outlet is securely connected to the quickfill attachment on the CABA suit, and using the beer tap arrangement, the pressure in the suit can rapidly be topped back up to three hundred bar. This will ensure all personnel have sufficient air supply to make their way outbye to a refill station, arriving with at least fifty bar left in their suit.

## **Distance Between Refills**

The distance between refill stations at Appin Colliery was determined by walk out trials and is currently one point two kilometres. The trials involved people attempting to escape in 'worst case' conditions (i.e. on foot in nil visibility but with lifeline as guidance system). The shortest distance traveled by any individual in these conditions BEFORE their warning whistle sounded (indicating 50 bar left in cylinder) was 1.5km. It was then decided to add another safety factor to the system and 1.2km was implemented.

## **Escapeways and Guidance System**

The quickest and least demanding means of escape for the crew will be on transport, and this is still easily achievable wearing CABA suits. Transport also means the whole crew will remain together and their consumption rates (regardless if they are wearing CABA or SCSRs) will be substantially reduced.

If transport is NOT available and visibility allows, the travelling road is a good option as it is known to all personnel and usually provides better walking conditions. There is no lifeline however in the traveling road and relies on signs as indicators for refill stations and caches.

In cases of very poor visibility it may be necessary to escape down the return roadway using the tactile guidance system. The lifeline consists of five millimetre diameter radio aerial which is held securely in place by rods attached to the roof or rib. The walkway beside the lifeline should be free of debris to allow a reasonable rate of travel without fear of slips, trips and falls.

Directional cones ensure the risk of total disorientation is minimised in cases of extreme visibility by allowing personnel to know with confidence they are heading to a place of safety. These cones are placed along the lifeline at nominal intervals of up to 100m. At every opportunity to move from the return roadway back to intake (i.e. trapdoors in overcasts or stoppings), there are 6 cones located back to back followed by a plastic disk. A 'spur line' then guides personnel to the trapdoor where an inspection is made followed by a decision on the most appropriate action.

## **Refill Stations**

The cascade refill system allows for up to five people to refill their suits simultaneously without having to be exposed to the outside atmosphere. Timing of the refill varies between thirty seconds and three minutes, depending on the number of people attached to the refill unit. The refill units come in two different sizes, though both have identical operating panels. The 'C-20' unit comprises 10 x 'G' size cylinders and has the capacity to refill 20 CABA sets from 50 bar (the minimum pressure any person escaping would arrive at the refill station with) back up to 300 bar. The 'C-40' unit comprises 20 x 'G'

size cylinders and refills 40 CABA sets. If there is a requirement for more than 40 refills at any one point (i.e. some outbye locations common to all panels escape routes), there would be more than one refill unit at the site.

The capacity at each of the refill stations allows the availability of refuge for injured or fatigued crew members. Residual air in the large cylinders allows for many hours of refuge for up to 5 persons. Although the air supply remaining may be too low in pressure to continue to refill CABA suits to 300 bar, there is sufficient volume for 1 man to refuge for up to 40 hours (based on 35 litre/minute consumption rate) at the C-20 unit, and obviously longer at the C-40.

Telephone communication will be located at each refill station and should be used by escaping crews to obtain updates of the incident and inform surface control of current locations. As the crews are wearing CABA units, communications are possible.

If the crew reaches a refill station and is not yet on the outbye side or clear of the incident, escape continues to the next refill station, using the guidance system if required. The system will continue to guide the crew to a designated place of safety, which is anywhere on the outbye side of the problem, or a place that needs to be determined at each mine as a place of guaranteed fresh air.

### **Advantages**

The major advantages of the escape system are:

- The PED communication system allowing quick dissemination of critical information to all underground personnel – currently only one way being surface to underground worker.
- The guidance system, which the trials proved was necessary to guide experienced personnel through underground workings that they were familiar with BEFORE poor visibility was encountered – disorientation can be equally as deadly as a fouled atmosphere.
- CABA is preferred by the workforce because of the cool air supplied by the set and the minimal breathing resistance.
- CABA allows communication between the crew as they are escaping, as well as with surface control.
- Crews can train with the actual equipment, rather than rely on simulation of the system (using training units which are not the same) as is the case with Filter Self Rescuers and Self Contained Self Rescuers based systems.

- The system is simple to use giving appropriately trained personnel the ability to operate with it in high stress circumstances.
- The system now gives the underground workforce in the Southern Districts the best possible chance to escape to a place of safety in the event of an emergency which adversely alters the mine atmosphere.
- The CABA system allows both a refuge and response option, and could readily be linked into in-seam response and / or rescue teams.

### **In-seam Response Options**

With the introduction of CABA equipment in-seam, the potential for rapidly dealing with an underground emergency is substantially increased. In this age of the eternal risk assessment and the subsequent difficulty in rapidly dispatching Mines Rescue teams from the surface, the advantages of in-seam response have never been greater – BUT - how is this achieved with due consideration to the health and safety of those responding?

Four critical components must exist to ensure that a mine has competent people within their workforce who are able to respond safely to a wide variety of U/G emergencies:-

1. A Company policy that lays out the circumstances in which in-seam response is allowed or encouraged or even more importantly circumstances when no attempt at all should be made and self escape to the 'place of safety' is the only priority.
2. Equipment located at strategic positions according to risk.
3. Competently trained personnel spread across each operational shift and roster
4. A set of risk assessments undertaken in peace time which translate into 'guidelines' for operational teams in an underground emergency.

While these four components assist mines in becoming more self sufficient in dealing with incidents, the facts are that in-seam response teams CANNOT do all of the tasks that Mines Rescue teams can, and they should not be expected to.

What the in-seam response teams can achieve (provided the Company policy allows it) is to respond to the situation within the first ninety (90) minutes of the occurrence. This is an area that has never been covered by mines rescue - in NSW at least. This potentially means that some of occurrences could be resolved in the early stages before they have time to escalate to larger events – underground fires are a classic example.

Even so, the links between in-seam response and mines rescue are great.

## **Links With Mines Rescue**

Long duration breathing apparatus, intense training in a wide variety of atmospheres and the experience and knowledge gained from years of responding to emergencies at different operations can never be replaced.

There are many events however, where short duration, open circuit BA teams hold a distinct advantage to the traditional Mines Rescue team. Fire fighting in hot and humid atmospheres and short duration tasks such as taking bag samples can be achieved more easily using CABA equipment.

The main advantage although, is of course the ability to respond to a major incident in a timely fashion.

While the introduction of the escape system gives an option of in-seam response, the fact that the system gives underground personnel a greater chance of survival actually increases the need for a likely use of BG Mines Rescue teams.

The escape system allows a refuge option and if this option was taken by person(s) in an evacuation, the only timely method of retrieving them would be with the use of long duration BG mines rescue teams.

The CABA used for self escape can not be expected to allow a rescue team to travel from an outbye refill station to an inbye one and back again nor even to penetrate for long distances in irrespirable atmospheres. This is because of three critical reasons :-

1. the CABA self escape system can not guarantee that the air pressure at the inbye refill station (which was used during self escape and/or for refuge) has sufficient air supply to refill the units for the teams return
2. that the CABA units duration is sufficient to allow the rescuers to assist the person(s) to a place of safety – this is mainly due to the increased breathing rates when doing activities like stretcher carry etc.
3. that it is likely that the emergency event is dynamic, in which case, CABA units have a limited 'Factor of Safety' in relation to their duration - this would restrict activities to approximately a 30 minutes in one direction.

So, even though the CABA teams can perform some initial rescue activities, there are limits to the type of occurrence and duration that they could be used. Once BG mines rescue teams have been formed and arrived then they would be used for the longer duration tasks - exploration etc. There is likely to be some cross-over areas and even some integration of teams for a number of the menial tasks that occur during an emergency event.

## CONCLUSION

The introduction of the Southern Districts Emergency Escape System is one of the largest changes to the underground mining industry in recent times – akin to the introduction of the Filter Self Rescuer in 1966.

The introduction process has not and will not be without further problems and these will be dealt with as they arise. It is important though, that right through this process we do not lose sight of the reason we are introducing such an elaborate escape system – it is for the same reason we as an industry have made many changes throughout the years – to make the underground mining industry a safer place for all who sail in her.

The role of traditional mines rescue needs to change as the industry itself does and the introduction of CABA equipment in seam, rather than threaten the existence of Mines Rescue, actually enhances the capabilities of the Mines Rescue brigades to respond to underground emergencies. It is now up to the Mines Rescue Service to work with the coal industry to ensure this eventuates.