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CHALLENGES ENCOUNTERED BY NEW ZEALAND MINES RESCUE AT THE PIKE RIVER MINE DISASTER

Trevor Watts

ABSTRACT: The loss of 29 lives in the Pike River Mine Disaster of 19th November 2010 will be forever remembered as one of the darkest days in the history of coalmining in New Zealand. The effects of this tragic event have also been felt by the mining industry in Australia. As an industry we are constantly aware of terms such as "Emergency Preparedness" and "Emergency Response Management Plans" and in fact, numerous seminars and forums are facilitated to study these topics in detail. This begs the question, "how well is your organisation really prepared if it was faced with a major disaster such as that which occurred at Pike River"? The incident management team, mine manager, mines rescue and other emergency organisations responding to the Pike River mine explosion faced significant challenges on planning a re-entry into the mine by rescue teams.

INTRODUCTION

Coal mining disasters can occur from a variety of circumstances such as explosions, inundation of water or fires to name a few. Every incident will provide different and at times unique challenges to people charged with control and management of the situation. Incident management teams rely on accurate and reliable information available to form the basis of robust decision making processes.

An emergency event can rapidly escalate depending on the dynamic nature of the situation and can also deteriorate quickly on the back of poor decision making. The gathering, analysing and interpretation of information form a critical function of incident management. Obtaining information during an emergency can be particularly challenging as often a significant amount of diverse information is required quickly.

Incident controllers are required to make numerous critical decisions and in some instances lives are dependent on people in incident management roles making decisions based on accurate, reliable and timely information. One of the most critical decisions that an incident management team and incident controller will be required to make in response to a dynamic incident such as an explosion, is the decision to deploy rescue teams into a mine.

This paper will provide an overview of the challenges that the incident controller, incident management team and mines rescue officer in charge were faced with in the hours following the explosion at the Pike River Mine. The known and unknown information that was available following the explosion will be described along with the complexities associated with gathering information.

The Royal Commission of Inquiry on the Pike River Coal Mine Tragedy was still sitting at the time of writing of this paper. Every endeavour has been made to ensure that this process is not jeopardised by the inclusion of subject matter that is subjective or still before the Commission. This paper is not intended to cut across the vital Royal Commission in any way, but rather to provide summary information in the context of the Coal 2012 Conference.

OVERVIEW OF THE PIKE RIVER MINE

The Pike River Mine is located 50 km north of Greymouth on the West Coast of the South Island of New Zealand. Construction of the main access tunnel commenced in 2006 and eventually intersected the coal seam at approximately 2.3 km. The main access tunnel is inclined at an average gradient of 1 in 10 with the tunnel dimensions approximately 6.5 m wide by 5.5 m high. The coal seam is between 3 and 12 m thick and the methane seam gas was measured from one sample as high as 10 m³/t.

The design of the mine with the incline tunnel intersecting the coal seam at the lowest point meant the seam gas make was at its highest in the early development stages of the mine. A gas drainage system

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was used at the mine and a number of in-seam boreholes were linked to a gas drainage line. Once the main tunnel had accessed the coal seam, a 110 m return ventilation shaft was constructed using a raise bore technique. The bottom 40 m of the shaft collapsed before strata stabilisation work was completed.

Following the shaft collapse a 2.5 x 2.5 m vertical raise shaft was driven from within the mine which then intersected the supported section of the main ventilation shaft. The vertical section of the shaft was 55 m high in which a ladder was installed. The 2.4 km access tunnel was the only practicable means of egress.

The mine was still in the early stages of development with only one small extraction panel completed. Development headings were driven using two continuous miners and one roadheader. Shot firing was required in areas of stone drive development and a hydraulic monitor was the method of mining coal in the extraction panel. Coal was cut using high pressure water and the water sluiced the coal to the pump bay located in the pit bottom area.

At the time of the disaster, Pike River Coal Ltd employed approximately 160 permanent staff and also had up to 60 contractors engaged in a variety of infrastructure work.

OVERVIEW OF THE NEW ZEALAND MINES RESCUE SERVICE

The New Zealand Mines Rescue Service was established in 1930 and employs six full time staff, the general manager, three training officers and administration officer based at the Rapahoe Rescue Station on the West Coast of the South Island and a station manager based at the Huntly Rescue Station in the North Island.

At the time of the Pike River Mine Disaster, the New Zealand mines rescue service brigade strength consisted of 24 underground rescue personnel in the North Island and 33 underground personnel on the West Coast of the South Island. Additionally the West Coast has 30 surface rescue personnel.

THE EVENTS OF 19TH NOVEMBER 2010

At 3:44 pm the control room officer was talking to a miner underground when communications were suddenly lost. At the same time the computer monitoring system started alarming and indicated that power had been lost underground. The control room officer attempted to contact personnel throughout the mine but was unable to raise anybody. He contacted the mine manager who was in a meeting with other senior mine officials and informed him of the situation.

The mine manager discussed the loss of power with the engineering manager who subsequently arranged for an electrician to go underground to investigate possible faults at the main electrical bay. The loss of power was not an unusual occurrence at the mine due to the fact that the mine was at the end of a main supply and had been damaged on previous occasions as the line was close to trees for 7 km.

The electrician entered the mine in a drift runner and after driving 1 500 m he came across a loader and a man lying on the ground. At this point he suddenly found breathing difficult and his vehicle was losing power. He returned to the surface and contacted the control room to report his observations and stated that he believed that there had been an explosion in the mine. This was the first confirmation that an explosion was believed to have occurred in the mine and the mine management initiated the mine emergency response procedures.

Phone call from survivor

At approximately 4:35 pm; 50 min after the explosion; a phone call was received from the pump bay area which is located 1 900 m into the mine. A miner who had survived the explosion spoke to the mine manager and stated that he could hardly breathe and the mine was full of smoke. The manager told him to stay low and start making his way down to the mine portal. He managed to make his way down the main tunnel until he came across the other survivor who was in a semi-conscious state. The miner then continued out of the mine dragging his colleague with him and both men exited the mine at 5:25 pm; almost 90 min after the explosion. The men were treated by Paramedics and immediately taken to hospital. No information could be obtained from the men prior to leaving the mine due to their poor physical condition.

Mines rescue response

At 4:30 pm the Rapahoe Mines Rescue Station received a call from the Pike River mine control room and the caller stated that they believed there had been an explosion underground. The staff at the rescue station initiated the emergency response procedures and began the task of contacting brigade personnel. Three teams were assembled at the station within 30 min and Drager BG4 breathing apparatus and other essential rescue equipment was readied for deployment.

The first two teams were transported to the mine site by the local rescue helicopter and an additional two teams travelled to the mine by road. The rescue helicopter had the first rescue team and officer in charge on site at 6:00 pm. On the approach to the landing site the mines rescue officer in charge instructed the pilot to fly past the return ventilation shaft.

The sight of the damaged *évasée* was confirmation that a significant explosion had occurred. In addition to the damaged *évasée* and infrastructure at the top of the return shaft, soot was observed in the trees across the valley directly in line with the outlet of the *évasée* and smoke was seen to be drifting from the return shaft.

When mines rescue arrived at the mine site the mine manager stated that no-one, including rescue teams; was to enter the mine due to a lack of information on the underground environment. By 6:20 pm four fully equipped mines rescue teams were on site and were completing preparation of their equipment and planning strategies for a rescue operation.

SUBSEQUENT EXPLOSIONS

The second explosion occurred at 2:37 pm on 24th November. The second explosion came as a devastating blow to the families of the twenty nine men as it was conveyed to them that it was clear from video footage that this explosion was not survivable. Many families had clung onto the hope that their loved ones had survived the first explosion and were still alive in the mine. The news of the second explosion crushed those hopes. It was officially announced that the operations had moved from one of rescue to that of recovery.

A third explosion occurred on the afternoon of 26th November. This explosion was not as violent as the previous explosions but reinforced the urgency that was required to seal the mine.

On the afternoon of 28th November the fourth extremely violent explosion occurred. The force of this explosion blew the seven tonne *évasée* off the top of the ventilation shaft, landing some distance away. Thick black smoke immediately began rising out of the ventilation shaft which clearly indicated that a large fire was now burning in the mine.

A few hours later flames emerged out of the shaft and these were initially up to 50 m high. The fire raged for another eleven days before the flames were finally extinguished with the use of the Queensland Mines Rescue Gorniczy Agregat Gasniczy (GAG) jet engine unit. Following the fourth explosion a major fall occurred in the main access tunnel as the natural ventilation flow into the mine ceased.

CHALLENGES OF OBTAINING CRITICAL INFORMATION

Information required for the deployment of mines rescue teams

In the early stages of this incident it soon became apparent that there was a lack of critical information available to the incident management team. The mine manager had given a clear directive that mines rescue teams were not to enter the mine due to a lack of information on the atmospheric conditions underground. This position was maintained by the NZ Police. The author fully supported this decision.

In the hours and days following the first explosion, the NZ mines rescue focus was on gathering critical information on the underground atmospheric conditions. Until such time that accurate and reliable intelligence could be analysed and interpreted, the level of risk associated with the deployment of mines rescue teams could not be adequately determined or fully understood.

The decision to deploy or not deploy rescue teams into the mine could only be based on the information available at the time. Decisions were based on “known” and “unknown” information, underpinned by robust risk management principles.

Known information

The known information available to the incident management team and the mines rescue officer in charge in the hours following the Pike River mine explosion was extremely limited but of significant importance to the decision making processes associated with determining the level of risk associated with the deployment of mines rescue teams. Known information is described as follows:

- The mine manager and the mines rescue officer in charge had flown over the return shaft and viewed the damaged *évasée* and adjoining infrastructure. This observation along with soot in trees on the side of the valley opposite the *évasée* was confirmation that a significant explosion had occurred.
- Smoke was seen to be drifting out of the return shaft. This was a critical piece of information as it had to be accurately determined if the smoke was a product of the explosion or combustion that still remained in the mine.
- The mine had a high gas make. Information provided stated that the gas make from the upper workings of the mine was approximately 200 L/s. Only six weeks prior to the disaster the main fan on the surface malfunctioned and the entire upper mine workings “gassed out” in a few hours. NZ mines rescue was called to assist with this event so was well aware of the mine gas make.
- The mine gas drainage line had been fractured somewhere underground. Information provided indicated that this may be delivering up to 800 L/s into the mine in addition to the normal mine gas make. Approximately 1000 L/s of methane was filling the upper workings of the mine. Total void volume of this area was approximately 50 000 m³.
- The main ventilation fan was located underground and power was off. It was considered highly probable that the ventilation control devices in the mine would be destroyed, particularly the double doors in the first crosscut between the intake and return shaft.
- Natural ventilation was entering the mine due to the inclined main tunnel and elevation differential between the intake portal and return shaft. Sufficient oxygen would be present to support further explosions (the quantity of air was measured at between 12 - 15 m³/s).
- The gas monitoring system had been lost as the mine only had a real time monitoring system installed in the mine. There was absolutely no intelligence on the underground atmospheric conditions.

To summarise the bullet points above, this was the information known to the mine manager and mines rescue officer in charge in the first few hours of the incident. A significant explosion had occurred in the mine, there was a high make of methane, smoke was coming out of the return and there was natural ventilation into the mine. Of the three main factors required for another explosion, two were present and the third (an ignition source) was possible and had to be suspected.

Additionally the following information was also known to the incident management team:

- Video footage of the windblast exiting the mine portal had been viewed. When the size of the mine is taken into consideration, the significance of the video footage is brought into perspective. This was a very small mine and a 52 sec windblast was recorded exiting the mine portal. Excluding the void volume of the main access tunnel, the total volume of all mine workings was approximately 80 000 m³;
- Two men had survived and walked out of the mine, 1 h and 45 min after the explosion;
- Possibly 34 men unaccounted for underground. The correct number of men missing was not confirmed by Pike River Mine until 10 h after the explosion;
- No communications had been received from any other locations in the mine. Additionally mines rescue personnel had lowered a radio down the slimline shaft into the area known as the “fresh air base” and remained at this location for many hours;

- There was only one practicable means of egress from the mine via the main, 2.4 km main access tunnel. The second means of egress was via the return shaft which would not have been possible following the explosion. The main drift was also the only access for rescue teams to re-enter the mine but this route meant they would have also been in direct line of any secondary explosion. The walking time to the top end of the main tunnel under normal circumstances was approximately 45 min;
- The walking time for rescue teams would have been considerably longer given the equipment the rescue teams were required to carry. If rescue teams were required to be withdrawn due to changes in the underground environment this could not have been achieved within a period of time acceptable to mines rescue. A loader operated by one of the survivors was blocking the main tunnel at 1 500 m which precluded the use of vehicles beyond this point;
- The workforce at the mine was trained to self-escape and all underground personnel were equipped with 30 min self-contained self-rescuer units;
- There was a cache of approximately 100 self-contained self-rescuers stored in the Fresh Air Base (F.A.B) at the slimline shaft;
- There were no boreholes into the upper workings of the mine to obtain gas samples;
- The real-time gas monitoring system had been lost. There was no road access to the return shaft; helicopters were required to obtain gas samples for Gas Chromatograph analysis at the mines rescue station. Only three samples were obtained in the first few hours as poor weather conditions prevented helicopters from flying until the following morning;
- The first gas samples analysed were highly diluted due to the difficulties in obtaining samples and the natural ventilation short circuiting through the first crosscut. These two factors meant that the gas samples obtained were not truly representative of the underground environment. Table 1 contains the details of the gas chromatograph analysis.

Table 1 - GC analysis results from the first three samples obtained on 19th November

#	Location/Time	CO%	H ₂ %	O ₂ %	N ₂ %	CH ₄ %	CO ₂ %	C ₂ H ₄ %	C ₂ H ₆ %
1	Fan Évasée – 10.30pm	0.0507	0.0286	20.39	77.29	0.2940	0.1020	0.0030	0.0009
2	Fan Évasée – 9.09pm	0.0277	0.0154	20.49	77.49	0.1280	0.0770	0.0016	0.0004
3	Fan Évasée – 9.06pm	0.0545	0.0298	20.44	77.53	0.2530	0.1090	0.0032	0.0009

Unknown information

- What was the composition of the atmosphere underground? This was perhaps the most significant issue facing the incident management team. Without accurate and reliable intelligence on the underground environmental conditions, it was not possible to adequately determine if there was an acceptable level of risk to deploy rescue teams into the mine.
- No intelligence from within the mine coupled with the fact that smoke was observed at the return shaft meant an ignition source had to be suspected as it could not be eliminated.
- What was the ignition source and did it or a secondary ignition source still exist underground? It was absolutely critical to ascertain if an ignition was present as it was highly suspected that a large volume of methane would be present in the mine.
- Where in the mine did the explosion occur?
- Was the smoke drifting from the return shaft the product of Afterdamp or combustion?
- What was the location of all the men working in the mine?

Obtaining critical information

Obtaining gas samples, temperature and pressure readings from within the mine were identified as a top priority. In the days following the explosion samples were obtained from the ventilation shaft hourly and analysed by parallel gas chromatograph analysis at the mines rescue station and mine.

However, obtaining gas samples proved to be a considerable challenge due to a number of factors. As previously described, the only access to the return shaft was by helicopter and to travel by foot, was a six hour round trip on foot in steep, mountainous terrain. Highly diluted samples from the return shaft meant there was no confidence in the data. Frustratingly there were no other sampling points available from the upper mine workings.

Early interpretation of gas data from the return shaft by Mr Robin Hughes, a highly respected and experienced New Zealand Ventilation Officer, Mine Manager and ex Chief Inspector of Mines was that there was a strong likelihood that a fire was burning in the mine. He stated that based on the data available he suspected this could be a clean burning methane fire.

In the early stages of the incident it was identified that additional boreholes were required. Suitable locations for boreholes were ascertained and an expert drilling team was quickly assembled. A suitable pad was constructed at the drill site with helicopters used for transporting all equipment and personnel. Crews worked around the clock to drill the 165 metres into the mine. Extremely difficult conditions were encountered, slowing the rate of drilling due to the very hard rock encountered. Breakthrough was achieved early on the morning of the 24th November.

Gas samples were taken following the completion of the borehole and expert interpretation of the gas analysis was provided by Professor David Cliff from the University of Queensland. Professor Cliff stated that it was his opinion that a methane fire was burning in the mine. A short time later this interpretation was confirmed when a second, violent explosion occurred in the mine.

COMPLEXITIES ASSOCIATED WITH THE DISASTER

Along with the many challenges that continually tested the incident management team, this was a complex incident on many different levels.

From a human factor perspective, it is difficult to fully articulate the effect that an incident of this scale and magnitude had on all those involved in the rescue efforts. The West Coast of New Zealand is a small tight knit community and all the men who lost their lives in this tragedy were well known to many of the people involved in the rescue efforts.

Highly trained mines rescue personnel were desperate to enter the mine. Eventually this desperation turned to despair and immense frustration as time went on as no rescue operation could be launched. However, the professionalism of the rescue personnel came to the fore. The rescue teams remained in a high state of operational readiness and continually worked on developing strategies that would be implemented if the incident management team could determine that there was an acceptable level of risk to allow entry into the mine.

The raw emotion that was displayed when mines rescue teams and all those involved in the incident were told of the second explosion is difficult to express. This is the moment that even the most remote hopes of a miracle were lost and the terrible realisation that 29 family members, friends and colleagues are dead.

The mountainous, inhospitable terrain tested the toughest of men and if it had not been for the skills of the highly experienced helicopter pilots, the work required to obtain gas samples would not have been possible. The West Coast is renowned for its high rainfall. Fortunately weather conditions only prevented helicopters from flying on a few occasions in the first days of the incident. At times rain can set in for many days or weeks on end which would have grounded helicopters.

SUMMARY

This paper has focused on the challenges associated with gathering information in the early stages of the Pike River mine disaster and what impact that the known and unknown information had on the rescue efforts.

This disaster has been and continues to be a complex and challenging event that has been continuous for just over a year at the time of writing. To fully encapsulate all of the complexities and challenges associated with this tragedy in one paper would be virtually impossible.