Risk Minimisation for Mines Rescue Teams

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AIM

This paper aims to propose a system for the systematic analysis and management of information whenever a Mines Rescue team is to be deployed. This will occur at three levels:

1. In the Incident Management Team (IMT) -a team established by the senior mine official in an emergency to advise in the management and control of the response and intervention,
2. briefing of mines Rescue Brigades prior to becoming active, and
3. rescue team management by the brigade captain.

The system incorporates a Risk Assessment pro-forma for IMT (the process used to determine risk control priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other nominated criteria), a Team Briefing sheet, and a Team Task sheet. The proposed system is to achieve the following:

- Ensure that all relevant information is assessed, risks (to the Mines rescue team) identified and suitable controls determined
- Ensure that brigades are presented all the relevant information in a clear concise way
- Ensure fit and competent brigades clearly understand their task
- Ensure that team captains have an appropriate management tool

INTRODUCTION

Mines Rescue Teams may be deployed for three reasons:

1. Training – this takes place in atmospheric conditions that do not pose any risks to the team.
2. Situation control – this usually takes place in an irrespirable atmosphere (an atmosphere which is unsafe for a person to breathe or which is outside the legal statutory limits) necessitating the deployment of brigades wearing self contained Breathing Apparatus. Tasks may be pre-arranged and vary greatly, and may include fire fighting, exploration, ventilation modifications.
3. Aided Rescue and assisted escape – teams are deployed in directly assisting/retrieving underground persons to escape from an underground emergency situation

self ignite. The heating developed into a large fire, which was assisted by the increased airflow when the mine fan was started. Efforts to extinguish the fire were unsuccessful. Recirculation of the ventilation occurred causing an explosive mixture of gas generated by the fire to ignite. The ensuing explosion resulted in the loss of seventeen lives, including those of a rescue team who had entered the mine to attempt to control the fire by sealing the intake.

The **Mining Inquiry** that ensued reported the following amongst its official **"Report, Findings and Recommendations"**:

"There is little doubt in our minds that re-circulation played a most important part in the events that night. It is clear that it was present at an early stage; certainly some hours before the explosion. Apparently the significance of this condition did not impress itself on the minds of those responsible for the conduct of operations, or, if it did, they did not accurately assess the potentiality of danger arising form it.

Regarding re-circulation, it must be observed that it appears no one questioned the course of conduct proposed, from which it follows that all present were apparently in agreement with the assessment of the position made by the manger, the Inspector of Mines, and other members of the team when they conferred from time to time. There were other experienced men present, who were aware that re-circulation was taking place, but it seems that they did not direct their minds to the potential danger of explosion inherent in this condition; rather, it seems that they were more concerned with the danger of being overcome by smoke and gases contained in it."

Germany – 13/9/80 –

An extract from "Accidents to Mines rescue Team members Wearing Breathing Apparatus During the period 1935 – 1982" Mines Rescue HQ for West Germany, Essen, 1983

Deployment: Situation control – pre-arranged exploration

Outcome: 1 fatality, rescue team member

"Four teams were to explore whether there was stagnant water in a roadway which was not ventilated (coal mine). The roadway in question was about 450m long with an average incline of 6gon. Atmospheric measurements showed a dry temperature of 36c (96f) and a wet bulb temperature of 32c (89f) giving a calculated work time of 60 minutes.

After the first team went in, the speech connection was broken after about 34 minutes. The second team went in, and after repairing the fault in the telephone system, relieved the first team. This means that the team 1 returned to the stand by station (fresh air base). Team 2 advanced further. After 45

advised and responded. Another entry was made by rescue teams which found very difficult climatic conditions (temperature 26 to 31.5 degrees Celsius, and humidity 95 – 98 %). A decision was made to withdraw and to ventilate the area prior to re-entry. In total 60 rescuers attended the rescue works. The chairman of the Mine authority established a Committee with the aim to investigate the causes and circumstances of the occurrence. As a result of the Committee's work the causes of the accident have been determined.

Causes of the group accident occurring during penetration and rescue works connected with rendering of the assistance to those affected were as follows;

1. *"Admission to penetration of the working without earlier exploration and analysis of ventilation-climatic conditions.*
2. *Carrying out of penetration of the working in the way infringing the elementary principles of work organisation of rescue teams in atmosphere not fit for, that consisted in:*
    - *not equipping the rescue team with indication tubes for detection of O 2, H 2S, NO 2, H 2and rescue phone,*
    - *execution of a hole in the isolation stopping without earlier exploration of air composition behind it,*
    - *separation of rescue team members,*
    - *lack of standby team on site,*
    - *Allowing for penetration of the working by rescuers equipped with AU-9L oxygen self rescuers instead of W-70 oxygen breathing apparatus without phone communication and respective measuring instruments such as: indicating tubes for detection of O 2, H 2S, NO 2, H 2and a thermometer.*
3. *Not withdrawing the three rescuers from the ventilation dip road by the foreman of the dust fighting division and allowing for further penetration of the working with the use of oxygen self rescuers AU-9L irrespective that mine air composition indicated to a possibility of occurrence of atmosphere not fit for breathing in a farther part of the working.*
4. *Opening of the working closed by isolation stopping and carrying out of penetration not in conformity with the rules of rescue works was the cause that:*
    - *the man-in-charge of rescue works was not appointed,*
    - *the hazardous zone was not determined, the observation points were not secures and the fresh air base was not founded,*

Mine management was aware that this mine had not been ventilated since April 2000. They also knew the temperature in the mine was expected to be near 100 degrees Fahrenheit with very high humidity. On June 23, 2002 two Barrick supervisors entered the Storm Decline for a distance of about 600 feet before low oxygen readings forced their retreat.

On the day of the accident, a three-man team had entered the mine and advanced 800 feet before the effects of high heat, high humidity, and foggy conditions forced their return to the surface. The failure to recognize the hazards presented by this environment resulted in the second team being allowed to advance into the mine and travel about 2,000 feet before returning to the surface.

The accident resulted from a failure to accurately assess the risks from environmental exposure to excessive heat and humidity. Contributing to the severity of the accident was the failure to maintain the Biopak 240S apparatus properly by ensuring that all units were equipped with a frozen Gel-Pak/Gel-Tube."

A root cause analysis was performed on the accident. There were three causal factors identified and one possible causal factor. The first causal factor listed in the report is as follows:

"Causal Factor: *The risk assessment process, conducted by Barrick's management, prior to sending the mine rescue team to conduct an exploration of the inactive Storm Decline was inadequate. Procedures were not established to address all hazards affecting the safety of the rescue team members while performing this task.*

The Storm Decline had been inactive for more than 2 years. Management knew the mine was not ventilated and the temperature in the mine was expected to be near 100 degrees F with high humidity, possible low oxygen levels, and elevated levels of carbon dioxide.

The mine rescue team coordinator was informed that he should utilize mine rescue personnel to assess the physical conditions of the Storm Decline. However, mine management did not correctly evaluate the hazards that this assignment presented. Management was aware of low oxygen levels and high temperatures prior to the rescue team members entering the mine.

The mine rescue team coordinator was left to direct this task and was not assisted by management to develop a protocol that listed a specific sequence of exploration along with procedures to be followed.

Even though all mine rescue team members were trained and experienced, management was responsible for communicating with teams in these circumstances and for safely directing their actions.

Corrective Action: *A plan should be developed to establish exploration procedures. The plan should*

Incident Management Team

Decision making in IMT is the first area that the human element comes into play and it is a critical role as all the information is assessed, options weighed and actions determined. As occurred at Box Flat, groups of persons tend to succumb to peer pressure, the tendency being for the stronger persons to dominate, and the others to follow. The guidelines say that a Risk assessment is required if one is to go outside of the guidelines. The guidelines offer guidance, they either need to be known and/or referred to at a time when the pressure is really on, and when persons feel the need to make decisions. The other difficulty faced by Mines Rescue management is that often Mine Management is not aware of, or lacks understanding of, those guidelines that determine the operational constraints of brigade deployment.

The Risk Assessment pro-forma that needs to be used at this time needs to be simple, concise and clearly provide detailed information to the brigades about the hazards they will face, the risks they pose and how they as the brigade need to control them. Simultaneously it needs to be comprehensive.

This completed risk assessment template could be used to brief brigades on their task in a `job safety analysis' format. This ensures that all of the team clearly understand their task, inherent hazards, controls and limits. Importantly it also allows a different group of persons (with a different perspective) to review the initial Risk Assessment. Simultaneously it allows for members of that work group to identify areas of the task they are unsure of, for example – how to use a specified instruments.

The form below provides the layout by which all hazards, risks and controls may be assessed. This form will need to be modified or added to depending on the industry involved, the specifics of the mining conditions, and the particular incident. **It is the use of such a form that adds value to the risk assessment by the IMT /management team.**

		☐ At ..... ☐ At ..... **MONITORING OF BREATHING APPARATUS LEVELS REQUIRED EVERY ..... MINUTES** **ENTRY LIMITATION: Methane levels**
Carbon Monoxide	Explosion Asphyxiation	☐ Is recirculation possible? ☐ Is the team equipped with an electronic detector **ATMOSPHERIC MONITORING IS REQUIRED:** ☐ Whenever the environment changes ☐ At ..... ☐ At ..... ☐ At ..... ☐ At ..... **MONITORING OF BREATHING APPARATUS LEVELS REQUIRED EVERY ..... MINUTES** **ENTRY LIMITATION: Recirculation & failure of Breathing apparatus**
Carbon Dioxide Oxygen	Asphyxiation Low oxygen levels causing asphyxiation	☐ Is the team equipped with an electronic detector **ATMOSPHERIC MONITORING IS REQUIRED:** ☐ Whenever the environment changes ☐ At ..... ☐ At ..... ☐ At ..... ☐ At ..... **MONITORING OF BREATHING APPARATUS LEVELS REQUIRED EVERY ..... MINUTES** **ENTRY LIMITATION: Failure of Breathing apparatus**
Roof	Roof falls; • on brigades • limiting withdrawal of team • affecting communications with team	**AREAS OF KNOWN POOR ROOF THAT MAY AFFECT TEAM:** Poor roof — Effect on team .... **AREAS OF SUSPECTED POOR ROOF THAT MAY AFFECT TEAM:** Poor roof — Effect on team .... **ENTRY LIMITATION: Area prone to roof fall**

Casual water	Conditions of travel may lead to slip/trip/falls Depth of may prevent access	**AREAS OF KNOWN CASUAL WATER THAT MAY AFFECT TEAM:** Area ..... Effect on team ....
Ignition source	Electrical sparking causing an explosion Existing fires/hot surfaces causing an explosion Materials/actions introduced into the environment causing an explosion	**UNDERGROUND POWER STATUS** Power is ☐ off ☐ on Anti-static and non – sparking: ☐ Clothing ☐ Tools ☐ Equipment – list below .... **ENTRY LIMITATION: Active ignition source in the area team will enter if flammable gas is also present**
Brigade team members	Unfit, incompetent team members placing themselves and the team at physical risk	**ARE TEAM MEMBERS ABOVE 0.02 BLOOD ALCOHOL LEVEL** ☐ Yes ☐ No **DO ANY TEAM MEMBERS HAVE SYSMPTOMS OF FLU** ☐ Yes ☐ No **DO ANY TEAM MEMBERS HAVE PSHYCHOLOGICAL SYMPTOMS THAT COULD IMPAIR THEIR PERFORMANCE** ☐ Yes ☐ No **HAVE ANY TEAM MEMBERS HAVE TAKEN MEDICATION THAT COULD IMPAIR THEIR PERFORMANCE** ☐ Yes ☐ No **DO ANY TEAM MEMBERS HAVE FACIAL HAIR EXCEEDING PERMITTED STANDARDS** ☐ Yes ☐ No **DO ANY TEAM MEMBERS EXCEED GUIDELINES REGARDING REDEPLOYMENT** ☐ Yes ☐ No **DO ANY TEAM MEMBERS EXCEED HYDRATION LIMITS** ☐ Yes ☐ No **ARE ANY TEAM MEMBERS NOT BREATHING APPARATUS CURRENT** ☐ Yes ☐ No **ENTRY LIMITATION: A NO in any category above will exclude that team member from entry** **DO ANY TEAM MEMBERS NEED TRAINING IN ANY ASPECT OF THE**

Brigade management

Mines rescue staff need to determine when brigades report for duty whether they are fit and competent to go active. *Guidelines do not generally require testing for all factors that affect fitness.*

Mines Rescue Staff need to give Brigade members a clear, concise briefing on their task. Brigades have two main tasks:

1. Team safety (achieved by monitoring of breathing apparatus, brigade member, environment),
2. The task at hand

As with all communication there is a high risk of miscommunication, there is no clear requirement for this to be in written format. Brigades clearly need to understand their actions once they have encountered conditions unexpected by IMT.

Brigades are meant to be competent on how to achieve that task. *Brigades receive regular training and competence(for breathing apparatus) is determined based on the number of trainings attended over a given time frame, competence however needs to be determined not only for breathing apparatus reasons but just as importantly in the fields required by the task allocated.*

In the proposed system **The Risk assessment carried out at IMT level would be used to brief the rescue teams.** This would overcome the limitations of the current system as outlined above.

For other factors that the teams need to be briefed on the following TEAM BRIEFING INFORMATION pro forma sheet would be used;

Brigades

Brigades are meant to perform their task with at all times having team safety as a priority. This entails constant monitoring of team members, their environment, their breathing apparatus, as well as maintaining a focus on their task. *The current paperwork (at least in NSW) that the captain has is excessive and distracting from the core tasks that must be maintained.*

In the proposed system **the use of the following TEAM'S CAPTAIN MANAGEMENT FORM by the Brigade team captain** would overcome the limitations of the current system as outlined above.

CONCLUSION

The human being is prone to make errors of judgement, either slips, lapses or violations. The quantity of these errors is prone to increase whenever physical and/or psychological stress is applied. The resultant error can and has led to fatalities of personnel involved in mines rescue.

To eliminate the risk of these errors occurring from all levels of a Mines Rescue Operation (wether it be a pre-planned exercise or an aided rescue) one needs to have a system in place. Such a system needs to ensure that all of information has been assessed with resultant hazards, risks and controls (to the Mines Rescue brigades) clearly documented, and that the mines rescue brigades clearly understand their task, and are fit and competent.

The process proposed in this paper is currently on trial by the Mines Rescue service in NSW, Australia. Please contact me (stevesmrs@austarnet.com.au) with your thoughts, and for updates on progress of the system.