

# **Emergency Mine Re-Entry and Knowledge Management**

**Presented by Geoff Nugent**

## **Author/s: Mine Re-entry Task Group**

Geoff Nugent      Operations Manager QMRS  
Seamus Devlin    State Manager NSW Mines Rescue Service  
David Cliff        Principal Research Fellow MISCH, University of Qld  
John Grieves      Senior Project Engineer New Hope coal Australia  
Darren Brady      Manager OHECC | SIMTARS

### **Introduction**

The underground coal mining industry both within Australia and internationally is littered with emergency response experiences where the response, and ultimately the outcomes, could have been significantly improved if adequate systems had been in place for;

- The collection and management of relevant information preceding the incident
- The acquiring of information during the incident
- The use of the information for risk mitigation and decision making purposes.

The subject and process of knowledge management is possibly the most critical for would be rescuers of endangered Coal mine Workers, as it has been demonstrated at numerous coal mine incidents that a lack of or mismanagement of crucial information can be fatal for both the rescuer and/or the endangered coal mine worker.

This paper will underline the scope and importance of robust knowledge management systems for emergency response within the underground coal mining industry and the process by which it is being achieved within the Queensland Mines Rescue Service and the NSW Mines Rescue Service.

### **History**

This paper does not intend to reside in or revisit past mining disasters other than emphasis the reality that post the primary incident the inability to collect, and utilize, relevant and much needed information has impacted on all modern mining disasters from Box Flat to Sago.

This universal problem is clearly highlighted in the Moura No.2 Inquiry Task Group 4 (Mines Rescue Strategy Development) report stating;

***“Knowledge of conditions in a mine following an incident is essential in planning any rescue effort. Information systems must be provided to support implementation of the most appropriate rescue measures”.***

This same report contained the recommendation (17) that ***“Industry should develop an effective computer-based emergency decision support system for incident management and training”.***

The above statement and recommendation could be applied to any previous Coal Mining disaster.

Unfortunately more than a decade later similar issues with the knowledge of mine conditions and applying the knowledge to mitigate risk during an emergency are still being experienced within the Coal mining industry. An example of this comes from a recommendation from the report for the 2007 Queensland Level 1 Exercise (held at Anglo Coal Grasstree Colliery) that ***“QMRS should formalise the guidelines by using a risk based approach to develop a set of mine re-entry TARPS based on explosibility rather than percentage of UEL and LEL of explosive gases.”***

Currently recommendation (17) from Moura No.2 Inquiry Task Group 4 (Mines Rescue Strategy Development) report has not been achieved.

### **Managing the Known –Unknown**

From previous emergency response experience, both real and simulated, it has been proven that a lack of and less than adequate knowledge of the incident status, the mines environmental conditions and vital operating systems including ventilation, mine services and gas drainage (both pre and post event) prevents or at the very least limits decision makers and rescuers making informed assessments of the existent risks leaving un-quantified hazards.

In every potential emergency situation we can distinguish risk in three possible ways: a) known-known -- we know the risk and have retired it, b) known-unknown -- we know that there is a risk and the risk needs to be quantified and c) unknown-unknown – we don't even know there is a risk. Effective emergency response significantly depends on quantifying and mitigating the known-unknown risks (Un-quantified Hazards) within a constrained time.

This is to say confronted with these known-unknowns it is impossible for people to take reasonable precautions and demonstrate proper diligence when developing and implementing strategies and plans for rescuers to apply.

The potential consequences and outcomes of a knowledge deficit or known-unknowns existing at an incident can be described in three broad categories;

1. Plans and Strategies are developed and implemented placing rescuers at an unacceptable level of risk.
2. Rescue operations are excessively delayed establishing information and facts resulting in;
  - Increased exposure of coal mine workers to the danger
  - Potentially compounding the extent of the danger and the likelihood of its consequence/s being realized.
3. Abandonment of any attempt of rescuing the coal mine workers.

Because the consequences of a less than adequate knowledge of a danger is extreme to both the Rescuer and affected Coal Mine Worker it is imperative that controls are established and implemented which lowers the likelihood of known-unknowns existing prior, during and after an incident.

Mines Rescue organizations and mining operations need to address the development and utilization of processes, tools and capabilities to capture the required knowledge to make informed decisions on mine re-entry in a constrained time through risk management logic and technology.

## **Legislation**

Prior to developing any process or tool which will form part of both a Mines Rescue Service and a Coal Mines Safety and Health Management System we must consider matters of legislation relevant to the organizations relationship within the coal mining legislation and the context where the process is being applied.

### ***Queensland***

Two important definitions need to be highlighted when considering the relevant legislation;

#### ***CMSHA 221 Meaning of mines rescue capability***

***Mines rescue capability*** is the ability to provide a suitable number of trained persons and maintained equipment to allow continuous rescue operations to take place and to help the escape or safe recovery of anyone from a mine if it has, or may have, an irrespirable atmosphere.

***Accredited corporation***, for part 13, means a corporation accredited under section 227.

***QMRS*** is an accredited organization by the Minister under s227 and meets all performance criteria.

## ***Legislation relevant to the organizations relationship***

### ***CMSHA 225 Provision of a mines rescue capability***

*(1) A coal mine operator for an underground mine must provide a mines rescue capability for the mine.*

### ***CMSHA 232 Functions***

*An accredited corporation has the following functions—*

*(a) Providing the following services (**mines rescue services**)—*

*(i) Helping each coal mine operator for an underground mine who is a party to a mines rescue agreement with the corporation to provide a mines rescue capability;*

### ***CMSHA 233 Performance criteria***

*(1) The mines rescue performance criteria for the provision of mines rescue services for underground mines by an accredited corporation are that the corporation—*

*(e) provides an effective procedure for coal mine operators to help each other in an emergency;*

### ***CMSHA 223 Coal mine operator must be a party to a mines rescue agreement***

*A coal mine operator must be a party to a mines rescue agreement for the coal mine operator's mine.*

### ***CMSHR 174 Mines rescue agreement***

*A mines rescue agreement for an underground mine must state the following—*

*(d) The operational procedures developed by the accredited corporation to be followed by the corporation in carrying out the mines rescue services at the mine.*

***Comment:*** It is important to note that the coal mine operator provides the mines rescue capability and the accredited corporation, through its functions and performance criteria, helps the operator to achieve this. Additionally because the coal mine operator and the accredited organization are a party to a Mines Rescue Agreement prescribed by legislation it would be reasonable to conclude that all operational procedures developed by the accredited organization (to carry out mines rescue services at the mine) form part of the mine operators Safety and Health Management System.

## ***Legislation relevant to the context of the Mine Re-Entry during or after an Incident***

### ***CMSHA 273 Withdrawal of persons in case of danger***

*(1) If a coal mine is dangerous, all persons exposed to the danger must withdraw to a place of safety.*

(6) *The minimum number of competent persons necessary to reduce the risk to an acceptable level may be readmitted to the coal mine or part of the coal mine if appropriate precautions are taken so that the risk to those persons is within acceptable limits.*

(7) *For this section, a coal mine is taken to be dangerous if—*

(a) *Sealing operations are to commence; or*

(b) *The coal mine or part of the coal mine has been sealed; or*

(c) *The controls detailed in a principal hazard management plan have not been implemented or maintained.*

### ***CMSHR 366 Withdrawal of persons in case of danger***

(1) *For section 27353 of the Act, a part of an underground mine required to be ventilated under section 344(1) (b) that has a general body concentration of methane of at least 2.5% is taken to be dangerous.*

(2) *For section 273(6) of the Act, and without limiting the subsection—*

(a) *Mines rescue trained persons are taken to be competent persons; and*

(b) *Appropriate precautions are taken to have been taken if the persons are working under mines rescue procedures developed by an accredited corporation.*

### ***CMSHR 359 Exposure to atmospheric contaminants other than carbon dioxide***

(4) *This section does not apply to a person who is wearing self-contained breathing apparatus in an emergency or for a mines rescue purpose.*

### ***360 Exposure to carbon dioxide***

(3) *This section does not apply to a person who is wearing self-contained breathing apparatus in an emergency or for a mines rescue purpose.*

### ***CMSHA 38 How obligations can be discharged if no regulation or recognised standard made***

(1) *This section applies if there is no regulation or recognised standard prescribing or stating a way to discharge the person's safety and health obligation in relation to a risk.*

(2) *The person may choose an appropriate way to discharge the person's safety and health obligation in relation to the risk.*

(3) *However, the person discharges the person's safety and health obligation in relation to the risk only if the person takes reasonable precautions, and exercises proper diligence, to ensure the obligation is discharged.*

**Comment:** Normally, once coal mine workers have been withdrawn from a place of danger it is a common experience that people are not permitted to re-enter the mine or that part of the mine until the danger has been removed. This logical action is supported by the limited definition of who is competent in the context of CMSHA 273 (6). The only definition in relation to this subsection is provided in CMSHR 366 which nominate Mines Rescue trained persons to be competent for the purposes of entering atmospheres containing methane at 2.5% or greater. In

addition the exposure to contaminants (including carbon dioxide) to greater than the prescribed level is not applicable to people involved in activities for Mines Rescue purposes.

Therefore for the purposes of Re-entering a mine or part of a mine in relation to atmospheric conditions there would appear to be no limitations for mines rescue trained personnel except for subsection 366 (b) of CMSHR requiring “*Appropriate precautions are taken to have been taken if the persons are working under mines rescue procedures developed by an accredited corporation*”. The key words in this subsection (according to the author) are “*procedures*” and “*developed*”.

Once a part of a coal mine has been declared dangerous (for any reason atmospheric or otherwise) there are no prescriptive controls or recognized standards which can be applied by competent people for mines rescue purposes to re-enter that dangerous place to remove the danger or the coal mine workers from the danger. The only way a person can discharge their safety and health obligations to themselves or the people re-entering a dangerous place is that “*the person takes reasonable precautions, and exercises proper diligence*”. How is this achieved?

Whether it is an emergency or a standard mining process there is only one way we can exercise proper diligence and take reasonable precautions and that is to achieve the following;

### **29 What is an acceptable level of risk**

*(1) For risk to a person from coal mining operations to be at an **acceptable level**, the operations must be carried out so that the level of risk from the operations is—*

- (a) Within acceptable limits; and*
- (b) As low as reasonably achievable.*

*(2) To decide whether risk is within acceptable limits and as low as reasonably achievable regard must be had to—*

- (a) The likelihood of injury or illness to a person arising out of the risk; and*
- (b) The severity of the injury or illness.*

### **30 How is an acceptable level of risk achieved**

*(1) To achieve an acceptable level of risk, this Act requires that management and operating systems must be put in place for each coal mine.*

*(2) This Act provides that the systems must incorporate risk management elements and practices appropriate for each coal mine to—*

- (a) Identify, analyse, and assess risk; and*
- (b) Avoid or remove unacceptable risk; and*
- (c) Monitor levels of risk and the adverse consequences of retained residual risk; and*
- (d) Investigate and analyse the causes of serious accidents and high potential incidents with a view to preventing their recurrence; and*

(e) Review the effectiveness of risk control measures, and take appropriate corrective and preventive action; and  
(f) Mitigate the potential adverse effects arising from residual risk.  
(3) Also, the way an acceptable level of risk of injury or illness may be achieved may be prescribed under a regulation.

Any developed procedures by an accredited organization must be developed so that an acceptable level of risk is achieved by definition of the above legislation and additionally by the process prescribed by this legislation.

Therefore when competent people are to enter a part of a mine which is deemed dangerous for the purpose of preserving life the decision makers and the competent people must demonstrate through an appropriate and auditable process that they have considered what could go wrong, how it could go wrong and why it would go wrong to ensure that the controls developed reduces the risk (to the competent people) to as low as reasonably achievable and is within acceptable limits.

No process or system for Mine re-entry and knowledge management can discharge a person's health and safety obligation unless it is founded on sound risk management logic and a thorough risk management processes.

## **The Project**

In order to achieve a successfully outcome for any project, it is important to clearly identify what is to be achieved and from that the method which to achieve it.

### **What do we want to achieve and why?**

The objective of the project is to establish a process, and a tool, for both Mines and Mines Rescue Services to quickly obtain the relevant knowledge (and validate it) to make an informed decision on the risk to rescuers entering the mine to preserve life when a mine or part of a mine has become dangerous.

The short answer for the projects objective is to minimise the time to make a decision, and as far as possible eliminate the issue of not acting because of ***what we don't know i.e. Knowledge Management***

### **Method to develop a risk based knowledge management system for Mine Re-entry**

In order to achieve the above objective the project has been divided into three (3) stages.

## Stage 1 – Risk Management

With the establishment of any critical process in a Mines Safety and Health Management System we must ensure that *the Risk to Coal Mine Workers is as low as reasonably achievable and within acceptable limits*. Therefore the very first stage of the project required a thorough and comprehensive Risk Assessment to be conducted on the subject of Re-entering a Mine or Part of a Mine involving relevant industry Stakeholders.

The risk assessment focused on the potential risk/s to would be Rescuers of Coal Mine Workers posed from a deficit of knowledge during a potential emergency situation at an underground coal mine. It was taken that the response (to the mine) has been adequate and Rescuers are ready to deploy underground.

The risk assessment team initially undertook a brainstorming process to assist with identifying the potential hazards or barriers which could prevent a Mines Rescue Team entering a Mine or part of a Mine which has become dangerous to Coal Mine Workers. The Brainstorm process identified a number of external barriers which could prevent Re-entry, however the team consciously followed and focused on the potential hazards and barriers existing at a mine, in what the team regarded as known-unknown information (un-quantified hazards) to the Rescuers and decision makers (Incident Control Team).

From the Brainstorm process Twelve (12) critical hazards were identified for the Risk Assessment Team to analyze how they could occur and why they would occur. The risk assessment techniques that were used to assist in the process were a customised Semi-Quantitative Risk Assessment Tool based on the Minerals Industry Risk Management Guidelines and DNR Recognised Standard 02 Control of Risk Management Practices. Due to the Risk Assessment not being mine specific the Team agreed that no current controls would be applied which therefore ranked all hazards as extreme. Proposed controls and hazard specific barriers were then provided by the group for each hazard to mitigate its risk.

This process was completed through a major industry risk Assessment (over four days) involving the Queensland Mines Rescue Service, NSW Mines Rescue Service, Queensland Department of Mines and Energy, CFMEU Industrial Safety and Health Representatives, Operators Representatives, SIMTARS, Mines Rescue Volunteers and other third party industry stake holders.

Since the completion of the Risk Assessment (November 2008), a Task Group has been formed to build on the controls from the Risk Assessment as well as developing a tool for implementation (Stage 2).

The core members of the task group are, Geoff Nugent (QMRS), Seamus Devlin (NSWMR), Darren Brady (SIMTARS), Dr. David Cliff (MISCH). John Grieves (New Hope Collieries).



## **Stage 2 – Guideline and Process Development**

The objective of stage 2 is to develop the results and controls from the risk assessment into a Guideline incorporating checklists and flow charts for emergency mine re-entry. The intention is to establish a tool which can be utilized by both Mines Rescue Services and operations with the aim of efficient and effective management of Emergency Responses.

The process to achieve Stage 2 is;

1. Categorize the controls from the Risk Assessment i.e.;
  - Identify responsibility for collection/interpretation of information (site, Mines Rescue, external provider)
  - Determine the ability to collect and maintain information prior to a response
  - Determine the information type e.g. automatic generation, manual collection.
  - Determine the information importance to assessment of risk i.e. Rank its level of criticality
2. Conduct Post-mortems of previous Emergencies and Emergency Exercises applying controls from Risk Assessment.
3. Develop audit tools from the risk assessment to conduct gap analysis between what information/processes are commonly/typically available at an operation (Qld and NSW) and what is required to comply with developed guidelines.
4. Seek key stakeholder feedback on draft guidelines via Operators Forum (Qld and NSW), Qld Safety & Health Conference presentation/workshop, QMRS Technical Advisory Committee, NSWMR Standards committee, Mine Managers' (Association/s) ECT.
5. Disseminate guidelines to industry
6. Test guidelines within Level 1 or 2 Emergency Exercise.

At the time of this paper's delivery at the 2009 Queensland Mining Health and Safety Conference the Task Group has conducted the categorizing process and developed an audit tool to conduct gap analyses at selected Underground operations in Queensland and New South Wales.

To date a Gap analysis has been conducted at Anglo Coals Moranbah North Colliery (Queensland) on the 29 July. This report is currently being compiled. The Task Group will next travel to Peabody's Metropolitan Colliery (Southern Coalfields NSW) to conduct the same gap analysis on 27 August.

The Task Group intends to complete a further four (4) gap analysis at operations in Queensland and NSW prior to developing the draft guidelines. Release of the draft guideline is planned for January 2010.

In addition to the Queensland Mines Rescue Service and the NSW Mines Rescue Service the Mine Re-entry Task Group is also supported and funded by the NSW Coal Services Health and Safety Trust and Queensland Department of Mines and Energy.

### **Stage 3 – Software/Hardware development.**

Based on the outcomes of stage 2 including stakeholder feedback and guidance, along with information obtained from the scoping activities for software development the Task Group would engage with an appropriately equipped third party for the development of fit for purpose software and hardware and test implementation.

They key principles the Task Group have identified for the outcomes of stage 3 are;

- To complete project under the QMRS/NSWMR banner
- To maintain rights to software with QMRS/NSWMR (if decision is made to develop software that fits with guidelines).
- The software as with the guideline will form part of QMRS and NSWMR Emergency Response Management System.
- Implementation, application and maintenance of any software at mine sites must be cost effective and operationally compatible, advancing operational efficiency.

At the time of this paper's delivery at the 2009 Queensland Mining Health and Safety Conference an application has been submitted to ACARP for research funding to develop a functional specification for an information collection and management system appropriate for efficient, effective implementation of the Mine Entry/Re-Entry Guidelines.

This application has been short listed for a long proposal due on 8 September 2009.

### **Benefits and transfer of results to industry**

The Task Group Believes, through the development of an emergency Mine Re-entry guideline and a knowledge management tool (founded on risk management logic) that when implemented, would significantly assist Rescuers and decision makers in potential emergency situations through;

- Taking reasonable precautions and demonstrating proper diligence in the decision making process.
- Determining and understanding the existent risk within a constrained time, promoting effective planning and strategies.
- Developing and implementing plans and strategies that do not place rescuers at an unacceptable level of risk.
- Rescue operations are not excessively delayed establishing information and facts resulting in;
  - Increased exposure of coal mine workers to the danger

- Potentially compounding the extent of the danger and the likelihood of its consequence/s being realized.
- Reducing the likelihood of abandonment of any attempt of rescuing the coal mine workers.

A significant improvement in knowledge management for mine emergencies will be achieved for both Australian Mines Rescue Services and Underground Coal Mines.

Throughout the risk management and review process it has been repeatedly noted that the identified hazards, potential failure modes and controls are also applicable to less significant incidents which occur at underground coal mines where lives are not at risk. Still these circumstances require timely assessment and action to bring the abnormal situation back under control to prevent the situation becoming further advanced.

The Task Group considers that the logic, processes and controls applied for knowledge management during Mine Re-entry are universal in their application for most levels of emergencies and consequently the tool and process developed could be beneficial to assist with more frequent abnormal events at a mine which require effective knowledge management to bring the operational status back to normal as quickly as possible and prevent the event escalating.

This project would be of little value if the results and learning's are not only disseminated to industry but forms part of the fabric of emergency response strategies within the underground coal mining industry. This can be achieved by;

- Mine re-entry guidelines form part of QMRS and NSWMR Emergency Management Plans promoting standardisation.
- Implement the guideline process and management tool into existing industry emergency management training programmes e.g. MEMS (QMRS) Emergency Management Course (NSWMR).
- Review competency standards for emergency management and Ventilation officers to determine any gaps or opportunity for improvement based on guideline and developed technology.
- Promote guideline and tool through industry forums via presentations and workshops.

In conclusion the Task Group believes if industry continues to support this project through to the completion of stage 3 it will lead to a quantum leap in knowledge management and emergency mine re-entry within our industry.