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Improving emergency management in underground coal mines

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IMPROVING EMERGENCY MANAGEMENT IN UNDERGROUND COAL MINES

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ABSTRACT: The findings of ACARP funded research project C17008 - Optimising the collection of information for effective use in the event of an emergency at an underground coal mine is reported. The aim of this ACARP funded research project was to identify ways of optimising the information collection and reporting processes used in emergencies in underground coal mines to ensure rapid and effective response, minimising the risk to life. This was to be achieved through evaluating the current emergency management systems at mines, identifying good practice and also areas that needed improvement. There were three areas of focus for the project: the control room, senior mine official on site and the incident management area. The control room in particular is a key area where accurate information is required during an incident especially in the early stages until a senior mine official can take charge. The control room remains the first point of contact during an incident for most personnel. Speedy evacuation and in seam response is predicated upon knowing what is happening and where everyone is located. A number of mines in NSW and Queensland were visited and their emergency management systems were analysed. In Queensland this was undertaken as part of the involvement in the level one emergency response exercises (LOERS).

A series of twenty recommendations for further action have been compiled and are listed in the final report submitted to ACARP. The main findings of this project were:

- The emergency management system (EMS) often seemed to be no more than a paper document that had not been properly tested.
- Most mines had not formally identified what information would be necessary in an emergency particularly what would be required to ensure rapid re-entry for rescue purposes.
- There is an urgent need to define the minimum information requirements.
- There is a need to define an industry wide competency for control room operators (CRO).
- Mines need to significantly increase the training carried out in emergency preparedness and response especially in the management of incidents.

INTRODUCTION

Ineffective and time consuming information collection, display and analysis continue to be major problems identified in the level one emergency preparedness exercises run each year in Queensland underground coal mines. The events in the USA over recent times at Sago, Aracoma and Darby mines also bear testament to this problem.

In recent years there has been renewed interest on rapid response to emergencies. In 2006 for example, the Queensland Department of Mines and Energy sponsored a workshop on "Fight or Flight, the first five hours". This seminar highlighted the need to respond using mine resources quickly as external aid will probably take five hours to be ready to deploy. This workshop has spawned three committees to drive the process further. Subcommittee three has been tasked with investigating emergency support and identifying research issues. Information management is one of the seventeen key areas being studied by the group.

The ACARP funded research project C12017 - Mine Integration of Robust Gas Monitoring and Communication and continued as C14026 Ethernet-Based Mine Communications and Information Systems set out to import gas, geo-technical and personnel monitoring data sourced from new and existing subsystems in order to analyse the levels of risks, and produce generic modules that employ an open access protocol as part of an integrated safety system that can be installed at other mines

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(Rowan et al, 2007).. In addition a real-time risk management system (RTRMS) was developed. The uptake of this technology has not been rapid and at the recent level one emergency exercise at Grasstree mine the NEXSYS system was not utilised by mine staff. It will take a significant time period before these systems are able to be installed in other mines. The systems are still being bedded down and debugged. In addition due to the cost, the leap in technology and understanding necessary to properly operate these systems, there will be delays in implementing this new way of doing things. This mirrors the development and lack of uptake of the ECAS system (Nemes-Nemeth, 1991) developed more than a decade previously in an attempt to provide expert system support in emergencies.

Previously ACARP has provided funding to improve the capabilities of underground mines and mines rescue services to rapidly and accurately investigate any abnormal gas concentration detected in a mine, through projects C11031 and C13010. These projects promoted the use of computers and electronic systems to collect, display, analyse and communicate information, using standard off the shelf computer software and hardware. In addition readily available decision making assistance systems were showcased and promoted. Despite wide distribution of the project outcomes and software there has been virtually no take up of this technology at mine sites. One reason put forward to explain this non acceptance is that it is designed to be used only in an emergency situation and personnel do not use it on a day to day basis. They are therefore unfamiliar with its operation.

In recognition of this, rather than import new systems to a mine only to be used in an incident, C17008 sought to capitalise on the systems used day to day at the mine for use in an emergency, identifying any improvements or modifications necessary. The types of information to be investigated included the location of persons and equipment on site, the ability to reliably characterise state of the underground environment, and the resources on site available to respond to an emergency.

C17008 aimed to improve the quality of information collection, analysis and dissemination at underground coal mines, the reduction in time taken to acquire the information and make decisions, and the associated improvement in emergency response capacity.

WORK PROGRAM

The objectives of this project were:

- To identify how information relating to the location of personnel and equipment is maintained during routine mine operation.
- To identify how the mine environment is monitored during routine mine operation.
- To identify how this information is accessed and utilised during an emergency by key personnel, in particular by the control room operator, the senior mine official on site and the incident management team.
- To identify what improvements are necessary for effective information usage during an emergency at an underground coal mine, especially during the first few hours of an incident.
- To identify ways of improving the information management at underground coal mines
- To provide practical examples of methods to improve information collection, analysis and dissemination.

From experience in analysing mine emergency response systems, the best way to analyse the information system requirements in an emergency is to step through the process at the mine when an emergency is triggered and ask a series of basic questions.

1. How is an emergency defined? How does an individual know to initiate an emergency response process?
2. Who declares the emergency?
3. When an emergency is initiated what initial information should be collected and by whom?
4. If senior staff is summoned for assistance what information do they require?
5. When is this information required?
6. Who will provide it?

7. In what form will it be provided?

From these observations it was intended to identify mechanisms to improve these processes to meet requirements by:

a. Identifying required characteristics
b. Identifying current processes
c. Identifying gaps and problem areas
d. Consulting relevant research eg past ACARP projects
e. Identifying practical solutions and improvements

At each mine visited current routine information collection and reporting processes were identified and information flow maps were created to identify:

a. How the location of persons and equipment at the mine were monitored
b. How the mine environment was monitored, analysed and reported, and
c. Who has access to this information, in particular in the control room, the senior mine official on site and if/when an incident management team was convened.

Observations from the level one emergency response exercises were analysed in order to:

a. Characterise information requirements
b. Compare the requirements with the actual processes uses
c. Identify gaps and problem areas

Experience gained from participating in the management of a number of actual incidents was also included for analysis.

BASIS OF ANALYSIS

In addition to legislative requirements, and based upon the technical literature, the analysis of the management of a number of significant incidents at underground coal mines in Australia over the past 20 years, and the findings from the level one emergency exercises in Queensland over the past ten years, it was concluded that there are some basic tenets that any effective emergency response system should follow:

1. It must be robust ie. It must function at any time of day or night and with the resources that are available or easily accessible. Historically too many systems are designed only to operate on day shift when a full complement of personnel are available or worse are dependent on
2. It must be simple to implement and not dependent upon the availability of specific personnel. The decision to evacuate a mine must be clear and able to be made by any responsible person not just the mine manager.
3. Specified actions should be clear and prioritised. Duty cards are usually read sequentially so those items at the top of the list get done first.
4. The response must be consistent with that specified within any major hazard management plans
5. The time taken to respond must be minimised. In an underground coal mine the time for effective response is immediate, the longer the delay the harder it is to respond and the higher the risk to personnel. Response time is crucial for mines that are isolated from support facilities.
6. Paperwork should be minimised and remove duplication of forms or functions.
7. The key to effective response is information – knowing what is going on, what will happen, who is where and who and what are available to assist.

8. Automatic actions and responses should be optimised. Computer based alarm systems can reduce the time needed to make decisions. Automated call-out systems are much quicker than manual systems.
9. Leave nothing to chance, be sure of actions – check completion, check response. In any call out system the response from those called out must be known i.e. are they coming and how long before they get to site.
10. Minimise the possibility for corruption of information. Multiple handing of information, especially by word of mouth or on hand written notes, significantly increases the possibility for misunderstanding and misinterpretation. The number of forms being used should be kept to a minimum and designed for optimum use.
11. People in key roles must be familiar with their roles, capable of carrying them out and have the resources available to carry them out. Often the Incident Management Room is not equipped to allow the incident management team (IMT) to operate effectively – inadequate communications, uncontrolled access, too much distraction from prime function, inadequate information display and monitoring.
12. Adequate support for key roles. A key feature is in the continuity of management of emergencies over time, this requires that suitably trained personnel are alerted to take over roles at designated times. This means that not only must they be rested prior to starting their stint but also the information is maintained to brief them quickly and effectively when the changeover of roles is affected. Staff should be changed over in a staged manner to ensure continuity of operation.
13. Interaction with offsite stakeholders needs to be carefully managed to allow the IMT to focus on managing the emergency. This requires adequate resourcing of suitably skilled individuals and that they be kept informed of all developments.

RESULTS AND DISCUSSION

General

At most of the mines visited the emergency response system appeared to have been mainly developed in response to the legislated requirements. The systems thus focused on evacuation and fire fighting. Incident management did not receive much attention. There was a general lack of recognition of what information is required to manage an incident and how to obtain it. At all the level one exercises and in the course of actual incidents much time was lost in identifying what information was required to manage an incident, where to get it from and who could generate it. There is an urgent need to develop an industry-wide guideline that identifies the scope and quality of information that is needed to effectively manage an emergency. Queensland Mines Rescue Service (QMRS) has established a project in cooperation with the NSW Mines Rescue Service to quantify the information needs for reentry and how best these needs could be satisfied. The project has been initiated to identify the gaps between what mines currently collect and what is needed. An ACARP grant application has been made by the QMRS to take this gap analysis further and identify a specification for a system (involving software and hardware) to meet this need.

Mine environmental monitoring systems

All mines visited had modern mine monitoring systems, or were in the process of installing them. The information required for effective incident management is often collected by such systems but is not commonly displayed on a single easily interpreted screen. Instead the information is fragmented, and displayed on a multitude of screens, reflecting the disparate monitoring systems that operate at a mine. Mine environmental monitoring systems should offer a readily accessible data display screen showing the information required for effective emergency management. This should include the status of mine services, the fan and atmospheric conditions.

In a number of cases it was found that mines were not maintaining their mine environment monitoring systems consistent with the appropriate Australian Standards. It was found that there were inconsistencies between the gas concentrations determined by the differing types of monitoring equipment. It is important that all gas monitoring equipment is properly maintained and calibrated. Basic information such as the gas concentration range and accuracy of each type of detection technique should be common knowledge at a mine site.

It was surprising to find how often the triggers in trigger action response plans (TARPs) did not reflect the alarm settings of mine environment monitoring systems. Modern systems should allow for the actions required when these triggers are reached to be displayed electronically and automatically.

Training and competency

It was found that there were generally inadequate levels of training in the management of incidents and in the incident management roles at mine sites. The level of training that mine site personnel receive in emergency preparedness needs to be significantly increased. In particular emphasis should be placed on testing the whole emergency response system, especially under worst case scenarios such as night or weekend. There is an opportunity for providers of training in emergency management to develop courses for mine site personnel in emergency management for personnel other than for the major roles. This would generate a wider understanding of what happens in an emergency and what needs to happen in what order.

Any whole of mine training in emergency management plans (EMP) should include the post incident analysis and investigation that may be required by the regulator. The training should also consider how the EMP would be implemented and maintained for an incident that continues for more than one shift.

Another area of concern, regularly identified in the level one exercises and during the current mine site visits, was the lack of consistency in the requirements and responsibilities for the control room operator. A number of mines were in the process of defining training requirements but most still relied upon a mentoring process with little formal training. There is a need to define a competency for a CRO. This definition needs to be consistent industry-wide.

Analysis of mine emergency response plans indicated that few if any had actually been put to the test of a full scale emergency exercise or incident. Many contained glaring errors and inconsistencies. The best way to validate an emergency response system is to test it. Mines need to regularly carry out emergency training exercises that require the convening of incident management teams and the interaction with offsite stakeholders.

Roles and responsibilities

Another example of the artificial nature of EMP was the impracticality of the functions specified in the EMP for the CRO. It was often impossible for him to carry out all his designated tasks in a timely and effective manner. Testing the plans would quickly identify whether or not this duty card can be carried out effectively or not.

EMP also gave inadequate consideration to the pivotal role played by the ventilation officer (VO). It is imperative that they have the resources and capacity to carry out their role in an incident. It was often found that the VO was the only person on site capable of operating the gas chromatograph; he was required to report on the mine environment to the IMT, generally he was also a member of a mines rescue team, and he would be required to generate ventilation simulations to analyse and develop incident management scenarios for evaluation.

The level of understanding and the number of site personnel competent to operate mine environmental monitoring systems need to be significantly improved with suitable training and practice in using the systems. There needs to be a basic guide to the operation of such systems readily available in an emergency so that these systems can be accessed without requiring the presence of specialists.

Duty cards remain poorly utilised. In a number of instances key personnel completely ignored their duty cards. Duty cards should be developed as aids to personnel to check that they are carrying out their designated roles. The personnel should be properly trained in their roles and only use the duty card as a check or information source. Duty cards are most useful when assigning personnel roles that they are not familiar with at a junior level – portal guard, site security, etc. Some mines had over thirty duty cards. Often the duty card contained a great deal of spurious information and documentation that was not referred to during the incident. Unfortunately often relevant information such as key contact numbers or mines rescue guidelines was often missing from the duty card kits.

The role of a process checker was shown to be valuable at several of the level one exercises and

should be considered for inclusion in EMP.

Emergency response systems

In too many cases the emergency management systems (ERS) and plans were found to be paper documents compiled to demonstrate compliance with legislation rather than real systems.
The most common omission from Emergency Response Plans were:

- The training requirements for site personnel were not specified.
- Regular practice of emergency response at panel, site and wider were not specified
- No on call roster of suitably trained and experienced personnel
- Information collection, analysis and management not dealt with.
- Not linked to principal hazard management plans (QLD) or major hazard management plans (NSW)
- No effective process needs to be established to collect witness statements and debriefs and ensure that the information contained within them is transmitted promptly to the relevant personnel
- No systematic information collection and reporting processes in place.
- Normal communications and task planning and allocation systems at the mine were not utilized.

Incident action plans (IAP) must include actions, person responsible for carrying out the action, and the status of the action. IAPS must be reviewed at each IMT meeting including status of outstanding actions.

The most effective emergency management systems are those that build upon those systems in daily use.

Miscellaneous

None of the sites observed during this project or during the level one exercise were able to demonstrate robust personnel location systems. Some were trialing electronic tagging systems with limited success. Tag boards augmented by white boards were universally found to be unreliable and required surface personnel to manually check and update on a regular basis. Control Room Operators regularly complained that underground workers were not reporting their movements. In the level one exercises it would often take in excess of five hours to identify who was where in the mine and who was unaccounted for. Personnel location monitoring systems need to be improved and be made reliable.

There was a wide variety in the quality of incident management rooms. A number were multi-function meeting rooms which at least meant the facilities were kept in a reasonable state of repair. On a number of occasions during level one exercise, the designated IMT room was not used as it proved to be either ill equipped or too far from other key areas of operation. IMT rooms generally did not adequately record and report key incident information, leading to poor or delayed decision making. Incident management rooms need to be equipped with operational equipment and be in a suitable location so that they will actually be used in an emergency. Previous research projects have highlighted the value of electronic and smart white boards.

Information transfer at mines was usually a combination of post-it notes, verbal briefings based upon memory and messages written on the back of hands. Far too often during level one exercises and incidents was key information lost or transferred incorrectly. Greater use of more systematic systems including email on site should be made to distribute information, particularly debrief information, incident action plans and status reports.

CONCLUSIONS

Currently mine evacuations occur once or twice a year across the whole underground coal mining industry in Australia. Incident management teams form probably about twice as often in order to deal with incidents at mines. Thus it is not likely that the average coal mine will experience the need to activate its emergency management plan in order to manage an incident. As such emergency response is not given the priority that it needs to be effective. Most of the shortcomings identified during this research project were created because the emergency response systems had not been fully trialled and evaluated.

The main findings of this project were:

- The emergency management system (EMS) often seemed to be no more than a paper document that had not been properly tested.
- Most mines had not formally identified what information would be necessary in an emergency particularly what would be required to ensure rapid re-entry for rescue purposes.
- There is an urgent need to define the minimum information requirements.
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