



QUEENSLAND MINING INDUSTRY

HEALTH & CONFERENCE 2004 SAFETY

Sustaining
our future

CONFERENCE PROCEEDINGS

15 – 18 AUGUST 2004
JUPITER'S TOWNSVILLE
HOTEL & CASINO

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Report on the Tripartite Overseas Mining Safety Study Tour – November 2003 Study Tour Members

Roger Billingham

In November 2003, a tripartite mining safety study tour group travelled from Queensland to Canada, United States and United Kingdom to compare industry safety and health performance with that of the Queensland mining industry.

The study tour was proposed by the Minister for Natural Resources and Mines, Stephen Robertson and funded through the Department of Natural Resources and Mines. The group consisted of Kam Leung (Cannington mine), Mitch Jakeman (Anglo Coal Australia Pty Ltd), Greg Dalliston (CFMEU), Hag Harrison (AWU) and Roger Billingham (NR&M).

The main objectives of the tour were to:

- Compare Queensland mining industry safety and health performance against those of Ontario, Canada and US mining industries, US nuclear industry and UK offshore oil and gas industry
- Compare legislative approaches
- Capture opportunities for improvement in Queensland from these industries
- Promote sharing of information and develop contacts for future opportunities.

Major opportunities for Queensland identified by the group were:

- The mines inspectorate to review with industry, incident/accident data collection and identify means of providing useful analysis to develop safety and health interventions
- To identify a group to collate, link and inform on mining related health and safety research programs
- To establish a central reporting system for worker's competency training
- To follow up with Queensland industry of the development of the "INPO" model
- To establish a working committee on musculoskeletal disorders, ergonomics and ageing issues.

In Ontario we were hosted by the Mines and Aggregates Safety and Health Association in Sudbury. Places visited included INCO's Stobie mine, Laurentian University, Natural Resources Canada, and the Northern Centre for Advanced Technology. Discussions were held with the Ministry of Labour, the United Steelworkers and representatives of Falconbridge Ltd.

The mine safety record in Ontario appeared to be similar to Queensland's in terms of lost time injuries and fatal accidents. Legislation is extremely prescriptive and risk management does not feature in the legislation.

Excellent examples of research to develop interventions in safety and health were observed. These include ergonomics research, machinery redesign, virtual reality experiments and diesel particulates monitoring. At the Stobie mine we saw loaders operating underground whilst being controlled remotely from a surface control room about 10 kilometres from the mine.

In USA we visited two of FENOC's nuclear power plants – one near

Cleveland Ohio and one near Pittsburgh Pennsylvania. At both plants we were able to see the influence of the Institute of Nuclear Power Operators (INPO) on safety management systems. INPO, an industry association, provides direction and support to all nuclear plants in USA through peer review, audit and provision of information exchange and training. The study group rated safety management at the nuclear plants to be higher than any of the other industries observed.

At Bruceton in Pittsburgh the former US Bureau of Mines premises are home to research facilities of the National Institute of Occupational Safety and Health. Projects which we saw and discussed, included:

- Diesel particulate emissions
- Personal dust monitors
- Ergonomic hazards and interventions
- Overhead power line contact alarm
- Mobile equipment proximity warning device.

The visit to NIOSH's Lake Lynn experimental mine was extremely interesting. At the underground laboratory testing is carried out on underground stoppings and seal design and research is carried out into dust explosion testing (coal, grain etc). The mine is also used for fire and mine rescue training.

In Arlington Virginia we visited the head offices of the Mine Safety and Health Administration, the United Mine Workers of America and the National Stone, Sand and Gravel Association.

In Aberdeen in UK, we visited an offshore oil-drilling rig (unfortunately not at sea), the Offshore Petroleum Division of the Health and Safety Executive and the offices of Step Change. Step Change is an industry organisation established to improve safety performance, awareness and behaviours throughout the UK oil and gas offshore industry. We also attended a conference on the Safety Case regime where there was considerable tripartite debate on the future direction for safety cases.

A program of knowledge transfer from our study tour is underway. The major opportunities identified have been discussed with Queensland Resources Council staff and working groups have been established. A CD outlining the tour was sent to industry in March and various presentations have been given.

The presentation at the 2004 Queensland Mining Industry Health and Safety Conference will be available to those wishing to have copies either through the Queensland Resources Council web page relating to this conference or directly from Roger Billingham by emailing him at <roger.billingham@nrme.qld.gov.au>.

On behalf of the study tour group, I express our thanks to the Minister for the proposal and the Department of Natural Resources and Mines for sponsoring the tour.

Addressing the Ageing Workforce and Fitness for Duty – By Changing the Lifestyle of Workers. It Can Be Done, But How?

Leanne Scanes, Corporate Bodies International Pty Ltd

ABSTRACT

There is increased recognition that Occupational Health and Safety (OH&S) legislation emphasises the need for a workplace to be not only safe, but also healthy. The majority of organisations are working to reduce workplace health hazards, such as exposure to noise, heat and dust. However the emerging trend is to go beyond this legislative requirement and offer health promotion initiatives to encourage employees to achieve optimal health.

At the 1993 Minesafe International Conference, Ric Charlton then CEO of Shell Australia, asked "Should lifestyle and health promotion of the workforce be the employer responsibilities?" Ten years on, this question remains unanswered, although most companies are beginning to recognise the negative impact of poor health on business profitability, and the influence of an employee's lifestyle outside work on their work performance.

The aging workforce, increasing workers compensation premiums, and increasing introduction of fitness for work policies across the industry have translated into a culture where poor health is not accepted. Ever increasingly employers are willing to assist employees to manage their own health and lifestyle, with the view of minimising the impact of the above issues.

Corporate Bodies International has been involved in the running of healthy lifestyle programs at 17 coal mines and 6 collieries in NSW and QLD over the past 2 years. Results showing that successful introduction of health promotion initiatives and programs can reduce an individual's risk of lifestyle related diseases. Weight, waist, blood pressure, body fat, flexibility and exercise levels were measured, and changes noted, as participants undertook healthy lifestyle programs or seminars.

This paper explores the results of these health programs and discusses the lessons learned from those involved in the implementation and organisation as well as the running of onsite health services. These ideas will assist other mines and collieries to implement effective health programs which address lifestyle issues.

Emerging issues in the areas of health and safety challenge us to increase our knowledge and constantly improve our workplaces. The result, an industry at the forefront of health and safety, aimed at ensuring all workers remain safe at work. Many companies have introduced policies or goals of 'zero injuries' to show the commitment to safety and are attending events such as this conference in an effort to learn and achieve their goals. However one issue of importance to nearly every worksite is how to deal with the effects of an aging workforce. The potential implications and possible loss of knowledge from the industry, are being researched more and more.

This, the mining industry, is a fortunate industry. One in which workers have a wealth of skills and knowledge specifically related to their individual roles, as well as a vast knowledge of the industry as a whole. It is a unique

work environment, were workers want to stay and employers want to keep their aging workers. However it must be recognised, over the past few decades work requirements have changed, and the physical and mental effects of aging do impact on the capability of workers to undertake the defined tasks.

We cannot draw conclusions and perceive all older workers as less physically or mentally capable than younger workers. Nor can we assume aging workers will be less productive or contribute to a greater degree to the accident and injury rates at site. To do so would be unjust. While the injury risk in older workers may be higher, statistics show older workers tend to take better care when at work, and due to their high skills and knowledge of the industry know how to avoid potentially harmful situations. It is this skill and knowledge base we risk losing if we assume all older workers should be replaced.

It must be recognised however, there are implications of the aging process, and while aging is a very individual, generalisations can be drawn¹. Once recognised these issues can be addressed with a range of site based initiatives. Individual capability must be assessed when considering the roles and responsibilities of aging workers. Discrimination against aging workers, while rare, is generally as a result of lack of knowledge and more so lack of skills in being able to assist employees to continue working. There are a range of general physical and emotional issues relating to aging which are important to consider when designing work tasks, these include¹:

- A persons aerobic capacity – which tends to decline with age
- Any reduction in endurance resulting from the natural aging process
- A decrease in musculoskeletal strength (especially around 45-50 years of age)
- Decreased ability to cope with shiftwork
- Diminished resistance to physical stress – leading to an increased chance of injury and longer recovery time
- Changes to metal function – decreased perception and speed of perception.

We are all gaining years, but importantly we are also gaining skills and knowledge. Including the knowledge to remain healthy and minimise the chance of the above factors disrupting our lives. With companies recognising health both physically and mentally as important issues, the introduction of 'fit for work/fit for duty' policies are a rapidly increasing trend. These policies include aspects such as clearly defined job roles and responsibilities, the skills and knowledge required to undertake the job, and the physical requirements of the various job tasks. Pre-employment medicals ensure the individual is not just fit and healthy, but also physically capable of undertaking the requirements of the specific job.

However most workers are not new to the industry thus are not undergoing preemployment medicals. Options currently being used to deal with the effects of age include change of job role/tasks, machinery redesign or alteration, increasing skills and awareness¹. However individuals have the ability to take steps to increase their health and fitness and lessen the effects of the aging process. It is important we as individuals take

information to help guide when designing a health program for your sites, or show what to look for when selecting a provider to run a program for your workers.

Methodology:

In the past three years 1950 staff at 21 mine sites and quarries across NSW, ACT and QLD have participated in a variety of health programs. Run by a Dietitian, the programs have been conducted in a range of formats, at various times (day and night, and on different days) to allow all staff and shift crews an equal chance to participate.

Three different health formats were delivered, although the content of each program consisted of similar information.

as to the true attraction of this style of program to workers, this method is required to be trialled at several other sites.

DROP OUT RATES

Participants commitment once they had joined the Working Bodies program was very high across all sites. To have the best chance of achieving long term lifestyle change an individual needs to be exposed to an array of easy to follow information and ideally attend all sessions to show their commitment. If an individual cannot commit to the time required to attend the sessions it is highly unlikely they will spend time outside the classes adopting the strategies taught.

The programs conducted in work time had the highest drop out rates.

| | How does the program run | Different methods of delivery |
|---------------------------------|---|---|
| 1. The Working Bodies Program | * Eight one hour sessions * A total period of 16 to 20 weeks * Participation in groups of 10-12 | a) A voluntary program in work time b) A voluntary program outside work time (after shift, in camp or in town) c) A voluntary program in town with partners invited to attend |
| 2. Training day health sessions | * Two 3 hour sessions * A total period of 5 or 9 weeks * Up to 25 people per sessions | a) A compulsory program with one month between sessions b) A compulsory program with two months between sessions |
| 3. individual appointments | * 3 or 4 individual appointments (from 1hour to 30 minutes) * A total period of 2 to 3 months * Appointments for individuals only | a) Offered to staff at risk or on a rehabilitation program |

Methodology

Summary of participants:

1. Average age between 43 and 46 (depending on the site)
2. Youngest participant 17, oldest 69 years
3. In total 1687 male participants and 263 female participants (which also includes partners at 3 sites)
4. 5% of programs in work time, 95% outside work time with voluntary unpaid participation
5. 4% of programs compulsory and 96% of attendees through voluntary participation
6. 8% of sites have invited partners to attend.

Work demands, changing production schedules and the level of management and supervisor support were contributing factors to attrition rates at different locations. At one site the drop out rate for work time programs was as high as 40%, at other sites the rate was just 7%. Across the board the average drop out rate for programs in work time at 26%, which was much higher than those programs in non-work time. A common belief of many people is that holding the program in work time will result in a much greater attendance and lower attrition rates. However in our experience this is not always the case. Programs in work time can be effective, however place pressure on schedules and work demands. Those program run outside of work time, either at the end of shift, in camp or in the local town, had a low drop out rate of just 13%, decreasing to 11% when Participants partners also attended. Given the low drop out rates of these programs participants are better placed to achieve long term health change.

Program results and discussion:

| | Health change in 3 or more key areas (%) | Enrolment rates (%) | Drop out rates (%) | Waist loss (cm) | Body Fat loss (%) | Exercise increase (hrs/wk) |
|---|--|---------------------|--------------------|-----------------|-------------------|----------------------------|
| 1a) WBP – work time, voluntary | 65 | 40 | 26 | 4.3 | 2.2 | 2.3 |
| 1b) WBP – outside work, | 80 | 40-50 | 13 | 4.8 | 3.1 | 2.6 |
| 1c) WBP – outside work, with partners | 90 | 40-50 | 11 | 5.3 | 4.1 | 2.6 |
| 2a) Compulsory health sessions, one month apart | 30 | 100 | NA | 3.2 | 2.1 | 1.9 |
| 2b) Compulsory health sessions, 2 months apart | 10 | 100 | NA | 2.0 | 1.5 | 1 |
| 3) Individual appointments | 70 | 1 | 15 | 4 | 2.8 | 2.3 |

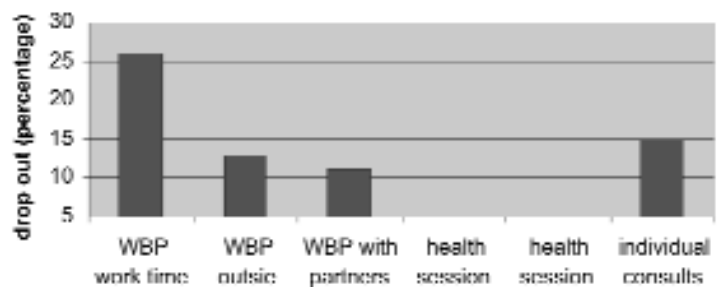
Table 1 - Participation and changes in major health parameters

PARTICIPATION

The enrolment rate for voluntary programs was essentially the same for all of the Working Bodies Program sessions. On site promotion of this program was conducted by staff of Corporate Bodies International. Information sessions were held to enable staff an opportunity to sign up for the program once fully informed of their commitment. There was no significant difference in the enrolment rate when partners were invited to attend, nor at the different sites, with 40-50% enrolment across the board. Some sites chose to offer the program to all workers, while other sites targeted particular crews or those who were assessed as high risk in recent medical. However no matter how participants were targeted the program remained voluntary.

Enrolment for individual consultations was conducted by the site. To be invited to participate an individual needed to be in a rehabilitation program or at very high risk, with referral from onsite health staff. This method has only been trialled at one site. While only 1% of the site was involved, very few people were invited to participate. Before any conclusions can be made

Drop out rates



In the experience of Corporate Bodies International, spouses are interested in attending for their own benefit, as well as to provide encouragement and support to their partner. This translates into not just fitter, stronger and healthier employees, but also happier people in the short and long term. Also, if the families of the employee are responsible for the cooking and shopping, and the program focuses on improved eating habits, it seems foolish not to include those who prepare the meals in the education. One of the greatest criticisms shiftworkers have of their lifestyle is the inability to spend time with their families. This is an initiative, if offered to families, that could help them spend time together, while learning and improving their health.

In many remote areas where it is difficult to attract young families to the area, these initiatives can provide services that may not be available in the local area. Thereby strengthening community ties and reinforce that the employer cares for the wellbeing of its staff and their families. For older workers it will allow partners to see that the site is still interested in the health and wellbeing of their partner, despite the fact they may not have many more working years at the site.

There was no significant change in exercise levels of participants who attended the working bodies program with or without partners. Most people find self motivation is the best way to become involved in regular exercise. Men in general get stuck into exercise, especially those who were active when they were younger. The biggest change when partners were involved in the programs was in terms of measurable health outcomes such as waist and body fat level. Participants often reported more significant changes to food intake when the whole family was involved. In some households the partners were responsible for shopping and cooking, thus this extra support aided the results. If the partner does the shopping and cooking and are not informed or nutrition or are not aware of the partners program (which is very common) they cannot know what to pack/buy/cook. Generationally older workers tended to leave the responsibility of cooking and shopping to partners, thus not involving the spouse resulted in lesser change than when partners were involved. Partner involvement also means family support, meals are cooked/packed as healthy, in line with recommendations. If both parents are involved children are more likely to follow, become active and eat healthier food, which is a contributing factor in ongoing motivation for many people.

COMPULSORY VS VOLUNTARY PROGRAM

Some of the greatest benefits that result from health programs are improvements in moral, teamwork, and onsite communication¹³. By making program compulsory there is the risk these benefits will not be achieved as resentment amongst those who are not interested. The other major factor is that those who do not want to learn or be part of the program can disrupt the learning of the other participants.

We must move through several stages of change in a means to make permanent improvement to our health and lifestyle¹². By running a program voluntarily participants are ready to learn, even if they don't make significant change to their lifestyle. When participants who are not completely ready to change their lifestyle are placed in a group with several highly motivated individuals the motivation will often spur on others to get involved and make lifestyle change. This is further increased when measurements are taken and participants see what results are attainable with a small amount of effort. Whereas groups with individuals not even willing to hear the information presented in the program will often lead to those considering change, to be influenced by peer pressure and need to conform often decrease their enthusiasm to change.

CONTINUING MOTIVATION – HOW IMPORTANT IS THIS, AND HOW TO ACHIEVE

In order to elicit lifestyle changes, there needs to be a movement beyond just supplying information. The latest research shows the most effective worksite health promotion programs are those that use multiple strategies in order to enhance awareness, convey information and develop skills¹⁴. A program that aims for maximum effect, needs to address the complexity of human behaviour in order to elicit change. One of the most widely accepted methods of ensuring a new behaviour is maintained is using behaviour modification techniques. Individual behaviour changes require modelling, practice, time for learning, recovery and reward. Programs must follow this continuum of change¹⁵.

The American Medical Association Council on Scientific Affairs concluded that behaviour modification of exercise and diet in obesity treatment is essential for long term weight control and a program that incorporated these elements is more likely to succeed¹⁶. When discussing worksite nutrition programs, the American Dietetic Association also concurred that behaviour modification was an essential ingredient in successful program. By encouraging achievable, incremental changes and then having rewards in place on a consistent basis, the participants can move through their own goals at their own pace and be suitably rewarded as they progress¹⁷. Desirable behaviours become self reinforcing with correct program implementation¹⁸. Any good health promotion program no matter what the overall aim, should have a large focus on individual goal setting as well as an established track record in motivating participants to achieve their goals with a built in reward structure.

When we asked participants for their main reasons that influenced their decision to return each week, the over whelming responses were because their health was improving (71%) and because they were learning something new (64%). Followed closely by to keep motivated (36%) and the program presenter (33%). Only 3% of people continued attending because they felt they had to. You do not want to promote an environment whereby people only attend each week because they are being forced to or feel they have to. This may show your program had low attrition, however it is unlikely these people will make any sort of lifestyle changes, especially those they will retain in the long term.

| Reason | % reported this as a reason for attendance |
|--------------------------------|--|
| Their health was improving | 71 |
| Learning something each week | 64 |
| Information was relevant to me | 45 |
| To keep motivated | 36 |
| Motivating presenter | 33 |
| Having fun | 13 |
| Time with workmates | 6 |
| Feel they have to attend | 3 |

Table 2 - Reasons why participants continue to attend each week

MEASURE SUCCESS IN MANY DIFFERENT WAYS

It is classic human nature to want praise for a job well done. When it comes to health improvement it is essentially the same. Thus, it is not surprising this was one of the main reasons those surveyed stated as a reason for continued attendance. Goals should also be realistic. Aging workers do not necessarily need to reach 'recommended health measures' to have achieved significant health improvement. As we age it is harder to change our habits thus any change or improvement should be viewed as success.

If health promotion is run with no real way to measure success, or no emphasis on improvements then people are likely to wonder what good there is attending each week⁸. Positive reinforcement of change no matter how small it is works¹¹. Participants especially those in nutrition and healthy lifestyle programs often fall into the trap of doing it purely to lose weight, when there are so many other health improvements that result from eating better and being more active. This is definitely the case in older workers, often the pursuit of a goal weight, something they were 20 years ago, can lead them to dismiss other benefits such as increased energy and better sleep.

What measurements to take will depend entirely on the health promotion initiative you are undertaking and essentially what the aim of the program is. Not everyone will improve their health in an equal fashion, so importantly ensure there are a number of different indicators/measures of progress⁹. This will allow those who improve in one area a sense of achievement and those who improve in another area to feel they are achieving something also.

Managing the Ageing Workforce: Issues and Opportunities for the Queensland Coal Mining Industry

Tony Parker and Charles Worringham, School of Human Movement Studies, Queensland University of Technology Injury Prevention and Control (Australia)

ABSTRACT

Ageing of the workforce, with more than 80% of Australian workforce growth between 1998 and 2016 projected to be in those over 45 (ABS, 1999), is a key issue in coal mining. New strategies based on an understanding of the match between the workplace and the older worker are needed to address the relatively high attrition rates of older workers, the significant level of impairment and reduction in the quality of life in retirement, especially with fewer younger workers entering the industry.

Queensland and New South Wales data shows that workers over 40 have a higher incidence of musculoskeletal injury, more severe injuries and disability, require more intensive medical care, and take longer to return to work than their younger counterparts. There are also significant costs e.g. hospitalisation, lost productivity and loss of independence associated with injury to older workers.

Overall, industries have often 'managed' the older worker issue through potentially discriminatory redundancies, particularly in recessionary periods. Older workers may also leave because of impairment or disability from cumulative exposure to adverse working conditions. Currently, the lack of credible exit data in coal-mining makes specific comparison difficult. Data is presented on the relative absence of accommodation strategies for older coal-miners in Qld and NSW, and consideration is given to measures in addition to job reassignment and allocation of less physically demanding work, the predominant methods currently used.

INTRODUCTION

A significant increase in the average age of the global workforce is taking place and many countries (including those in North America, Europe, and Australasia, together with parts of Asia, such as Japan and Singapore) are experiencing a large increase in the proportion of workers in the age groups of 45-60 and older. In Australia, more than 80% of the projected workforce growth between 1998 and 2016 will be in those over 45 years of age (ABS, 1999). Ageing of the workforce is also identified as a key issue in the coal mining industry and concern has been raised at industry meetings of the relatively high attrition rates of older workers, their significant level of impairment and the reduced numbers of younger workers entering the industry. Older workers bring greater experience to their work, and are often irreplaceable because of their high skills levels and because of declining numbers of younger workers in many countries. However, this demographic change presents major challenges in the organisation of work and the workplace to accommodate age related changes in work ability. This concept of *work ability* has been extensively studied in Scandinavia, and in particular with respect to ageing. It refers to "*both individual and occupational factors that...are essential to a person's ability to cope in worklife. Work ability is the result of the interaction between individual resources and work*" (Ilmarinen, 1999). Industries at large have managed the issue of the ageing workforce – particularly in recessionary periods – by reducing the size of the workforce through retrenchment of older workers. There is also evidence from other industries to suggest that older workers leave the industry because of impairment or disability, and reduced capacity to continue in their position, and do so as a function of cumulative exposure to adverse working conditions throughout their

working life (Turner, 2000). At this time the lack of credible exit or attrition data in the mining industry makes more detailed commentary on this issue difficult.

Thus, new strategies to keep productive workers working longer are required, and these must be based on greater understanding of the match between the workplace and the physiological and psychological changes characteristic of the older worker. Failure to achieve this match may adversely affect productivity and longer term health, since work related illnesses or injuries in which work design and work organisation are significant factors (such as stress and musculoskeletal disorders) are experienced more adversely by older than younger workers. These may be a significant cause of early departure from the industry (Griffiths, 1999). Coal-miners may also carry some of the adverse effects of their working life into retirement. A recent French study indicating that one-third of retired coal miners with exercise dyspnoea had moderately impaired exercise capacity irrespective of their pulmonary function scores (Favre et al., 2002). Calmels et al. (1998) looked at locomotor impairment and functional disability and its effect on daily living activities of retired coal miners. The study found a significant relation between occupational strain and subsequent reduction in functional independence in retirement. In addition, a significant association was found between locomotion impairment and the length of time spent working at the coal face.

Management of an ageing workforce is a complex issue and, to be effective, needs basic knowledge of the relationship between work ability and work demands. Limited information is available in this area for the Australian mining industry, consequently this presentation will review relevant information from overseas, and identify a number of priorities being considered in relation to current research programs being initiated under Injury Prevention and Control (Australia) in collaboration with members of the Australian mining industry, and supported by the Joint Coal Board Health and Safety Trust.

Some of the data presented in the following section come from two surveys: one of just under 200 coal-miners from three underground mines in Queensland, focussing on major work tasks and their physical demands, and a second completed by occupational health and safety managers from a sample of open-cut and underground mines throughout Queensland and New South Wales, representing a total of 22 pits and over 3,800 miners. This second survey addressed a range of occupational health and safety issues with a view to identifying emerging issues and areas needing research. A number of questions in each survey concerned worker age directly, or could be analysed by worker age subsequently. These are presented in four sections, below.

1. DEMOGRAPHICS

It is widely recognised that the workforce in coal-mining is becoming older, as is the case in a number of industries. Figure 1 shows ABS data depicting the age distribution of miners in Queensland and New South Wales, a particular feature of which is that the demographic structure in New South Wales is more heavily skewed towards the older worker.

older workers to remain in these occupations, provided that suitable accommodation is made. For example, an early study of long-line fishermen showed that, like mining, it is characterised by short periods of high demand intense work (heart rates of up to 165 beats per minute), but that it need not be considered unsuitable for older workers 'provided an effective system of job rotation is practiced and the size of the crew is large enough' (Rodahl & Vokac, 1977). Job rotation practices in coal-mining exist, but are not always based on well-established criteria, and crew size is a recurring issue.

Most industries do not adjust the work of the older employee in this or other ways, and a survey of countries in the European Union indicated that relatively few differences were found between younger and older workers in their exposure to vibration, noise and temperature and physical work loads (Ilmarinen, 1999). Importantly, workers over 45 years were generally able to determine for themselves when to take breaks and decide on work order, methods and speed of work. The reduced functional capacity with ageing may in part contribute to the finding that the lack of opportunity to 'self regulate' their work is a major factor in early retirement.

Responses to the OH&S survey indicated that the majority of the responding mines (77%) had no specific policies or procedures in place to accommodate older workers. In the minority of mines where these existed, they were reported as consisting primarily of job reassignment to less physically demanding jobs (83%), redesign of the job (33%) and reassignment of shift (17%). This appears to conflict with the data reported above, but it may be due to reassignment of workers to a different work category, rather than simple reallocation of duties. In any event, a general expectation is that miners are capable of undertaking most or all duties irrespective of age, an expectation that is not consistent with the evidence.

4. FACTORS CONTRIBUTING TO INJURY AND FATIGUE

It was also evident from the review that workforce demographics should be considered in the assessment and management of injury risk. The age profile indicates that serious efforts will be required to accommodate an older workforce in a physically demanding environment while at the same time maximising their contribution in terms of skills and experience. Strain and sprain injuries are more common in older miners, at least in New South Wales (see Figure 4). Although the relationship between injury risk and increasing age generally is not conclusive, there seems to be agreement on the fact that when older workers are injured, the injury is more severe and recovery takes longer. For example, a recent study of about 50,000 workers in California confirms that older workers miss more days because of acute low back injury and tend to have longer periods of disability (Peek-Asa, 2004).

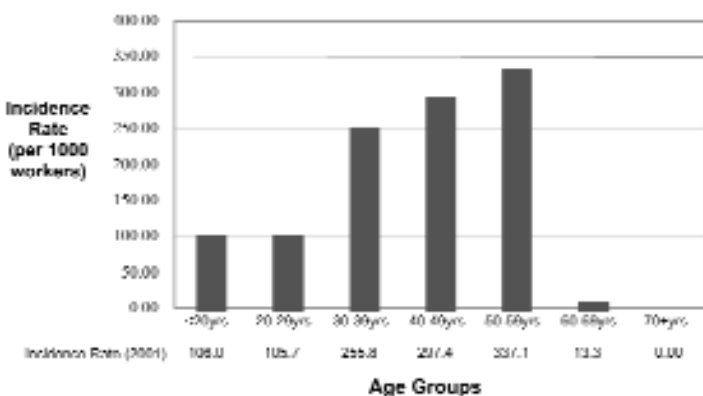


Figure 4 - Incidence rate of reported sprain and strain related injuries by age, 2001 (per 1000 employees) (NSW Coal Mining Industry)

The types of accidents that disproportionately affect older workers include falls from heights or machines, slips and trips, and being struck by vehicles, machinery or falling objects. The reduced physical capacity of these individuals to keep their balance or to move out of the way of hazards is a major factor in such accidents. Similarly, in spite of increased mechanisation in mining many of the tasks still demand heavy physical work (Shepherd, 1999). This poses particular difficulties for older workers with reduced functional capacity and exposes them to increased risk of overexertion injuries and cumulative damage to the musculoskeletal system. There is good evidence to suggest that cumulative damage occurs

over the course of a career in physically demanding work. For example, in the construction industry, the odds-ratio of a back injury for those who have worked for more than 10 years as a bricklayer is more than double that for those who have worked for less, even after adjustments for age (Sturmer, 1997). In this sense, a good part of cumulative damage is not really attributable to age *per se*, but to exposure, with which it is inevitably confounded in most workforces.

Preventing such accidents or reducing their impact requires better understanding of the relationship between physical capacity and accident causation. For example, tasks that pose a specific hazard to older workers may be modified; focussed training and education programs can be implemented both for workers and managers; and, if individual risk factors could be reliably assessed, workers could be assigned appropriate safe duties on the basis of capacity, not age. Unfortunately, very little is known about the relationship between physical capacity and workplace accidents in older workers, particularly in the mining industry.

Increasing the functional capacity of workers through complementary exercise programs is seen as a positive strategy to keep older workers working longer. Despite the relative lack of information about the older worker in coal-mining, there is a sound basis for paying special attention to health and fitness in the older age groups. This is not just out of concern for worker health in an altruistic sense. It is also an issue of cost and retention. For example, experience overseas has indicated not only that a heavy physical workload is associated with an increased risk of being retired on a disability pension (in a study of men aged between 42 and 60), but that this association was strongest that older workers with poor physical fitness (indexed by aerobic capacity). These retirements were caused not only by musculoskeletal injury, but all causes combined (Karpansalo, 2002).

The question remains however as to how much and what type of exercise is required to provide a protective function. Additionally, is it reasonable to expect older workers to participate in additional activity programs following tiring and often extended work periods? Other strategies that have been used overseas include more flexible work arrangements, job redesign (such as reducing tasks with high physical demand), and alteration of shift arrangements. The latter recognises the reduced tolerance to shift work, particularly night shifts, often experienced by older workers. It is also important that work ability can vary considerably not only across age but also among workers of the same age.

Both injury and fatigue are complex, multifactorial phenomena, in which the contribution of age, no less than the part played by other causal factors, is very difficult to determine. While conventional injury data-sets can be analysed by age, they do not establish that age causes the injuries, since exposure to hazard is generally not controlled. Perhaps for this reason, injury data are inconsistent with respect to age effects. While the ratings of OH&S personnel are clearly subjective, they also reflect a broader base of information than is included in accident statistics. It is therefore noteworthy that OH&S professionals in coal-mining did not rate age highly as an *independent* contributory factor to either injury or fatigue, but viewed a range of other specific factors as major contributors. For example, lack of fitness and skill, total exposure period and the work environment were seen as major contributory factors to injury, while type of shift, job type, work environment and boredom ranked highest for fatigue (Tables 1 & 2).

| Ranking | Contributors to work related injury |
|---------|---|
| Rank 1 | Lack of fitness |
| Rank 2 | Work environment |
| Rank 3 | Total exposure period |
| Rank 4 | Lack of skill |
| Rank 5 | Lack of stamina |
| Rank 6 | Mismatch between worker and job demands |
| Rank 7 | Inadequate workload distribution |
| Rank 8 | Insufficient training |
| Rank 9 | Fatigue |
| Rank 10 | Shift length |
| Rank 11 | Age |
| Rank 12 | Psychological stress |

Table 1 - Ranking of factors contributing to work related injury at participating mines

| Ranking | Contributors to work related injury |
|---------------|-------------------------------------|
| Rank 1 | Type of shift |
| Rank 2 | Boredom |
| Rank 3 | Job type |
| Rank 4 | Work environment |
| Rank 5 | Physical demands |
| Rank 6 | Lack of fitness |
| Rank 7 | Overtime |
| Rank 8 | Age |
| Rank 9 | Travel to/from work |
| Rank 10 | Insufficient breaks |
| Rank 11 | Psychological stress |
| Rank 12 | Insufficient training |

Table 2 - Ranking of factors contributing to work related fatigue at participating mines

Thus, new strategies to retain workers are required, and these must be based on a greater understanding of the match between the workplace and the physiological and psychological changes characteristic of the older worker.

There are several other important avenues for addressing the needs of the older worker. One specific approach is to make it possible for older workers to modify their exposure to shiftwork, in part by allowing longer recovery periods, but also by progressively moving away from night shifts. There is strong evidence that older workers are more adversely affected by shiftwork than younger employees. (Härmä, 2001; Parkes, 2002).

SUMMARY

The largest continuous study of the influence of ageing on work ability was conducted in Finland at the National Institute of Occupational Health (Ilmarinen, 1999). The 11-year longitudinal study of municipal workers emphasises the importance of the interaction between working conditions, individual physical and psychosocial skills and lifestyle factors in the work ability of older workers. Social factors are difficult to influence but there is strong reason to spend useful time on improving work conditions, environment and work organisation. Any interventions aimed at the individual or organisational level must be supported by evidence gained from rigorous scientific research. The Finnish study indicated that regardless of the occupation, improvement in work ability was most significantly influenced by increased satisfaction with supervisor, a reduction in repetitive and monotonous work and participation in increased physical activity. Information on conditions beneficial for retaining older workers is increasing and provides a large number of suggestions for practitioners working in these areas. What is needed in the mining industry is well conducted scientific investigations of a longitudinal nature which evaluate the efficacy of different interventions. These should take account of the specific cultural and environmental conditions operating within the mining industry.

We need more definitive information on:

- The numbers of older workers in the industry and the nature of the work in which they are involved
- Age related injury and adverse health patterns of older workers
- The strategies being employed in the industry to manage the older worker with respect to changes in work organisation, health surveillance, health promotion and training
- Reasons for older workers leaving the workforce, and
- A better understanding of the health and functional status of miners following retirement.

Cooperation between people of different ages will become a competitive factor in Australia and its enterprises, and it will be necessary to determine the appropriate blend of experience and 'youth', and identify the qualities of more experienced worker that must be retained for this cultural mix to impact positively on safety. To do this we need to understand the demographic trends in the mining industry and the level of potential imbalance in the workforce prior to establishing guidelines and rules to ensure cooperation between, and contributions of different ages. While the anti-discrimination and OHS legislation has been helpful in reconciling any differences in the position of employers and unions to accommodate those with a disability, successful accommodation of the older worker will require the employers and unions to initiate change (Freeman, 2004). This should be considered on the basis of scientific evidence and within a structural framework which recognises the need for engagement of a range of experts able to develop innovative and cost effective approaches to job design and redesign, work organisation and work environment.

REFERENCES

- Australian Bureau of Statistics. (2002). *Labour, Hours and Work Patterns*. Australian Bureau of Statistics, Canberra.
- Calmels P; Ecohard R; Blanchon MA; Charbonnier C; Cassou B; Gonthier R. (1998). Relation between locomotion impairment, functional independence in retirement, and occupational strain resulting from work carried out during working life. Study of a sample population of 350 miners in the Loire valley in France. *Journal of Epidemiology and Community Health*, 52:283-8.
- Favre M.N., Roche, F., Januel, B., Rigaudière, P., Seydoux, D., Fournel, P., Vergnon, J.M., Costes, F. (2002). Exercise test and evaluation of exertional dyspnoea in former coal miners. *Revue des Maladies Respiratoires*, 19:315-322.
- Freeman, E.J. (2004), Union-management solutions for preventing workplace injury of older workers, *Work*, 22, 145-151.
- Garg, A. (1991). Ergonomics and the older worker: An overview. *Experimental Ageing Research*, 17:417-430.
- Griffiths, A. (1999). Work design and management – the older worker. *Experimental Ageing Research*, 25:411.
- Hansson, R.O., Killian, J.H., Lynch, B.C. in Sanders, M.J. (Ed.) (2004). *Ergonomics and Management of Musculoskeletal Disorders*. St. Louis: Butterworth Heinemann.
- Härmä, M. (2001). Shiftwork, age and well-being: recent developments and future perspectives. *Journal of Human Ergology*, 30:287-93.
- Ilmarinen J. (1999). *Ageing Workers in the European Union – Status and promotion of work ability, employability and employment*. Finnish Institute of Occupational Health: Vantaa, Finland.
- Savinainen, M., Nygård, C-H., Korhonen, O., Ilmarinen, J. (2004). Changes in physical capacity among middle-aged municipal employees over 16 years. *Experimental Aging Research*, 30:1-22.
- Karpansalo, M. (2003). Cardiorespiratory fitness and risk of disability pension: a prospective population based study in Finnish men. *Occupational and Environmental Medicine*, 60: 765-769.
- Montoli, M.A., Gonzalez V., Palenciano L. (1995). Cardiac frequency throughout a working shift in coal miners. *Ergonomics*, 38:1250-1263.
- Parkes, K. (2002). Age, Smoking, and Negative Affectivity as Predictors of Sleep Patterns Among Shiftworkers in Two Environments. *Journal of Occupational Health Psychology*, 7:1076-8998.
- Peek-Asa, C. (2004). Incidence of acute low-back injury among older workers in a cohort of material handlers. *Journal of Occupational and Environmental Hygiene*, 8:551-7.
- Rodahl K; Vokac Z. (1977). Work stress in long-line bank fishing. *Scandinavian Journal of Work, Environment & Health*. 3:154-9.
- Shepherd, R.J. (1999). Age and Physical Work Capacity. *Experimental Aging Research*, 25:331-344.
- Spirduso, W. (1995). *Physical Dimensions of Aging*. Champaign: Human Kinetics.
- Stürmer, T. (1997). Construction work and low back disorder. Preliminary findings of the Hamburg Construction Worker Study. *Spine*. 22:2558-2263.
- Turner, J.A. (2000). Predictors of chronic disability in injured workers: a systematic literature synthesis. *American Journal of Industrial Medicine*, 38:707-722.
- Wu H.C., Wang, M.J. (2002). Relationship between maximum acceptable work time and physical workload, *Ergonomics*, 4: 280-289.

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Use of Mine Fire Simulation for Emergency Preparedness

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ABSTRACT

The structure of a comprehensive research project into mine fires study applying the Ventgraph mine fire simulation software, preplanning of escape scenarios and general interaction with rescue responses is outlined. Some outcomes from a project funded by the Australian Coal Association Research Program and substantial mining company site support are described. Mine site testing has allowed the approach to be introduced in the most creditable way. The project has assisted the Australian coal mining industry to attain an improved position in their understanding of mine fires and the use of modern advances to preplan actions to be taken in the advent of mine fires and possible emergency incidents. Work undertaken at individual mines is discussed as examples. Most Australian mines of reasonable size currently use a ventilation network simulation program. Under the project a small subroutine has been written to transfer the input data from the existing mine ventilation network simulation program to Ventgraph. This has been tested successfully. To understand fire simulation behaviour the mine ventilation system must first be understood correctly. The simulation of safe escape scenarios as part of emergency evacuation is described. Approaches to improving the ability of all levels of the mine workforce to evacuate mine workings in the safest way are examined, developed through pre-learning of appropriate escape strategies. The effect of use of a GAG inertisation unit to smother a fire after personnel have been withdrawn is examined.

Work undertaken with appropriate bodies during preplanning and subsequently during the course of a mine rescue and recovery emergency exercise is discussed. Some comments have been made on the ventilation aspects of the emergency exercise from observations made during the course of the incident. Some of these are set down as observations and some were personal comments from participating individuals. A key aspect of the software is the ability to model fires in a mine and the consequent effects of control measures such as ventilation changes and the introduction of inertisation using the GAG engine. Management is provided with a pre-emptive tool that gives ability to have control measures such as emergency seals or doors in place, as well as a predictive tool for analysing actions prior to implementation in the event of a fire.

INTRODUCTION

Mine fires remain among the most serious hazards in underground mining. The threat fire presents depends upon the nature and amount of flammable material, the ventilation system arrangement, the duration of the fire, the extent of the spread of combustion products, the ignition location and, very importantly, the time of occurrence. The response to the fire by mining personnel will depend upon all of these factors.

There is a lack of knowledge about fire/heat dynamics, some unproven technology in the field of gas sensors and no general agreement on appropriate alarm response systems and measures to be taken in the event of a significant incident. There is a need to couple the detection system with the response system. A research project and a number of mine site exercises has been undertaken focused on the application of mine fire and ventilation software packages for contaminate tracing and fire modelling

in coal mines and validation of fire modelling software against real mine incidents to reduce the effects of fire incidents and possible consequent health and safety hazards.

With the increasing complexity of technological and managerial development of mines, the effects of mine fires must be better understood. Task Group No 4 Report arising out of the Moura No 2 coalmine disaster of August 1994 in Australia made a number of recommendations including that, *"the capability to model ventilation and the mine environment following an incident should be available at mines"*.

Following these recommendations, sub-committees were formed in 1997 to further progress various findings with Sub-Committee 5 – Incident Management given certain tasks including the question, *"that there is a need for a wider appreciation of current knowledge and improved capability of ventilation management at mines for both routine as well as emergency conditions; guidelines for modelling should include...*

- *Computer modelling of post incident mine ventilation and atmosphere to be a required element in mine safety management plans*
- *Models interface with standard mine planning packages and be kept up-to-date and*
- *Development of learned ventilation and fire control responses occur for different incident scenarios and locations, pre-determined for each mine and with plans prepared and personnel trained in appropriate action plans"*.

A primary objective of the study has been to implement a program of research into this complex area utilising the recently upgraded Polish mine fire simulation software, Ventgraph. There is a need to understand the theory behind the simulation program and to allow use by those already familiar with the main existing mine ventilation analysis computer program currently popular within the Australian industry, "Ventsim", as an aid to incident and emergency management. "Ventsim" was not designed to handle fire simulation or in fact compressible flow effects in mine networks.

When a fire occurs outbye the working section, the immediate safe evacuation of miners from these areas should always be the first action during the rescue operation. Usually, the intake entries are dedicated as the primary escapeways from the working section. In many cases, the dedicated escapeways are contaminated with fire by-products from abutting entries (eg, belt entry) due to interconnection or leakage through stoppings. It is important to keep these escapeways unobstructed and free from contamination.

It is difficult to predict the pressure imbalance and leakage created by a mine fire due to the complex interrelationships between the mine ventilation system and a mine fire situation. Depending on the rate and direction of dip of the entries (dip or rise), reversal or recirculation of the airflow could occur because of convection currents (buoyancy effect) and constrictions (throttling effect) caused by the fire. This reversal jeopardises the functioning of the ventilation system. Stability of the ventilation system is critical for maintaining escapeways free from contamination and therefore available for travel.

Simulation software has the great advantage that underground mine fire scenarios can be analysed and visualised. Details of the Ventgraph program have been described by Trutwin, Dziurzynski and Tracz (1992). The software provides a dynamic representation of the fire's progress (in real-time) and utilises a colour-graphic visualisation of the spread of combustion products, O₂ and temperature throughout the ventilation system. During the simulation session the user can interact with the ventilation system (eg, hang brattice or check curtains, breach stoppings, introduce inert gases such as those generated by a GAG unit and change fan characteristics). These changes can be simulated quickly allowing for the testing of various fire-control and suppression strategies. Validation studies on Ventgraph have been performed using data gathered from a real mine fire as undertaken by Wala, et al (1995).

A major part of the paper examines a comprehensive emergency training exercise held at an operating colliery incorporating a fire incident. The Ventgraph simulation software was used to model the fire and mine conditions as various mitigation strategies were assessed. A number of viable and non viable alternatives were examined to achieve rescue. This incident and its outcome are examined. Some comments have been made on the ventilation aspects of the emergency exercise from observations made during the course of the incident. Some of these are set down as observations and some were personal comments from participating individuals.

The main purpose of this paper is to examine the effects of fires on mine ventilation systems using numerical fire simulation software such as Ventgraph. Various case studies based on the modelling of fire scenarios in a number of different mine layouts are discussed.

EFFECTS OF FIRES ON MINE VENTILATION

An open fire causes a sharp increase in the temperature of the air. The resulting expansion of the air produces a number of distinct effects. First the expansion attempts to take place in both directions along the airway. The tendency to expand against the prevailing direction produces a reduction in the airflow. Secondly, the expansion in volume increases air velocity downwind from the fire causing additional pressure loss. This is known as the choke or throttle effect. Finally, the decreased density results in the heated air becoming more buoyant and causes local effects as well as changes in the magnitudes of natural ventilating energy.

The Choke or Throttling Effect

This effect results from an increase in volume of air as it passes through the fire. This increase in volume is due to gas expansion as well as the addition of combustion products such as fire gases and evaporated water. As a result the velocity of air downwind from the fire is increasing and additional pressure loss following the square law results.

The choke effect is analogous to increasing the resistance of the airway. For the purposes of ventilation network analyses based on a standard value of air density, the raised value of this "pseudo resistance", R_t , can be estimated in terms of the air temperature as followed (McPherson,1993).

$$R_t \propto T^2$$

The value of R_t increases with the square of the absolute temperature (T). However, it should be recalled that this somewhat artificial device is required only to represent the choke effect in an incompressible flow analysis.

Buoyancy (Natural Draft) Effects

Local or Roll Back effect

The most immediate effect of heat on the ventilating air stream is a very local one. The reduced density causes the mixture of hot air and products of combustion to rise and flow preferentially along the roof of the airway. The pronounced buoyancy effect causes smoke and hot gases to form a layer along the roof and, in a level or descensional airway, will back up against the direction of airflow.

Whole mine Natural Ventilation Pressure effects

A more widespread effect of reductions in air density is the influence felt in shafts or inclined airways. The conversion of heat into mechanical

energy in the ventilation system is called the buoyancy (natural draft, natural ventilating pressure or chimney) effect. The effect is most pronounced when the fire itself is in a shaft or inclined airway and promoting airflow if the ventilation is ascensional and opposing the flow in descensional airways. In addition, in the latter case, flows can reverse in all parallel airways to the airway with fire. Indeed, in this case, the airflow may be reversed in the airway with fire, bringing combustion products into adjacent parallel airways and also resulting in non-steady state flow of toxic atmospheres.

Natural ventilating pressure always exist in a mine and its magnitude mostly depends on the mine's depth and difference in air density in the inclined and horizontal airways. In the case of fire, this effect is magnified due to high temperatures leading to unpredictable changes in air density and the airflow distribution.

If the air temperatures can be estimated for paths downstream of the fire then it is possible to determine the modified natural ventilating pressures. Those temperatures vary with respect to size and intensity of the fire, distance from the fire, time, leakage of cool air into the airways affected and heat transfer characteristics between the air and the surrounding strata.

CASE STUDIES OF AUSTRALIAN LONGWALL DEVELOPMENT PANELS

One of the major goals of the study is to examine the effects of fires on mine ventilation systems. To demonstrate how the choke or throttling and buoyancy effects influence the mine ventilation system, fire scenarios were simulated for several case studies based on a typical Australian two entries longwall development panel with various panel configurations.

Panel configurations varied in the case studies covered panel lengths of 1.5km or 3km with panel dipping angles of plus and minus 5 degrees and 10 degrees. To generate an uniform ventilation airflow of 22.8m³/s through the panel at the working face, a differential pressure equal to 70Pa was introduced across the stopping at the first cut-through between intake and return entries for the 1.5km panel length cases studied and a differential pressure of 235Pa was used for the 3km panel cases studied.

Figure 1 shows typical two-entry longwall development panel ventilation systems with various panel lengths of 1.5 and 3km. The fresh air reaches the face through one intake entry and exhausts from the face through the other, which is the belt entry and return. The fresh air intake entry is isolated from the return entry by a series of short life stoppings.

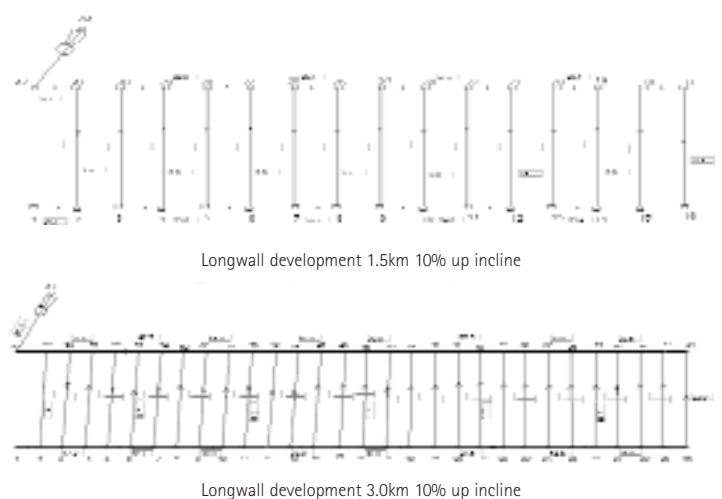


Figure 1 - Two-Entry Longwall Development Panels

Table 1 shows a summary of the simulation results with diesel fires set in the middle of the development panel for each case study at either intake or return airways. The fire has a 5m fire zone length, a fire intensity of 10 and a time constant 120 seconds. There were two cases under which that the face airflow almost reversed. One is observed when the diesel fire is set in the middle of the return airway at nodal points 24-25 in the 1.5km longwall development panel mining on a 10% incline upward.

| Panel Length | Panel Inclination | | Face Q m ³ /s | | Air Reversal |
|--|-------------------|------|--------------------------|-------|--------------|
| | | | Initial | Final | |
| Fire at return airways (branch 24-25 or 45-46) | | | | | |
| 1.5km | 5% | Up | 22.8 | 16.1 | No |
| 1.5km | 5% | Down | 22.8 | 25.7 | No |
| 1.5km | 10% | Up | 22.8 | 1.3 | Almost |
| 1.5km | 10% | Down | 22.8 | 30.2 | No |
| 3.0km | 5% | Up | 22.8 | 21.3 | No |
| 3.0km | 5% | Down | 22.8 | 24.4 | No |
| 3.0km | 10% | Up | 22.8 | 20.1 | No |
| 3.0km | 10% | Down | 22.8 | 24.5 | No |
| Fire at intake airways (branch 8-9 or 14-15) | | | | | |
| 1.5km | 5% | Up | 22.8 | 26.7 | No |
| 1.5km | 5% | Down | 22.8 | 16.2 | No |
| 1.5km | 10% | Up | 22.8 | 29.3 | No |
| 1.5km | 10% | Down | 22.8 | 1-1.3 | Almost |
| 3.0km | 5% | Up | 22.8 | 24.3 | No |
| 3.0km | 5% | Down | 22.8 | 21.4 | No |
| 3.0km | 10% | Up | 22.8 | 25.7 | No |
| 3.0km | 10% | Down | 22.8 | 19.4 | No |

Table 1 - Summary of simulation results for 5m-fire zone

In this case the buoyancy effect of the fire acted against the fan pressure but was not enough to overtake the fan pressure to reverse the airflow. As the airflow reduced, the O₂ supplied to the fire is decreased. This caused a significant reduction in the magnitude of the fire and thus the buoyancy effect of the fire working against the fan pressure is reduced. There is more air available to the fire so the fire starts to grow again (non-steady state).

This can be observed in the fire simulation output graphic and is illustrated in Figure 2 showing the heat production of the fire during simulation. It can be noted from the figure that the fire causes a sharp reduction in the airflow entering the development panel. In the case of a mine with high seam CH₄ levels this will lead to higher gas levels in the mine air.

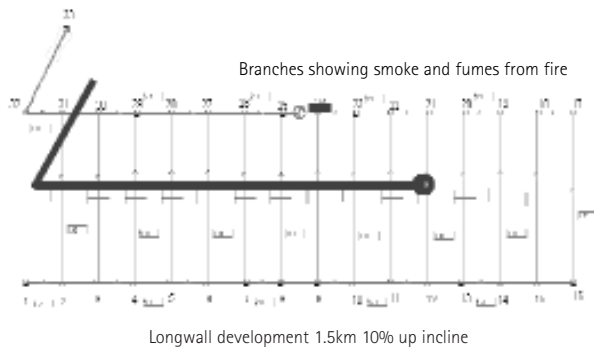
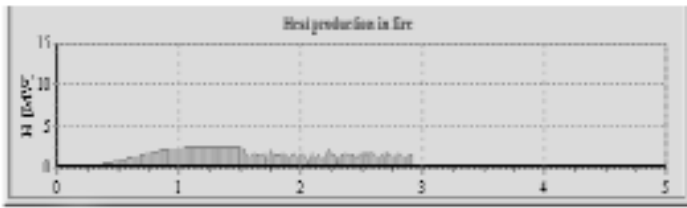


Figure 2 - Smoke progressions and heat production for 5m long fire zone in return roadway

A similar situation was observed in the second case of reversal almost occurring when the fire was in the intake airway at nodal points 8-9 in the 1.5km longwall development panel mining at a 10% decline down. Again, the buoyancy effect of the fire acted against the fan pressure was not enough to overtake the fan pressure to reverse the airflow. The airflow at the faces in both cases was drastically reduced to approx. 1-1.3m³/s.

Simulations were re-run for these cases with a 10m fire zone length instead of 5m and a summary of results is shown in Table 2. Airflow reversals at the face were observed in the 10% incline case with fire in return airway and also with 10% decline with fire in the intake air. Figure 3 shows how the smoke progresses and the amount of heat produced during different stages of the fire simulated in the 10% incline case with fire in return air.

| Panel Length | Panel Inclination | | Face Q m ³ /s | | Air Reversal |
|--|-------------------|------|--------------------------|----------|--------------|
| | | | Initial | Final | |
| Fire at return airways (branch 24-25 or 45-46) | | | | | |
| 1.5km | 5% | Up | 22.8 | 4.1 | No |
| 1.5km | 5% | Down | 22.8 | 29.0 | No |
| 1.5km | 10% | Up | 22.8 | 16.8* | Yes |
| 1.5km | 10% | Down | 22.8 | 33.4 | No |
| 3.0km | 5% | Up | 22.8 | 20.9 | No |
| 3.0km | 5% | Down | 22.8 | 24.6 | No |
| 3.0km | 10% | Up | 22.8 | 18.4 | No |
| 3.0km | 10% | Down | 22.8 | 26.2 | No |
| Fire at intake airways (branch 8-9 or 14-15) | | | | | |
| 1.5km | 5% | Up | 22.8 | 28.1 | No |
| 1.5km | 5% | Down | 22.8 | 3.5 | No |
| 1.5km | 10% | Up | 22.8 | 36.6 | No |
| 1.5km | 10% | Down | 22.8 | 1.5-4.5* | Yes |
| 3.0km | 5% | Up | 22.8 | 24.9 | No |
| 3.0km | 5% | Down | 22.8 | 20.6 | No |
| 3.0km | 10% | Up | 22.8 | 27.4 | No |
| 3.0km | 10% | Down | 22.8 | 16.0 | No |

Table 2 - Summary of simulation results for 10m-fire zone

* Air flows in opposite direction to initial flow direction

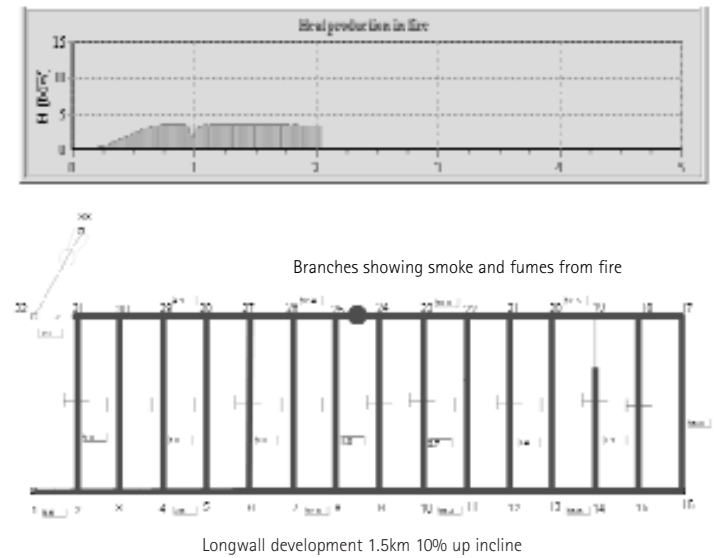


Figure 3 - Smoke reversal and heat reduction observed during simulation for 10m long fire zone in return roadway

It is noted that a reduction in heat production from the fire was observed before the airflow reversal occurred. As the products of fire are forced passed or over the fire at the moment when airflow reversal occurs, the amount of O₂ available to the fire is drastically decreased.

EFFECTS OF MINE FIRE IN GASSY MINES

Effects from mine fires on ventilation system in gassy mine situations were also investigated in this study. The development panel studies were used to demonstrate the effects of mine fires in gassy mines. All panel parameters remain the same as previously stated. A CH₄ source of 230 l/s was placed at the development face to give approximately 1% (0.23m³/s / 22.8m³/s ≈ 1%) CH₄ concentration in the return air in the development panel.

Table 3 shows a summary of the simulation results with diesel fires set in the middle of the development panel in either intake or return airways for each of the two case studies.

The fire has a 10m fire zone length, a fire intensity of 10 (on a scale of 1-10) and a time constant 120 seconds (time taken to build up to full size). There were two cases under which that the face airflow reversed as observed previously. It should also be noted that there were two cases (that of a 1.5km panel with 5% incline up with fire in return air and secondly a 1.5km panel with 5% decline down with fire in intake air) under which the face airflow was drastically reduced to less than 4.5m³/s due to the effects of buoyancy from the fire.

In these two cases, the CH₄ source at the face will cause gas concentration to increase from 1% to over 5%, which means the mine atmosphere

became explosible or potential explosible. It is a very dangerous situation as it is very easy to think that with no ventilation reversal resulting from the fire the ventilation system is still intact and safe. However, the reduction of fresh air to the face in these gassy mine situations results in the mine atmosphere at the face becoming potentially explosible. The gas laden face air quickly passes to return and over the fire ignition source. Figure 4 shows the CH₄ levels at the face and the amount of heat produced during different stages of the fire simulated in the 1.5km panel length 5% incline up case with fire in return air.

| Panel Length | Panel Inclination | Face Q m ³ /s Initial | Face CH ₄ % Initial | Face Q m ³ /s Final | Face CH ₄ % Final | Air Reversal | |
|--|-------------------|----------------------------------|--------------------------------|--------------------------------|------------------------------|--------------|-----|
| Fire in return airways (branch 24-25 or 45-46) | | | | | | | |
| 1.5km | 5% | Up | 22.8 | 1.0 | 0.6 | 38.3% | No |
| 1.5km | 5% | Down | 22.8 | 1.0 | 29.0 | 0.78% | No |
| 1.5km | 10% | Up | 22.8 | 1.0 | 16.8* | 1.34% | Yes |
| 1.5km | 10% | Down | 22.8 | 1.0 | 33.4 | 0.67% | No |
| 3.0km | 5% | Up | 22.8 | 1.0 | 20.9 | 1.08% | No |
| 3.0km | 5% | Down | 22.8 | 1.0 | 24.6 | 0.91% | No |
| 3.0km | 10% | Up | 22.8 | 1.0 | 18.4 | 1.22% | No |
| 3.0km | 10% | Down | 22.8 | 1.0 | 26.2 | 0.86% | No |
| Fire in intake airways (branch 8-9 or 14-15) | | | | | | | |
| 1.5km | 5% | Up | 22.8 | 1.0 | 28.1 | 0.80% | No |
| 1.5km | 5% | Down | 22.8 | 1.0 | 1.5 | 15.3% | No |
| 1.5km | 10% | Up | 22.8 | 1.0 | 36.6 | 0.61% | No |
| 1.5km | 10% | Down | 22.8 | 1.0 | 1.5-4.5* | 5-15% | Yes |
| 3.0km | 5% | Up | 22.8 | 1.0 | 24.9 | 0.90% | No |
| 3.0km | 5% | Down | 22.8 | 1.0 | 20.6 | 1.09% | No |
| 3.0km | 10% | Up | 22.8 | 1.0 | 27.4 | 0.82% | No |
| 3.0km | 10% | Down | 22.8 | 1.0 | 16.0 | 1.41% | No |

Table 3 - Summary of simulation results for 10m-fire zone in gassy mine situation

* Air flows in opposite direction to initial flow direction

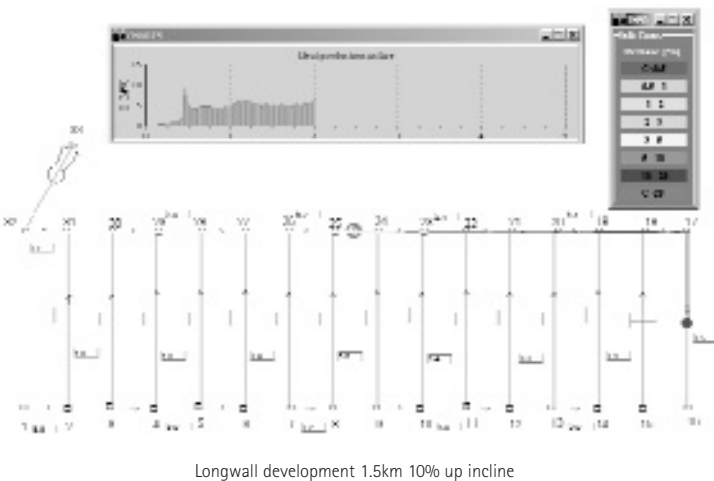


Figure 4 - CH₄ level and heat reduction observed for 10m long fire zone in return roadway

LONGWALL VENTILATION CASE STUDY

Typical Aspects of Australian Longwall Mining

A typical layout of an Australian longwall mine is shown in Figure 5. In terms of ventilation nomenclature intake roadways are shown as solid, single arrow roadways whereas return roadways are shown as dashed, double arrow roadways.

In this case a raise borehole exists behind the current goaf and is shown as a circle with an intake roadway connecting to the longwall face roadway (Mayes and Gillies, 2002). Australian longwalls at present normally use only two roadway maingate developments and have typically between five and seven Mains' roadways. In development, A Heading (as shown in Figure 6) is an intake roadway with B Heading the return roadway through which the panel conveyor runs.

In the Mains, B, C, and D Headings are typically intake with flanking return roadways, A and E Headings. When all longwalls are being extracted on one side of the Mains only, D and E Headings may be used as return roadways with A, B and C Headings as intake roadways. The conveyor runs in the

intake headings, typically in C Heading. In Queensland this roadway is generally segregated from either one or both of the other intake roadways.

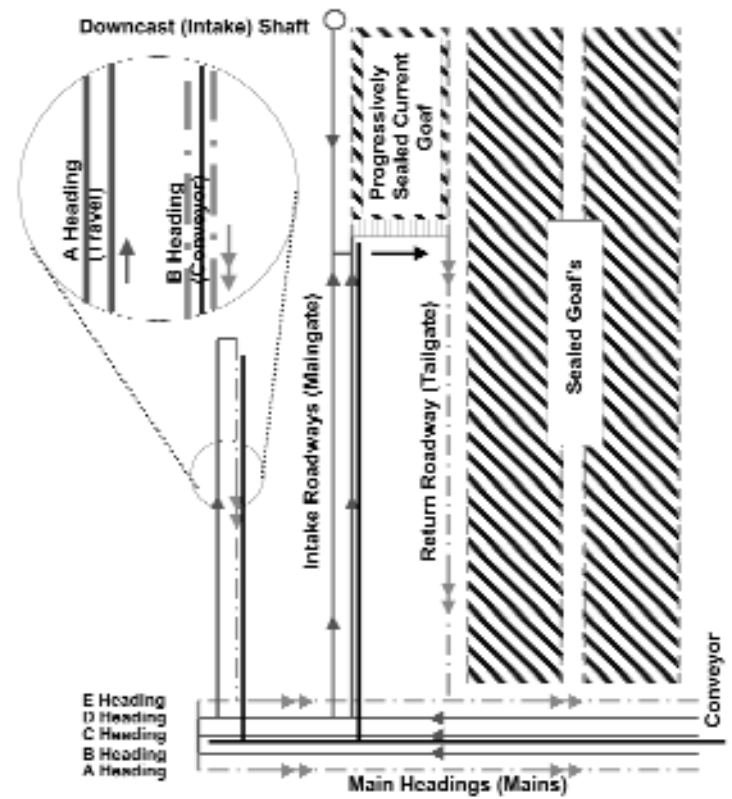


Figure 5 - Typical Layout of Australian Longwall Mining (After Mayes and Gillies, 2002)

Simulation of Inertisation Usage

Inertisation has been accepted to have an important place in Australian mining. The two GAG units purchased by the Queensland government in the late 1990s have been tested and developed and mines made ready for their use in emergency and training exercises. Various incidents in 2003 underlined the need for more information on their use and application. The NSW Mine Shield nitrogen apparatus dates to the 1980s and has been used a number of times. The Tomlinson boiler has been purchased by a number of mines and is regularly used as a routine production tool to reduce the time in which a newly sealed goaf has an atmosphere within the explosive range.

Pressure Swing Adsorption units are available and in use. Each of these approaches puts out very different flow rates of inert gases. Each is designed for a different application. Background information is needed to allow their use in pre-training and emergency risk management assessments exercises.

Because of complex interrelationships between the mine ventilation system and a mine fire it is difficult to predict the pressure imbalance and leakage created by a mine fire. Depending on the rate and direction of dip of incline of the entries (dip or rise), reversal or recirculation of the airflow could occur because of convection currents (buoyancy effects) and constrictions (throttling effects) caused by the fire. This reversal jeopardises the functioning and stability of the ventilation system. Addition of the gas stream from the unit adds another level of complexity to the underground atmosphere behaviour. Should the main mine fans be turned off so as not to dilute the inert gas or will this action cause, in conjunction with buoyancy effects, airflow reversal and the drawing of combustion products or seam gases across a fire leading to an explosion?

Simulation of the introduction of the GAG or other apparatus has indicated that there is a substantial lack of knowledge on use of these facilities. The Queensland GAG unit was used successful in a mine fire incident in the Lovridge mine in the USA in early 2003. A fire in West Virginia in late 2003 attempted to use a Polish owned GAG unit without success. The Queensland GAG unit was called to the Southland, NSW mine fire at the end of 2003 but not utilised in full.

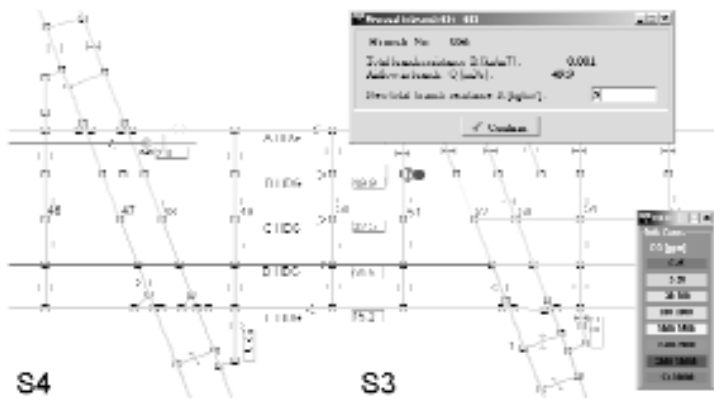


Figure 14 - Part of Oaky North pit commencing to place fly ash outbye fire and GAG operating at Drift Portal showing CO levels

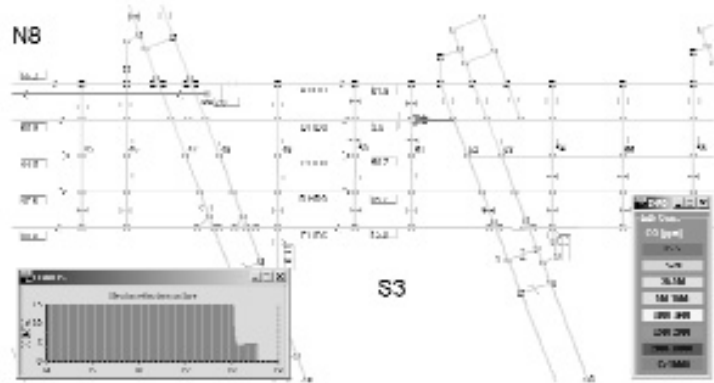


Figure 15 - Part of Oaky North pit 12 hours after placement of fly ash outbye fire GAG operating at Drift Portal showing CO levels. Air quantity outbye the fire is reduced to 3.6m³/s (O₂ is 12%, very high CO levels) and the heat output from fire reduced to 5MW.

Alternative Rescue Approaches Simulated

A number of alternative scenarios were simulated. The mine normally has three fans running.

1. After starting up the GAG, an attempt was made to gradually shut off fans to reduce the O₂ supply to the fire. It was found that after shutting off the second fan (with the third fan still running), the airflow is reversed at the fire site and an explosion may occur. This is an unsatisfactory solution. This simulation can be seen in Figure 16.
2. After starting up the GAG, an attempt was made to shut off one fan and then progressively close off two of the highwall entries to reduce the O₂ supply to the fire. Shutting off one fan successfully reduced the airflow to the fire but due to a lack of segregation, closing off the highwall entries had no effect in further reducing the flow to the fire. This alternative approach did not appear to cause a situation under which a gas explosion would be likely. However it is not effective as the fire would not be starved from lack of air. These simulations can be seen in figures 17 and 18.

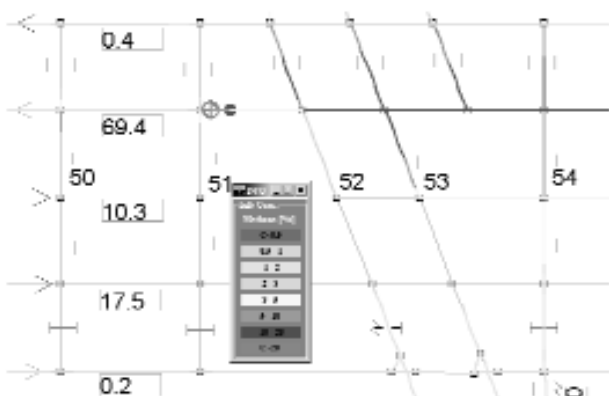


Figure 16 - Part of Oaky North pit showing airflow and CO levels at time 13 hours and 22 minutes. Airflow reversal has occurred across the fire

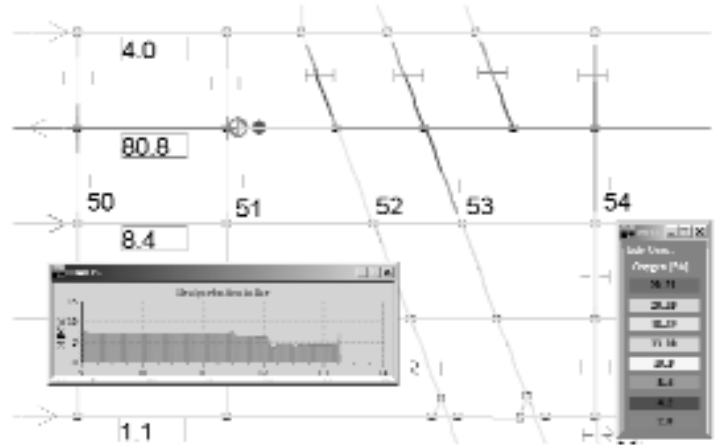


Figure 17 - Part of Oaky North pit showing airflow and O₂ levels at time 13 hours and 31 minutes. Airflow reversal has occurred across the fire. Fire is in an O₂ lean state with reduction in heat output.

Scenarios Summary

Table 4 gives a summary of key information from the scenarios tested. The scenario which was considered to be the best option is laid down in three sequences in the first three rows of the table. The other two alternatives tested that gave unsatisfactory outcomes are included in the last three rows.

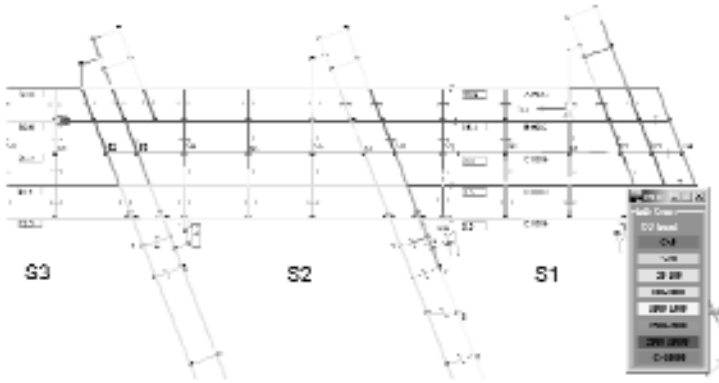


Figure 18 - Part of Oaky North pit showing airflow with one fan off

| Nexis Scenario | O in B, C, D High wall entry (m ³ /s) | O in G1/G2 (through borehole) (m ³ /s) | Gas and Temperature Conditions | | | Comments | |
|----------------------------------|--|---|--------------------------------|------------------------|-----------|----------|---|
| | | | Inlet Fire O ₂ (%) | Air O ₂ (%) | Temp (°C) | | |
| Before fire started | R 40.0 C 40.0 D 10.0 | 0.2 | 21.0 | 0 | 25 | 21 | |
| Gas after fire started | U 25.0 C 35.4 D 10.0 | 0.5 | 17.0 | 100 | 21 | 21.4 | Leakage from B to A high wall doors observed at G1/G2 borehole |
| Drift portal sealed, GAG started | U 50.7 C 33.5 D 50.0 | 0.4 | 17.0 | 0 | <20 | 21.0 | Improved flow from borehole and no leakage from doors into refuge |
| Turned off 1 st fan | R 57.8 C 26.2 D 40.7 | 0.2 | 16.0 | 0 | <20 | 21.0 | Flow into fire reduced but not enough to starve the fire out |
| Turned off 2 nd fan | B 33.7 C 27.7 D 26.6 | 0.2 | 16.4 | 0 | <20 | 21.0 | Reversal of airflow at D High wall into fire - explosion |

Table 4 - Summary of the various emergency exercise simulations

Observations on the Emergency Exercise

The following comments can be made on the ventilation aspects of the emergency exercise from observations made during the course of the incident. Some comments are set down as observations and some were personal comments from participating individuals.

1. The evaluation of the various fire control options on Ventgraph had resolved that the optimum solution was to drill a borehole from the surface and block B Heading using a medium such as sand or concrete. The singular use of the GAG was ineffective without positive control over the ventilation quantity but did have an impact on the intensity

Monitoring Mine Fires — Facts and Fantasies

David Cliff, Minerals Industry Safety and Health Centre

ABSTRACT

This paper will discuss some of the do's and don'ts relating to monitoring and analysis of underground mine fires based on the authors 15 years experience in this area. The topics covered include location of monitoring points, types of analysers used, and ensuring reliability accuracy and precision. In addition reality checks will be discussed where spot evaluations are carried out to ensure that there are no flaws in the logic. Standard textbook theory will be contrasted with results obtained in actual mine fires, to show the limitations and oversimplification of what is done. Answers to such questions as: (1) If you burn coal what products are formed, and what influences their concentrations? (2) What are the limits of textbook values for ratios and indicators? (3) What effect does inert gas have on indicators and the mine fire? (4) Why do ratios behave the way they do?

INTRODUCTION

Over the past 15 years enormous progress has been made in the monitoring and analysis of mine environments. We now have high speed gas chromatographs capable of ppm resolution of the fire gases that can analyse samples in less than two minutes based at most Queensland underground coal mines, a number of NSW coal mines as well as at SIMTARS NSW Mines Rescue Service and DMR. Gas monitoring is much more widely spread than ten years ago with sophisticated systems using a combination of sensors and tube bundle systems being in place. Parameters such as temperature, humidity and air quantity are also routinely monitored.

Mines use ventilation simulation programs to assist in planning and operating the mine ventilation systems, some programs such as VENTSIM and VENTGRAPH offering limited pollutant dispersion modelling. VENTGRAPH also offers a model that can simulate the impacts of buoyancy and throttling due to mine fires on the ventilation network.

External inertisation techniques have been developed that allow a range of high, medium and low flow applications to prevent or control mine fires. CFD modelling of goafs is available to allow for simulation of goaf gas behaviour.

Despite all this mine fires continue to occur and have significant impacts, though fortunately not causing death or injury.

To understand why this occurs we need to delve into a number of the components relating to mine fire detection and control and understand the limitations of these techniques and some of the common pit falls of using them. They need to be used with care and applied intelligently; they are not "magic bullets" and are not quick, fool proof solutions.

MONITORING (THE SAMPLE IS ALWAYS CORRECT?)

The key to effective monitoring is having enough monitoring locations to give an adequate representation of the mine atmosphere. In addition each location needs to be representative of the atmosphere that it is sampling.

Issues here are:

→ Layering of gases – do you sample near the roof, the floor mid point, or average all three?

- Where you sample depends upon what you want to detect. If it is the overall atmosphere then average sampling is required if the atmosphere is not well mixed. If the early detection of spontaneous combustion is required then sample near the roof for any warm gases.
- Response time – how fast a situation can change will determine what type of monitoring is undertaken.
- Belt fires can develop rapidly and thus need sensor technology to detect the onset. Spontaneous combustion relies on detecting a suite of gases and allows for supplementary analysis for hydrogen and ethylene – hence tube bundle supported by GC is required.
- Sampling needs to be reliable.
- Tube lag times should be checked regularly and pressure drops up the tubes monitored for signs of leakage or blockage.
- Sensor technology often requires oxygen concentrations in excess of 10% to function accurately so beware of taking at face value CO readings, flammable gas readings at below this.
- Flammable gas sensors often are labelled as Methane detectors when they can respond to all flammable gases – to varying degrees of sensitivity. This is especially important if significant concentrations of CO and H₂ are present.
- It is better to have too many sampling locations than too few. The closer sample to an event the more reliably that event is described. Sample points do not have to be monitored at all times provided they are established prior to need. Far too often even now mines expect a detailed accurate analysis of the state of a mine fire or heating based on one monitoring point located in a panel return several kilometres from the site of the heating.
- Sampling can be used to indicate abnormal conditions rather than active fires or heatings. For example the presence of oxygen where none should be indicates the precursor to a heating, which may or may not develop, but preventive action to remove it will prevent the heating. Thermal imaging can identify leaking seals long before the coal in the goaf progresses to advanced oxidation. Thermal imaging can also detect failing rollers and bearings long before they fail catastrophically and cause belt fires.

Despite the recognition of these issues recent mine incidents continue to demonstrate that sample points are not necessarily where they are supposed to be.

ANALYSIS (THE COMPUTER NEVER LIES?)

The analysis undertaken is only as good as the data collected. Too often computers are set up to automatically collect data and calculate indicators without human intelligence being applied to screen out non-meaningful results.

- If samples are extracted from tubes for GC analysis the tube bundle analysis should agree with the GC results – who checks this?
- GC's analyse for all major gases except water vapour – the analysis is done on dry gas so there is no water present in these samples anyway. Do you check that it adds up to 100%? GC columns suffer wear with the throughput of high volumes of samples especially those containing

Fitness for Work in Mining — not a “one size fits all” Approach

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ABSTRACT

Health promotion programs can help prevent work-related illness or injury. However, in many industries only a very small number of organisations effectively plan, implement, monitor and review risk management processes, and the emphasis has been on injury management rather than prevention. In coal mining, this is exemplified by the lack of accepted strategies to maintain and enhance the fitness levels of miners. A recent survey of a cross-section of OH&S officers working in Queensland and New South Wales mines, nevertheless, indicated that lack of fitness, stamina and skill rank highest, along with work environment factors, as contributors to injury.

There is relatively little evidence on the efficacy and cost effectiveness of existing injury prevention programs. An opportunity exists to develop a more holistic approach to the fitness of miners as a component of the health surveillance program. This begins with the selection of miners following a medical examination supplemented by relevant fitness or work related tests, enabling more targeted strength, aerobic and flexibility programs designed to match the physical demands of mining and maintain or enhance fitness at levels required for injury minimisation.

This presentation uses the workplace health literature and surveys of the mining industry to suggest strategies to implement realistic and more holistic fitness interventions for miners in line with continuing health surveillance and preservation of longer term health.

INTRODUCTION

Increasing competition has led to significant change in a majority of businesses in the industrialised world, stimulating efforts to reduce costs and increase efficiency. This has changed patterns of employment, particularly towards a greater use of contract, casual and part-time work and other non-standard employment structures. Commensurate with these organisational changes is the necessity to understand their impact on the health of the individual and the family. Maintaining the health of the workforce falls under duty of care legislation and generates significant costs in the coal mining industry. It has been suggested that the industry has emphasised safety and that within the occupational health and safety domain, the health component has been somewhat neglected. This would appear to be particularly relevant when considering preventive aspects of health, where companies have struggled to identify the most appropriate strategies to maintain and enhance the fitness levels of miners.

In this paper, we consider what it means 'to be fit for work in mining', and why it is a significant issue. Using both the workplace health literature and surveys of the mining industry, including our own, we outline strategies to implement realistic fitness interventions for miners. These adopt a more holistic approach that is in line with continuing health surveillance initiatives and the maintenance of longer term health.

Traditionally, fitness for duty has been described as “the detection of medical problems that may compromise personal, co-worker, and/or public safety” (Kales et al. 1998). This view of work ability focuses solely on the identification of pre-existing medical conditions and the resultant risk of injury. Mining and

some other hazardous industries have responded to legislation and increased awareness of risks by also testing employees for drug and alcohol intoxication, and in some instances, excessive fatigue. Thus, if a worker is found not to have either medical problems or impairments related to drugs, alcohol or fatigue, he or she is considered 'fit for work' – implicitly extending the concept of fitness for work. However, a broader view of this concept should consider the interaction between a worker's capacities and the demands of the job, and how much they do, or do not, match. It should also take a long-term view of how a worker's health and fitness status may change over a career, the capacity for and limits to physical adaptation, and cumulative effects of work demands. This more comprehensive concept of fitness for work is consistent with the goals of career-long health surveillance, and would allow interventions to preserve health and maintain work capacity to be implemented in a timely way, and tailored to the individual's needs.

A specific challenge in defining fitness for work in mining is that the actual physical fitness requirements of many work tasks can easily be under-appreciated. This reflects conflicting philosophies as well as major structural change. Historically, it has always been accepted that underground mining work imposes heavy physical demands on miners, and that not all are suited to this work. Mechanisation in general, and open-cut methods specifically, have reduced many physical demands, but in an inconsistent way. Some manual tasks have disappeared completely, but mechanisation has itself created new physical demands, especially in maintenance, moving and set-up of equipment. The legal and philosophical background has also changed, with equal employment opportunity legislation leading to the presumption that most work should be open to most people, and that exceptions must be properly justified. Finally, these changes have occurred against a background in which physical activity and fitness levels have arguably declined, and levels of overweight and obesity have clearly increased (Cameron, 2003).

However, despite a range of ergonomic and job re-design efforts, many of the work tasks undertaken by miners still require significant manual handling, exertion of high forces, often with non-optimal postures, and frequently in poor environments. Furthermore, the work is often of an intermittent nature. There is a real danger that in trying to comply with the goals of equal employment opportunity, and the ergonomics credo that work should always be modified to fit the human, the effects of those “irreducible” physically demanding work-tasks on miners will not be properly appreciated. Because of population-level health and fitness changes, the expectation that all members of the general workforce could perform all mining work-tasks, and that they could do so with no risk of injury, may be increasingly unrealistic.

THE PHYSICAL DEMANDS OF COAL-MINING

We present results of our own studies and the broader literature to first describe some of the general issues of mining's physical demands, and then to consider some of the specific challenges in the areas of musculoskeletal and cardiovascular health.

Our own data confirms that many tasks remain physically demanding, at least in underground coal-mining. A group of miners rated the frequency,

The Seven Deadly Sins: What They Don't Tell You About Managing Risks

Hayden Cater, Health and Safety Regulation, Department of Primary Industries

INTRODUCTION

Health and safety legislation requires organisations to pro-actively manage their risks and many organisations spend an enormous amount of time and of resources on the process of risk management. In the world of health and safety there is no shortage advice on how to manage risks. Standards Australia has developed a formal risk management process¹ that is used by most organisations as the basis of their risk management strategy. Many Regulatory Authorities publish Codes of Practice. External educators, consultants and corporate risk managers all provide advice on the identification, assessment and control of risks. In addition much of the health and safety legislation² also contains prescribed risk assessment methods which should be followed.

The type of risk management strategies used by organisations and their overall effectiveness varies greatly. However, there are however common elements within all risk management processes. These elements include employee involvement and use of technical expertise to identify and assess risks, estimations of consequences and likelihood of occurrence that produce a measure of the level of risk and actions to control, minimise or mitigate the impact of those risks. While there exists a vast amount of information on the general topic of risk assessment and its applications, very few references include a critical review of methodologies or information on risk assessment pitfalls.

There are seven deadly sins that organisations can commit when they undertake the risk management process. The seven deadly sins are very common and each of them has the potential to cause significant damage to the risk management process. Whilst we may publicise our successes in risk management, pitfalls and information on the seven deadly sins are harder to find.

To improve our risk management processes we need to better understand these deadly sins and how to avoid them. This involves looking at each step of the risk management process and identifying any weaknesses in the process. By dissecting the risk management process in this way we can begin to understand the strengths and weaknesses of the available approaches and we can use this information to develop strategies to improve our risk management capabilities and outcomes.

This paper outlines the seven deadly sins of risk management, ways to avoid them and highlights best practice risk management techniques.

KEY WORDS

Risk, Risk Management, Pitfalls, Best Practice.

INTRODUCTION

In health and safety there are a number of common pitfalls associated with risk management. Each of these pitfalls has the capacity to compromise the integrity risk management process and can lead to poor risk management outcomes. In this paper I describe each of the pitfalls that many organisations and individuals commit as the seven deadly sins of risk management.

The seven deadly sins have been around for a long time. They have been recast many times to describe the pitfalls of different situations. They are useful in a modern safety context because they allow us to focus attention on the major problems associated with risk management.

Many of these seven deadly sins will seem self-evident to senior managers, safety professionals and OHS representatives. Many would protest that their organisations are not guilty of committing any of these sins. But in reality how many understand the sins, their own organisational culture and how hard are they looking to see if one or more of these sins are being committed in own their organisation.

As a health and safety regulator when I visit a mine site I am always told how committed an organisation is to health and safety. I am shown documents and procedures, training records, risk assessments, job safety analysis and other records and yes these do indicate that there is a certain level of commitment to safety at the site.

But if you dig a bit further it is surprising what you can find. Many organisations are not aware of the full impact of the seven deadly sins. They may be unsure even if they are committing them and what will be their ultimate impact.

THE SEVEN DEADLY SINS OF RISK MANAGEMENT

The seven deadly sins of risk management must be respected and avoided at all costs. They are:

1. Waste
2. Disorder
3. Avoidance
4. Arrogance
5. Ignorance
6. Apathy
7. Complacency.

All organisations developing, implementing and maintaining risk management systems need to improve their understanding these deadly sins and how to avoid them. This paper involves looking at each of the deadly sins and highlighting some golden rules to avoid them so that we can improve our risk management capabilities and outcomes.

SIN 1 - WASTE

"to consume, spend, or employ uselessly or without adequate return; use to no avail; squander"³

Waste is probably the easiest and most common of all the seven deadly sins to commit. For many organisations maintaining high standards of health and safety and in particular risk management is a resource and time intensive process. In today's competitive environment no company or health and safety managers can afford to waste their limited time or budget on inefficient or ineffective risk management programs.

Expensive risk management programs or initiatives that make little or no

Keeping up with the Jones's — H&S Benchmarking

Tony Pooley, Qest Consulting
(based on a DNV process)*

Keeping up with the Jones's is something we all know about. Whether we are secretly envious of our neighbour's new car or swimming pool, or whether our kids are, according to them, the only ones in the neighbourhood without the latest computer game or mobile phone. If we are not careful we all find ourselves trying to meet the standards of the highest achievers in any given area.

In our social lives we know that some realistic limits have to be set but it's not unknown for organisations to set their policies and targets based on those of other organisations only to find out in the fullness of time that they were set unnecessarily and uncomfortably high. They then find themselves having to make the crippling decision between announcing a change in expectations (normally interpreted as failure) or plowing on, spending valuable resources on something that is now known to have a poor return.

Word to the Wise #1 : Define your objective(s) before you start looking and resist making that objective "We will be the best", at least until you know what that entails.

Of course the areas that you could benchmark yourself in are many and varied. Even when limiting the scope to Health and Safety, the list can be large. Here are the suggested DNV topics of direct concern to those in the field:

benchmarking in mining



It is my strong belief that, in terms of Health and Safety particularly, there are great gains in going outside of your own industry...but substantial traps for the unwary. Every time I have been involved in such benchmarking I have found differences between industries that can lead you to a poor outcome. On some occasions I've been smart enough to avoid the pitfalls and in others I've been to slow-witted.

An example of both comes to mind in relation to the first "safety case" we carried out in mining (*actually all we were doing was a Quantified Risk*

Assessment and cost benefit analysis of potential improvements but most people insisted on calling it a safety case). The process had been pretty well developed for the oil and gas and chemical industries and my company (Qest Consulting) thought we knew it all. We felt the differences between Oil and Gas and Mining were only those of style, you know the sort of thinking... "If we can handle know-it-all drillers from Texas, then we can sure handle some hard-nosed miners". The point was we didn't allow for significant fundamental differences and yet they were there.

The first of the two big differences we did wake up to early on. In O&G a major hazard was always deemed to involve a multiple fatality. Single fatalities were generally deemed to indicate a non-systemic failure and anyway, the solutions to multiple fatality scenarios always seemed to cover single fatality systemic failures too. Helicopter crashes, platform collapses, fires and explosions, drill rig rollovers, diving incidents, ship collisions and crazy sea states were the order of the day and, to be honest, there weren't many lives lost that didn't involve this sort of scenario. Whilst confined spaces and falls from height were tackled comprehensively by the O&G companies, it wasn't within the safety case framework.

In mining, however, things are very different. Sure there are the underground events that could kill many and a crew bus or tour bus might end up in an open cut pit. Some processes on some sites had some very toxic substances that you'd hate to think of being released, but if you look at the statistics, single fatality scenarios involving a systemic failure make up a very large part of the risk story. In our very first workshop there was nearly a rebellion before I stopped talking and started listening. The missing fact was that, unlike in the O&G and chemicals businesses, in mining people are part of the process...not safe bystanders for 99% of the time whilst the process operates quite nicely without direct human involvement.

The second big difference we managed to miss until it became all too obvious at the end of the process. That was that there simply isn't enough recording of mining failures (not just those events that result in a fatality but all significant failures like processing valve or pump failures, conveyor belt breakages, significant ground movement, etc) to create a meaningful statistical basis for QRA fault and event trees. In O&G the industry had been collecting this stuff for at least three decades.

The result was that we were guessing all too often and when the results came out, the team at the site had no confidence in them. The short term result was that the site concerned (Northparkes in NSW) worked very hard with us to go back over the fault and event trees and make sense of things so that we salvaged something. It is so lucky for my company's reputation that they did because now, some 4 years later, we have undertaken many successful major hazards risk assessments and the mining safety case is a real and proven process. Could it have been done with less pain?...you betcha!

Sometimes I like to make very simple analogies to make a point. I know there are often dangers in this but I feel the gain is worth it. When I first came to Australia some 20+ years ago I couldn't believe that AFL players (VFL as it was then) would pick up the ball in front of goal to kick it over the line. Soccering off the ground was for fairies yet as a soccer player it

An Industry-wide Approach to Sharing Lessons about Incidents and Innovations

Sue Leveritt, Minerals Industry Safety and Health Centre (MISHC), The University of Queensland

There is currently no cohesive national system that gathers information related to unwanted events that occur in the minerals industry. There is no attempt, beyond company and state level, to classify and trend event information and communicate the results back to industry. Thus, it is not possible to search for events that relate to an activity or risk assessment being undertaken at a site.

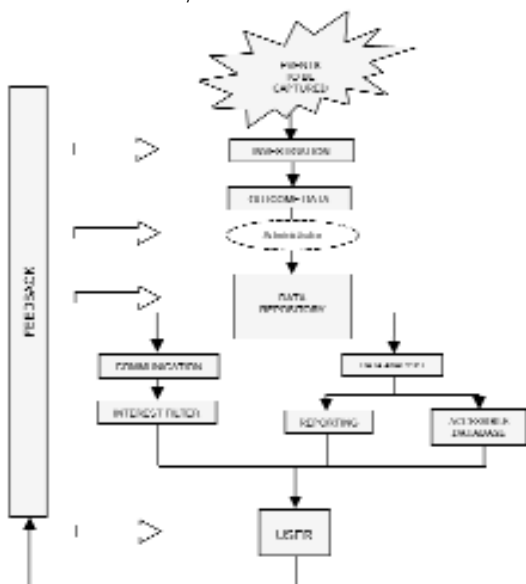
Various bodies throughout the Australian Minerals Industry foster the development of innovative solutions to everyday health and safety issues by conducting annual award campaigns. However, there is currently no comprehensive database of lessons learned from these innovations that is readily accessible to industry workers.

This paper will outline the work that is currently being undertaken at the Minerals Industry Safety and Health Centre (MISHC) to establish a system for gathering information about and providing access to findings and learnings from unwanted events and innovations. This research will form the basis for a National Lessons Learned Information Retrieval System.

LESSONS LEARNED INFORMATION SYSTEM

In 2003 a model of an ideal Lessons Learned Information System was developed and a survey conducted to determine what aspects of such a system were already in existence within the Australian Minerals Industry. This was the first phase of the Lessons Learned project that is one of a suite of projects that form part of the Minerals Industry Cooperation Initiative (MICI).

It was found that many aspects of a Lessons Learned System are already in place across the minerals industry, although there is generally no consistent approach used to define events, manage incident investigations and disseminate outcomes. There is also considerable uncertainty about how best to use the findings and learnings from unwanted events. Data analysis is mostly limited to site or company level, which places limitations on the usefulness of the analysis.



EXISTING LESSONS LEARNED INFORMATION SYSTEMS

A Lessons Learned Information System is not a new concept in our current society. A number of industries around the world have developed systems intended to deliver lessons that may help to prevent future unwanted events. However, these systems vary in the nature of information they deliver, type of user access to the system and the usability and appearance of the system.

During the first phase of the Lessons Learned project a number of existing Lessons Learned systems were analysed for strengths and weaknesses in an attempt to identify good practice parameters for the proposed model for the minerals industry. These included SafetyShare (Minerals Council of Australia), the APPEA (Australian Petroleum Production and Exploration Association Limited) Safety Alert system, the public version of the NASA Lessons Learned Information System (LLIS) Database, DOE Lessons Learned Database and the Safety Alerts Database and Information Exchange (SADIE), which is a component of the greater information system supported by the Step Change in Safety group in the UK.

In 2001, the MCA attempted to coordinate information sharing by trialling SafetyShare. Despite philosophical support for this initiative, the practicality of using it has proved to be a major stumbling block to success. The website functions performed adequately, but the process of inputting information was onerous. Issues touted related to time required by people at corporate level to identify and sanitise information as well as additional people resources for keying information into the web-based template.

Whilst there is general agreement that lessons from unwanted events should be disseminated across the greater minerals industry, a process that maintains confidentiality and eliminates double handling of information is required for this to occur. Research is ongoing to develop an information transfer process that meets these needs. Meanwhile, it is imperative that information that is already publicly available is presented to the industry in a manner that will assist with the site risk management process.

Similarly, the Minerals Industry would benefit from ready access to learnings and findings about existing innovations as a resource that would reduce the amount of time required to identify and develop new ways to reduce site risks.

The second phase of the Lessons Learned project will focus on developing strategies to identify the **findings and learnings from events** and to establish an effective information transfer process for dissemination them via an **information retrieval system** that is web-based, searchable and Minerals Industry specific.

FINDINGS AND LEARNINGS FROM EVENTS

Findings and learnings from both innovations and incidents will be targeted, with the initial focus on innovations.

Innovations

It is the intention of this project to identify innovations that have been effective in eliminating or reducing specific risks and to develop a process

The Development of a Borehole Tool for Investigating Otherwise Inaccessible Areas in Underground Coal Mines

Associate Professor David Cliff¹ and Mr John Lakeland²

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ABSTRACT

This report outlines the first two phases of a project to develop an investigation tool for use in sealed or inaccessible areas of underground coal mines, deployed via a borehole. The device would gather gas concentration data, video and other relevant information. This will aid in the rapid identification and treatment of heatings and other incidents.

INTRODUCTION

Once an underground coal mine has been evacuated due to a significant incident, there is currently no reliable way of remotely identifying the source of a heating or investigating abnormal gas concentrations in a goaf, unless a number of boreholes are drilled. Direct access for investigation requires demonstration that it is safe to re-enter. It takes time and money to drill the boreholes.

In recent years there have been a number of incidents where elevated gas concentrations (particularly hydrogen and carbon monoxide), often associated with spontaneous combustion, have been detected in the goafs of underground coal mines. Because of the potential for fire and/or explosion and their consequences, there is a need to identify and treat the source of these incidents as quickly as possible. In addition, as mines are often unable to retain personnel underground or mine coal until the situation has been controlled, there can be substantial financial costs accrued and revenue lost. There are many examples of this including North Goonyella (1997), Dartbrook Colliery (1997, 1999, 2002), Southland (2004), United Colliery (2001) and Wallarah Colliery (2001).

Effective management is hampered because the area of concern is inaccessible. Access to the adjacent areas can also be restricted due to the potential hazard of fire and explosion. There have been a number of incidents where personnel have been evacuated to the surface and are unable to return until the situation can be shown to be safe. There is usually insufficient gas monitoring in place to adequately define the situation. An example of this would be the incident at Endeavour Colliery in 1995, where a substantial goaf fall caused a large methane rich gas cloud to enter the workings and be ignited. All personnel were able to evacuate the mine, but re entry was hampered and slowed because of the limited ability to establish what had happened and what residual risk existed.

Much time and cost is then expended in drilling boreholes to gain access and information. Practical constraints including cost and limited surface access, can mean that only a few boreholes are drilled and interpretation is then based on very limited data. In the case of Wallarah Colliery in 2001, the surface area above the mine was a heavily forested region with very hilly terrain. This made it impossible to drill many boreholes. Interpretation must be circumspect and of limited accuracy. This in turn creates the need to be cautious which translates to delays in re entry and re-establishment of mining. The cost of treatment is also increased where the source of the incident cannot be accurately located. Large amounts of inertisation materials must be used to blanket the whole area rather than being able to target a specific zone. If it is possible to locate the source then the inertisation material can be targeted, and the incident treated quickly with the minimum material.

Other prominent examples where improved accurate data would have expedited investigations include Moura No.2 (1994), and Chain Valley (1996). In these cases, due to either non-existent underground monitoring or damaged monitoring equipment, immediately after an incident occurred, there was no reliable picture of what was happening underground. Re-entry and rescue attempts had to wait for borehole access or staged rescue team investigation.

A device that uses a borehole as an entry point and is capable of limited travel within the mine to collect gas samples and other information, from a range of locations, would significantly expand the quantity and quality of the information available. Increasing the amount of reliable information available will hasten accurate diagnosis and prompt treatment can be effected. It is important to recognise that there are situations where boreholes cannot be drilled, such as for mines beneath lakes, roadways or the sea, where this device could not be used.

By utilising available technology, the proposed system could reduce the number of boreholes required and increase the amount of data able to be quickly collected. There are a number of borehole video camera systems that have been commercially available for many years. These can enter via standard size boreholes and provide pictures of underground areas. In addition there are a wide range of pipeline inspection devices similar to the borehole camera systems that may be relevant. These are small, mobile, carry video cameras on motorised carriages and are deployed through small openings. The existing systems often have explosion proof certification for the carriage and camera to Ex p II T3 zone 1. Down hole video cameras have been used in the past, for example in the aftermath of the Moura No.2 explosions, to view the state of seals and stoppings and evaluate the extent of damage.

The difficulties in adapting one of these devices may come from the need to make it:

- Steerable
- Intrinsically safe or flameproof
- Capable of travel beyond the borehole through water and rough terrain
- Able to identify its location
- Capable of extracting gas sample for detailed analysis
- Able to be extricated from the mine via the borehole.

There are many useful lessons from the past research projects, both here and overseas, in dealing with developing robotic vehicles for emergency situations.

At the Willow Creek Mine fire in 1998 a SANDIA NATIONAL LABORATORIES built robot – RATLER™ was used to assist in evaluating the conditions of the mine under very adverse conditions. The robot was able to negotiate the steep slopes of the coal mine roadways and be successfully tele-operated. A Forward-Looking Infrared (FLIR) video camera was used to give good vision. Current power levels and radio frequency control limitations gave it an effective range of only 250 feet (80m). The device was not intrinsically safe, though this was not an issue in investigating a mine with no persons trapped underground (SANDIA 2002). Subsequently it has been modified to use fuel cells rather than heavy and bulky batteries.

Comparison and Benefits of Participating in Australian and World Mines Rescue Competitions

Geoff Nugent and Warwick Libbury

INTRODUCTION

During June and July 2004 North Goonyella Coal Mine's rescue competition team competed in the International Competition in Glogow, Poland. This was the first time an Australian team has competed in a major international competition and their performance was well beyond expectations. This paper looks briefly at what was needed to achieve high performance results and what the benefits of this level of commitment are.

BACKGROUND

With the change in management of North Goonyella Coal Mine in January 2003 it was identified that a change in the way industry perceived North Goonyella was required. A major area of concern identified was safety and health management. Management immediately committed to put processes into place to commence a major upgrade of safety and health management.



The Mines Rescue Competition Team comprised Geoff Nugent (Captain), Peter Purdie (Vice Captain), James Ticehurst, Andy Neville, Steve Kell, Kim Taiepa, Mark D'Elboux and are shown receiving the awards at the national competition.

The team's achievements during 2003 were:

- Winners of the Neil Marshall Shield (Dysart District competition) in July 2003
- Winners of the E.K.Healy Cup (Queensland Champions) in July 2003
- Winners of the Captain's Award, Chief Inspector's Award and First Aid Award
- Winners of the 41st Australian National Titles at Appin Colliery in October 2003.

On being notified of the Fourth International Mines Rescue Competition to be held in Glogow, Poland the team presented a proposal to North Goonyella Management. The proposal fitted in well with management strategy and also was encouraged by Peabody Energy Australia Coal's purchase of the mine. NGCMPL Management considered the benefits of such a competition and agreed to the proposal.

The team obtained support from industry and gained considerable backing. Major sponsors were the Queensland Mines Rescue Service, Queensland Government through the Department of Natural Resources, Walters Construction, Valley Longwall Drilling, Drager, CHUBB, and the CFMEU.



THE INTERNATIONAL COMPETITION

This year the international competition was organised by the Polish State Mining Authority and hosted by Poland's largest mining company KGHM. The competition had 12 teams competing from 10 countries including Australia, USA (2 Teams), Russia, Peru, China, Poland (2 teams), Ukraine (2 Teams), Czech Republic and Slovakia.

The competition structure was based on the USA Mines Rescue competition style, being simulated exercises conducted on the surface. The USA style was procedurally clinical and focused heavily on the decision making process in gas management and mine ventilation. This differs from the Australian competitions, which are designed to be as realistic as possible and conducted underground.

The competition comprised of a main event being a simulated underground mines rescue exercise including mapping, gas management, ventilation problems, first aid, and fire fighting. A separate first aid competition using three team members confronted with three scenarios was done and a Benchman's exercise where a team member had to assess breathing apparatus mechanical problems and repair them in a given time.

The team had to use the new Drager BG4 Breathing apparatus, which had not been introduced to the Australian Mines Rescue at the time and was a focal point in the training and preparation for the international competition.

During the competition the team had to map the entire simulated mine and safely reventilate it taking into account explosive gas mixtures found and potential ignition sources, as well as noxious gases and positioning of patients.

The international competition focused on problem solving skills and tests, whereas Australian competitions centre on pure mines rescue techniques.

Synergies Gained by Adopting a Multi Company Approach to Addressing High Risk Injury Periods Both in the Workplace and Wider Community

Angela Seidel, PWCS
Ross Thomson, Ravensworth Operations

INTRODUCTION

Coal & Allied operates 3 mines in the Upper Hunter Valley, Hunter Valley Operations, Bengalla and Mount Thorley Warkworth. Coal & Allied is a publicly listed company with Rio Tinto being the majority shareholder. Each open cut mine operates with various joint venture partners except Hunter Valley Operations, which is 100% owned by Coal & Allied. Ravensworth Operations is also based in the Upper Hunter Valley, situated halfway between Muswellbrook and Singleton. It is part of the Xstrata Coal group and operates Narama mine on behalf of joint venture partner Iluka Resources. Up until 1 March 2004, Ravensworth Operations also operated the nearby Ravensworth East mine.

The mining industry, amongst others, identifies each year the high risk periods and devises an approach to get through this period without injury or incident. For operations that have multiple sites this has been undertaken on an individual basis or as a coordinated approach. The individual campaigns are often shared by safety professionals between companies as part of an informal networking process but very rarely as a publicly combined campaign across multiple businesses and industries.

Coal & Allied over the period 2000 to 2003 saw its total injuries decrease from 219 to 54. Whilst this was pleasing it was still short of our goal of zero injuries. Our injuries were predominantly occurring during the lead up to Christmas, early in the New Year and during quarter 2/early quarter 3.

Ravensworth Operations over the period 2000 to 2003 saw its total injuries decrease from 39 to 16 however this was still considered unsatisfactory as the 2003 injuries had seen an increase on the 2002 figures. There had traditionally been an increased number of injuries over the Christmas period.

Coal & Allied and Ravensworth Operations have previously undertaken individual campaigns during the identified high risk periods at each of its sites eg Christmas, Easter, the month of May and various long weekends.

- They were often very similar in idea and format with employees commenting in the community on what each of the companies were undertaking to address the known safety concerns. These have included
- Using variable message boards in the pit with regular changing of the messages
 - Using moveable radar units in the pit and on approaching roads to the mine
 - Running an actively caring campaign across the site
 - Showing NBN Television driving segments at tool box talks
 - Using a safety incentive scheme
 - Providing self test alcohol units for New Years Eve
 - Undertaking safety observations to verify safe actions/behaviours
 - Having Police talk to Apprentices about driving safety.

Over the Christmas period 2001 to 2003 there has been a reduction in the number of injuries at both Coal & Allied and Ravensworth Operations sites which was seen as beneficial but new strategies and shared learning's with other organisations were seen to be able to provide assistance in reducing this even further.

DEVELOPING EFFECTIVE ACTIVATORS TO IMPROVE SAFETY BEHAVIOUR

Can you recognise the scenarios depicted in the cartoons? Many workplaces can fall into the trap of having so many posters/signs up that it can be a hazard reading them all as you go about your task. One of the other identified concerns with posters / signs is that unless they have a short catchy message then people will either not read them to begin with or they will become very used to them and hence they are part of the furniture and don't actually realise that they are there. As a result they can become ineffective very quickly. Coal & Allied and Ravensworth Operations wanted to be involved in a strategy that overcame these known concerns.

Behavioural based psychologist Scott Geller has discussed the need to develop intervention techniques to increase safe behaviours or decrease the at risk behaviours. These techniques can be either activators or consequences. Activators were selected for this joint campaign. In the design for the campaign it was acknowledged that the areas that needed to be addressed included:

- Specifying behaviour – needed to specify a desired response but not to be overwhelming with complexity
- Maintaining salience with novelty – this was addressed via two methods. The images needed to look 'real' for the workforce to take notice. Frequent change was also identified as overcoming the habituation problem
- Vary the message – needed to be in a medium that could be changeable with relative ease and various employees were asked for their contributions towards the content so that there would be ownership of the final product
- Involve the target audience – an actively caring campaign would be run on the mine site in conjunction with the media campaign so that the workforce would be reinforcing the messages.

HISTORY OF "SAFETY – ITS YOUR CHOICE"

OneSteel & Tomago Aluminium has undertaken joint safety campaigns and ideas over a lengthy period realising the value of shared resources. Christmas 2001 saw OneSteel & Tomago Aluminium undertake a joint Christmas campaign through the Newcastle region providing posters to all major employers therefore sharing a common message with the working community. This was again undertaken in 2002. Both Coal & Allied and Ravensworth Operations received copies of these posters each year and used them for their own campaigns. The posters were normally received a few weeks before Christmas when their own themes had already been decided so the posters were an "add on" to our campaigns.

During 2003 Coal & Allied and Ravensworth Operations were invited to join OneSteel and Tomago Aluminium providing a unified team throughout the Lake Macquarie, Newcastle and Hunter Valley region in addressing a recognised high risk safety period, that being Christmas 2003/New Year 2004. This would result in all of the major employers in the region working together on one common safety theme over a known high-risk period.

The theme for the poster campaigns was "Safety – Always Your Choice".

Think Globally, Act Locally — Corporate Sponsorship Supports Safe Community

Marie-Claude Brown

Why would a corporate giant invest almost \$200,000 over 3 years in the community project of a thriving regional town? For 2 reasons: because of a commitment to contribute to the betterment of that community. And because of the belief that "safety" is a state of mind.

Corporation employees are also parents, friends, siblings, and neighbours. Work experiences have a flow on effect toward home life, and vice versa. And beside, the body does not differentiate between work and home injuries.

BHP BILLITON¹

BHP Billiton is the world's largest diversified resource company. BHP and Billiton merged in 2001 and now has over 100 operations in 20 countries employing 35,000 people.

BHP Billiton's charter is the company's corner stone document. The charter states what the organisation is about, how it conducts business, what it values, how the organisation sees itself and on what it wants to be judged. The BHP BILLITON charter contains 6 values:

- Safety
- Win-Win Relationships
- Integrity
- Courage to Lead Change
- High Performance
- Respect of Each Other.

The charter also describes "success" in part, as when...

"The communities in which we operate value our citizenship."

CANNINGTON²

Cannington is the world's largest tonnage and lowest cost silver and lead producer. Cannington is part of BHP Billiton's Non Ferrous Materials Customer Sector Group.

Cannington is a silver lead and zinc operation with 4 locations: a mine, a transshipment depot at Yurbi, a port facility and an administration office – both in Townsville. The operation employs over 330 people directly and has an equal number of contractors.

The Cannington mine is located approximately 800 kilometres west-south-west of Townsville, and approximately 250 kilometres south-southeast of Mount Isa. As a point of contemporary reference, Cannington mine site is 83 kilometres from the small community of McKinlay (population 17) – one of the locations that was used in the filming of the movie "Crocodile Dundee".

The mine's employees and contractors fly in and out of site on a roster basis of either 9 days on and 5 days off, or 2 weeks on and 1 week off.

Cannington is a silver lead and zinc underground mine using both open-stope and bench mining methods. The concentrate travels by road to a transshipment depot at Yurbi, near the township of Cloncurry,

180 kilometres from the mine, where it is loaded onto rail wagons for the 800 kilometres journey to Townsville.

At the Port of Townsville, the concentrate is loaded onto ships and shipped to customer smelters in Australia, Canada, China, Germany, Japan, and South Korea. The end uses for silver, lead and zinc include the fabrication of jewellery, photographic material, car batteries, sun protection creams, etc. In 2000, all Sydney Olympic and Paralympic medals contained Cannington silver.

Aside from being a world-class ore body, Cannington has the advantage of being a recent, modern operation, having been discovered by BHP Billiton in 1990. The pre-feasibility studies were conducted in 1992. Once mining leases were granted by the Queensland Government, development work started in 1996 and was completed by 1997.

From the very beginning, the team leaders of Cannington endeavoured for the operation to be a benchmark, not just in the mining community but in the community at large. The vision of Cannington is "Creating Success through People with Passion". Cannington sees "success", "people" and "passion" as key words in the delivery of the BHP Billiton Charter.

Approximately 70% of Cannington's employees and their families are based in Townsville Thuringowa, while a further 20% live in the Townsville-Mount Isa corridor, which includes Cairns.

87% of employees are males and 13% are females, and the median age is 35 years old. 53% of employees have children³. The company demographic is similar to that of Queensland, from the single professional/trades person to families with young and growing children⁴.

Cannington along with another local BHP Billiton operation, Queensland Nickel Inc, are the largest non-government employer of North Queensland. As such, BHP Billiton is in a position to positively impact the community in which it operates.

The mineral industry, like many other industries, puts safety as its first priority. Mining operations are intrinsically hazardous. To avoid the devastating effects of harm, hazards are identified, while the risks of those possible hazards are managed. The mineral industry understood a long time ago that safety is good business. The investment in safety systems, training of employees, design of equipment, research and networking pays off in terms of production, profit, and reduced Lost Time Injury (LTI's) rates. It also adds value to less tangible contributors like employee satisfaction, family and community support, and reputation.

Aside from the safety systems directly related to operations, Cannington has, over the years, developed a number of initiatives to encourage a "culture of safety" amongst its workforce. For example, the "Strainbusters"⁵ program, helps to reduce soft tissue injuries, by promoting fitness, stretching and weight management. Or the "Take 5" program, a simple hazard assessment/risk management chart used by every employee before starting a job.

Safety with Attitude

– A Case Study of a Cultural Change at Placer Dome – Osborne Mines

Bobbie Selleck

INTRODUCTION

1. In mining there are hazards
2. In mining taking risks is inevitable
3. Miners make decisions every day about hazards & risks
4. Incidents are inevitable.

Incidents and injuries are a part of mining and will continue to happen as long as we all share the attitude they are inevitable.

We prove it month after month as we produce information on 'safety' performance detailing incidents that have happened at each and every one of our mines. We report in minute detail the incidents and the reasons why they have occurred, but let's face it mining has risk and where there are risks and people, incidents will happen.

Every month we trot out our failures and say better training, better system, better understanding or better compliance to rule number 368 would have prevented this incident. Too bad if the person didn't even know there was a rule number 368 or if they did know it existed there was a gap in the system enabling the incident to occur. So what do we do, we redesign the system, we close the gap that existed for that specific instance and if we are really concerned consider similar events that might occur and attempt to design the system to prevent those instances we can think of.

Ask yourself:

- How much money has your site poured into safety and developing systems?
- How much training have you put into each of your people?
- How much have you spent eliminating hazards on site or re-engineering plant and equipment? How many barriers, guards or other protection devices have you put in?
- How much protection has been put around your people?

Yet incidents still happen!

How many times have you experienced a worker vent his frustration as even another rule, restriction or barrier to prevent an incident has been put in place, that makes their task even more complicated and more time consuming? The comment I have received is "you'll be putting us in cotton wool soon and we will never get the job done!"

When a serious accident happens I often think to myself what will it take to make this person understand about safety? At times I will be thinking the person is a real loser and wonder what they were thinking when they drove out into an open stope. Don't they realise chasing a rock is never worth their life?

What is the answer? How can we get our people to be safe workers?

SAFETY POLICING?

I drive a car and I often drive approximately 7 to 10km over the limit. My experience indicates I can handle the car at these speeds and I will not be

penalised by the police. However, I also know the potential severity of an accident is significantly greater for every kilometre faster I travel and the chance of an accident occurring is greater as I have less reaction time. But does this change my behaviour? No I still speed because I know the police usually 'let you go' if you are under 10km as it is not worth their time and effort to stop everyone travelling at this rate over the speed limit.

INCREASE PROTECTION?

So the risk of being caught doesn't deter me or change my behaviour. Even understanding the potential consequences of having an accident from speeding does not change my behaviour or decisions I make. If anything I actually travel faster than I used to do because my car can go faster, handles better, does not slip and slide on the road, I can brake on a dime particularly with anti-lock brakes and if I do have an accident I probably won't sustain the same injuries due to the air bags. Hang on weren't all these improvements in the design of the car aimed at preventing accidents? What has changed? My behaviour has changed. As more protection has been added to the car I drive harder and faster knowing the car's improved capability will protect me better.



So how does this relate to mining? The more safety protection we put in place the more risks our people take, assuming the 'system' or the protection will keep them safe. Like the car industry we have sold the concept the improvements in safety protection means they do not need to look after themselves, 'the system' will do it for them.



OSBORNE'S SAFETY CULTURE

When Osborne Mines looked at the incident statistics and reviewed the causes of incidents in 2001 and 2002, eighty percent were attributed to behaviour. Our people were well trained, understood the work required but

Reducing Respirable Dust Exposure of Longwall Coal Miners Through Water Infusion

Hugo du Preez, Department of Natural Resources, Mines and Energy – Simtars
Matthew Page, Central Colliery – Anglo Coal (Capcoal Management) Pty Ltd

ABSTRACT

Coal mining using the longwall mining technique is the main method used to extract coal from a deep underground seam. Because of the inherent confined nature of longwall mining, personal exposure to respirable coal dust and quartz can be high if dust emissions are poorly controlled.

Application of appropriate engineering controls is an important means of controlling occupational exposure to dust. The main engineering controls that are universally applied are dilution ventilation, water spray systems, and dust scrubbing systems. Although these systems have been found to be effective in reducing airborne dust levels they are secondary in nature in that they do not prevent the hazard from originating.

Saturation of the coal seam with water prior to cutting can eliminate the hazard from being created and is therefore considered a primary control. However full coal seam saturation is found to be only partly achievable using water spray systems. Application of large water quantity and long retention times are required to obtain full saturation.

The aim of this water infusion trial was to identify and formulate a safe, simple, easily replicable and cost effective solution, whilst achieving a worthwhile reduction in respirable dust without adversely impacting on production.

The mine currently undertakes methane drainage as part of the mine's gas and outburst management plans, which is predominately carried out using horizontal in-seam boreholes. Methane drainage is viewed as one of the main contributing factors of high concentrations of respirable dust at Central. This is mainly due to the large amount of water that is drained out of the seam along with the seam gases.

The method of water infusion chosen involved introducing water into the horizontal in-seam boreholes previously used for Gas Drainage where possible, utilising fractures and cracks with the coal to facilitate the flow of water throughout the coal seam.

Extensive dust monitoring was conducted over a seven month period. The results of the data analysis show a 32-40% reduction of respirable dust concentration in areas that have been saturated. Further refinement is required to improve the consistency and overall viability of the water infusion process so that a reasonable reduction in respirable and visible dust over a large portion of future longwall blocks can be achieved. Testing and analysis is required to assess any further reductions in occupational exposure that further refinement of this process may be achieved.

INTRODUCTION

The aim of the water infusion trials at Central Colliery was to identify and formulate a safe, simple, easily replicable and cost effective solution, whilst achieving a worthwhile reduction in respirable dust without adversely impacting on coal production.

Central Colliery was the first longwall operation in Queensland when commissioned in 1984. The Colliery operates at the Northern end of the

German Creek lease and produces approximately 2.3Mtpa. The majority of coal is extracted via a retreating longwall, with remaining coal produced by developing gate roads and main headings.

Central Colliery currently undertakes methane drainage as part of the mine's gas and outburst management plans. Gas (predominately methane) is drained from the areas that are to be mined which have a high gas concentration. Drainage is predominately via a series of in-seam boreholes.

Methane drainage is viewed as one of the main contributing factors of high concentrations of respirable dust at Central. This is mainly due to the large amount of water that is drained out of the seam along with the seam gases. The lack of water in the seam results directly in a greater concentration of respirable dust when coal is mined. Water infusion is planned to overcome this problem by saturating the seam with water.

The method of water infusion chosen involves the introduction of water into horizontal in-seam boreholes previously used for Gas Drainage where possible, utilising fractures and cracks within the coal to facilitate the flow of water throughout the coal seam.

The effectiveness of the water infusion trial was determined by a measure of the potential dust reduction when mining in infused and non-infused sections.

GEOTECHNICAL INFORMATION

The maximum depth of cover of the 311 Longwall block was approximately 400 m. Coal seam thickness varied between 2.2m and 2.7m, and dipped approximately 5° to the east. On average, Central Longwall blocks are generally 2.5km long and 230m wide, containing coal in excess of 1.9Mt.

The roof is moderately strong (UCS 60MPa) laminated siltstone and sandstone. The floor provides a competent base and primarily consists of hard siltstone (UCS 70MPa). The coal seam is mostly homogeneous, however a band of crushed coal (approx 150mm thick) causes zones of mid seam shearing (Jones, 2003).

For the purpose of the trial, the main geological concern was identifying holes with significant floor and roof contacts. All in-seam drainage holes were checked before infusion took place.

The seeking of geotechnical advice was an integral part in the overall success of water infusion. From this advice it was then determined if there would be any adverse impact associated with the introduction of water and therefore the suitability for water infusion to take place.

PREPARATION OF BOREHOLES FOR WATER DELIVERY

The original proposal (Jones, 2003), was for the water to be introduced via the maingate with the use of packers. This was deemed not to be practical and an alternative method for delivery of water was developed.

The maingate ends of the in-seam holes were grouted and water was introduced from the Tailgate end. The holes were grouted during periods of

no production (ie, mostly on weekends). The boreholes had to be grouted 10 (ten) metres length to provide enough support to the water pressure. This can be seen in the figure below.

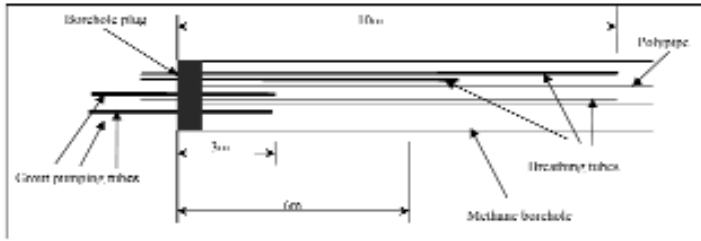


Figure 1 - Grouting of Inseam Methane Drainage Hole - 311MG

The main drawback with grouting the maingate end of the holes was that water was then introduced via the tailgate. As a result, virtually all monitoring and moving of the water infusion equipment was done by the Longwall Coordinator and the Longwall Deputies, due to restrictions on entering and working in the tailgate of the longwall.

WATER INFUSION AND DUST MONITORING TRIALS

Injection of water into the boreholes commenced several weeks before the area was mined. This allowed sufficient time for saturation to be achieved. The major problem affecting the success of the trial encountered during the project was getting water to migrate via all available inseam holes. Numerous holes failed to hold any significant amount of water. The main indicator of this was water flowing out of the tailgate ribs, particularly in and around the driller's niche. This was mainly due to poor condition of the ribs in the tailgate niche, around the boreholes that leaked. The poor condition of these ribs was caused by abutment loading from the previous longwall block (310 LW) and to a lesser extent, the advancing face.

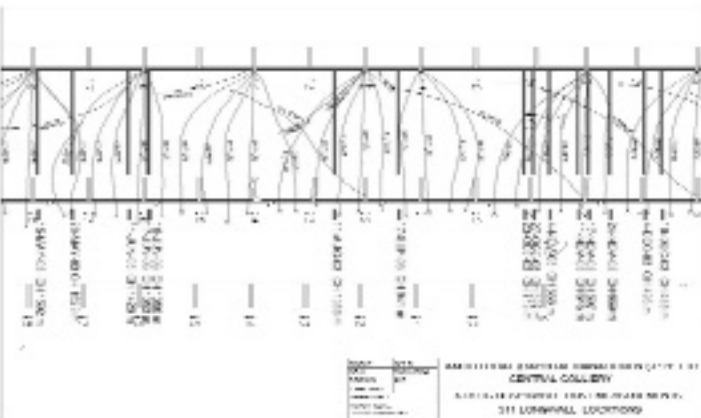


Figure 2 - Position of Surveys with respect to water infused holes. Respirable dust monitoring was conducted at specific dates when the mining was being conducted in infused and non-infused regions. Figure 2 above shows the boreholes and dates that respirable dust monitoring was conducted.

The respirable dust monitoring was primarily via static dust monitoring at strategic locations (see figure 3 below) along the longwall face to maintain consistency of results.

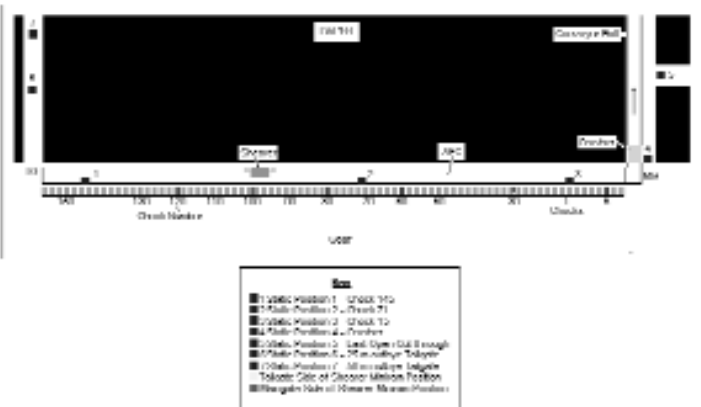


Figure 3 - Plan view of static survey locations at Longwall 311

The monitoring was carried out using sampling pumps and respirable sampling cassettes that are normally used to monitor personal respirable dust concentrations. Respirable dust sampling and analysis was carried out in accordance with *Australian Standard AS2985 - 1987*. The sample heads for respirable dust samples were Cassella metal case and plastic case cyclone elutriators. These were loaded with Gelman GLA 5000 37mm diameter PVC membrane filters with a pore size of 5mm mounted in 37mm carbon-based plastic cassettes. The filters were weighed prior to and following sampling on a six figure Mettler M3 microbalance.

RESULTS

| Bore ID | Date Start Pumping | Date Stopped Pumping | Quantity of Water Injected (m³) | Comments |
|-----------|--------------------|----------------------|---------------------------------|----------------------------|
| 311 16 01 | 15/4/03 | 16/6/03 | 729 | Bore held water |
| 311 16 02 | 24/4/03 | 28/4/03 | 87 | Turned off - water leaking |
| 311 16 03 | 15/4/03 | 22/4/03 | 61 | Turned off - water leaking |
| 311 16 04 | 15/4/03 | 17/4/03 | 85 | Turned off - water leaking |
| 311 14 01 | 5/6/03 | 11/7/03 | 578 | Bore held water |
| 311 14 02 | 6/5/03 | 22/6/03 | 503 | Bore held water |
| 311 14 03 | 20/5/03 | 20/5/03 | 3 | Turned off - water leaking |
| 311 14 04 | 1/5/03 | 2/5/03 | 27 | Turned off |
| 311 14 05 | 1/5/03 | 2/5/03 | 57 | Turned off |
| 311 12 01 | 24/6/03 | 28/8/03 | 682 | Bore held water |
| 311 12 02 | 6/5/03 | 7/5/03 | 2 | Turned off |
| 311 12 03 | 20/5/03 | 20/5/03 | 3 | Turned off - water leaking |
| 311 12 04 | 1/5/03 | 2/5/03 | 27 | Turned off |
| 311 12 05 | 1/5/03 | 2/5/03 | 57 | Turned off |
| 311 11 01 | - | - | - | - |
| 311 11 02 | 14/7/03 | 23/9/03 | 747 | Bore held water |
| 311 11 03 | 14/7/03 | 17/7/03 | 57 | Turned off - water leaking |
| 311 11 04 | - | - | - | - |
| 311 08 01 | 8/8/03 | 5/11/03 | 455 | Bore held water |
| 311 08 02 | 8/8/03 | 5/11/03 | 624 | Bore held water |
| 311 08 03 | 6/8/03 | 20/10/03 | 450 | Bore held water |
| 311 08 04 | - | - | - | - |
| 311 08 05 | 6/8/03 | 11/8/03 | 77 | Turned off - water leaking |
| 311 08 06 | 6/8/03 | 6/8/03 | 0 | - |
| 311 06 01 | 29/9/03 | 7/11/03 | 257 | Some leakage |
| 311 06 02 | 29/9/03 | 3/10/03 | 154 | Turned off - water leaking |
| 311 06 03 | 29/9/03 | 29/9/03 | 0 | - |
| 311 06 04 | 29/9/03 | 3/10/03 | 146 | Turned off - water leaking |
| 311 06 05 | 29/9/03 | 3/10/03 | 182 | Turned off - water leaking |

Table 1 - Bore Performance Figures

Table Notes:

- Data shaded in this grey shade are for bores that successfully held water
- Data shaded in this grey shade are for bores that partly held water
- Data not shaded are for bores that failed and held very little water

Data given in Table 2 shows cutting time adjusted respirable dust concentrations for all surveys from May to December. For each survey undertaken the average respirable dust concentration is given which is representative of cutting time only. Downtime periods have been excluded from the averaged data.

| Survey Date | Last Open c/t | Crusher | Chock 15 | Chock 71 | Chock 145 | TG Road 25m outbye | TG Road 50m Outbye |
|-------------|---------------|---------|----------|----------|-----------|--------------------|--------------------|
| 15 May | 0.4 | 5.0 | 1.6 | Fail | 3.6 | 10.8 | 5.6 |
| 28 May | 0.1 | 1.3 | 3.1 | 9.3 | 13.8 | 6.4 | fail |
| 11 June | 0.6 | 0.8 | 3.1 | 16.1 | 9.2 | 23.5 | fail |
| 17 June | 0.9 | 9.2 | Fail | 15.9 | 10.8 | 13.7 | 12.4 |
| 18 June | 0.8 | 3.8 | 3.7 | 8.4 | 2.6 | 26.0 | 11.3 |
| 11 Aug | 1.3 | 2.3 | Fail | 7.5 | 12.3 | 11.2 | 14.0 |
| 17 Sept | 0.3 | 0.9 | 2.5 | 4.4 | fail | - | - |
| 23 Oct | 0.5 | 0.7 | 3.4 | 3.7 | 7.6 | 4.9 | - |
| 27 Oct | 0.9 | 0.9 | 1.9 | 2.0 | 3.1 | - | - |
| 4 Nov | 0.3 | 1.6 | 2.5 | 5.9 | 5.7 | 4.1 | 6.0 |
| 11 Nov | 0.3 | 1.6 | 2.2 | 5.6 | 5.0 | 5.9 | 5.1 |
| 17 Nov | 0.8 | 3.9 | 1.5 | 4.0 | 6.5 | 4.8 | 4.2 |
| 24 Nov | 0.5 | 1.3 | 3.6 | 5.1 | 6.6 | 4.1 | 5.6 |
| 4 Dec | 0.2 | 1.8 | 1.2 | 2.1 | 6.0 | 5.6 | 5.7 |
| 10 Dec | 1.1 | 2.9 | 7.0 | 10.3 | 8.2 | 5.6 | 6.6 |

Table 2 - Static Respirable Dust Results (Longwall Operating Time Corrected)

Table Notes:

- Data shaded in this grey shade are for dust monitoring undertaken in water infused regions
- Data shaded in this grey shade are for dust monitoring undertaken in partly water infused regions
- Data not shaded are for dust monitoring undertaken in non-infused regions

The operating time corrected data given in Table 3 indicates that there is an average reduction of 40% of airborne respirable dust concentration in water infused areas. The highest reduction of 64% was measured at 25 metres outbye of the tailgate road.

| Sample Location | Chock 15 | Chock 71 | Chock 145 | TG Road 25m Outbye | TG Road 50m Outbye |
|---|----------|----------|-----------|--------------------|--------------------|
| Mean value (water infused) | 2.4 | 4.9 | 6.0 | 4.9 | 5.0 |
| Mean value (not infused) | 2.8 | 8.4 | 7.9 | 13.8 | 10.8 |
| Percent reduction % | 14 | 42 | 24 | 64 | 54 |
| Probability that Means are statistically different* | 0.666 | 0.947 | 0.854 | 0.985 | 0.974 |

Table 3 - T-test statistical analysis of Table 2 Data (production cutting time corrected) *A value of 0.9 or greater indicated a high confidence that percent reduction is statistically significant

DISCUSSION OF RESULTS

The results indicates that water infusion using the methodologies employed in this trial is an effective method for reducing respirable dust from longwall blocks that have been methane drained. Further refinement is required to improve the water retention capabilities of boreholes.

Water infusion involves several complex mechanisms. Some of the variables that have been found to affect the success of water infusion are:

- Permeability
- Virgin gas content
- Pressure of the gas in the coal seam
- Porosity, depth of cover
- Water delivery pressure
- Lead-time.

The lead-time for the infusion is a very important factor, however, low infusion pressure is not a principal factor. Therefore the main objective was to use several fan boreholes at every cut-through. Holes with significant floor or roof contact should not be used, along with holes where ribs are in poor condition.

Significant water leakage around some of the boreholes in the tailgate resulted in a number of holes failing to hold water. This was mainly due to poor condition of the ribs in the tailgate niche around the boreholes that have leaked.

The poor condition of these ribs was caused by abutment loading from the previous longwall block (310 LW) and to a lesser extent, the advancing face. A cost effective and practical solution to reduce/eliminate water leakage in the tailgate and increase number of holes that are able to hold water has yet to be found.

To maximise the effectiveness of water migration through the panel, future water infusion systems should be designed to incorporate a pressure differential between methane drainage holes. The pressure differential

could have been created by: Infusing every second hole with water, or infusing every second hole with water, and leaving the un-infused hole connected to the methane drainage suction plant.

Water infusion should be integrated into the mining process. Also more successful holes are needed for the trial to progress further. Alternating water infused holes should be trialed as previously mentioned, once the number of holes that can be infused is increased.

Cross drilling of methane drainage holes and water infusion should ultimately be incorporated into a single process (ie to enable the trial of initiatives such as longer standpipes, alternative hole layouts, etc to improve the process), with water infusion being considered as part of the drilling/drainage process to increase overall ownership and to achieve a consistent, reasonable reduction in respirable and visible dust.

Further investigation is also required into the possible used of packers rather than grouting and/or the methods to introduce water via the maingate side of the longwall block in order to lower costs and increase water migration.

Other refinements to the system will need to be made on an as needs basis to continually justify the viability of water infusion.

CONCLUSIONS

The data indicates that water infusion using the methodologies employed in this trial gave an average reduction of 40% of airborne respirable dust concentration along the longwall face in water infused areas. The highest reduction of 64% was measured at 25 metres outbye of the tailgate road.

REFERENCES

Jones R, 2003. *Implementation of water infusion at Central Colliery*, undergraduate thesis (unpublished), University of New South Wales, Sydney.

Standards Australia, Australian Standards AS2985 – 1987, Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Respirable dust.

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 Michelle Falwasser (Chemist, Simtars)

Risk Reduction Through Better Technology

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ABSTRACT

Today's mining is a heavily mechanised industry. Machine operators have at their fingertips previously unimaginable levels of power to extract and transport large quantities of ore and rock. This has made it possible for the industry to achieve large improvements in mining productivity. It also made it easier to control the operator environment and address some of the health and safety issues found in past practice.

However, the workplace health and safety is not an area in which the industry can rest on its laurels. It is an area the industry is expected to continuously improve its performance to maintain its licence to mine. At the same time, introduction of new technology brings new health and safety issues with it, including operator fatigue and boredom, noise and vibrations caused by higher power levels, risk of catastrophic failure caused by substandard operating practices, misreading of the environmental risks due to isolation of the operator from the excavating end of the machine through mechanical and electronic linkages.

CRCMining has been working with the industry since 1991 developing new technologies to address such issues facing the industry. In this paper, examples will be given from past and present CRCMining projects producing increased health and safety outcomes for the mining industry.

1. INTRODUCTION

Over the past century, a growing understanding of geophysics allowed improved mine site design practices to be employed to reduce the risk of injury and death of operators. This has contributed to the ever-dwindling LTI statistics of Australian Mining, however the most significant improvements in mine safety have been afforded by technological advance. Digital methane sensors have replaced the sacrificial canary; RF remote detonators have replaced unreliable twine fuses; sophisticated semi-autonomous coal shearers have replaced backbreaking, hand-held picks. Virtually every piece of modern mining equipment is the replacement to a less-safe, technologically inferior predecessor. Further improvements in mine safety, however, are fundamental to the sustainability of our industry.

CRCMining, formerly CMTE, continues to develop technology to both reduce the risk to personnel and improve mine productivity. The technologies outlined in this paper range in maturity from the initial research phase through to proven, commercially available products.

2. SAFETY IMPROVEMENTS IN THE MINING ENVIRONMENT

2.1 Improved gas drainage from coal seams

The majority of coal seams mined in Australia today can be characterised as gassy and relatively impermeable. The quantity of these gases contained in the seams must be reduced to safe levels before underground mining of the coal can take place. The low seam permeability makes this gas reduction operation difficult. In general the most, and often the only, effective way is to drain the seams by drilling holes in regular patterns in the coal. The gas flows into and along these holes and from there into pipes that convey it safely to the surface.

Today in Australia some 300km of these in-seam holes are drilled each year from underground workings across coal blocks that are to be mined. These holes are made using directional drilling techniques at a cost of about \$100,000/km, or a total annual drilling cost of about \$30 million. The instantaneous drilling speed achieved by these drills is a respectable 2m/min, but the delays involved in drill set up, drill pipe installation and removal, surveying and steering, reduces the effective drilling rate to about 80m/shift; equivalent to less than 0.2m/min. Obviously the drilling cost is related to the effective drilling rate. In other words if the effective rate was increased the cost would fall.

A new drilling approach that has the promise to displace much of this underground drilling is the surface-to-in-seam method. The technology that has been most widely applied to date is medium-radius drilling (MRD) which starts with an inclined hole at the surface.

Although the cost per unit length of these MRD holes is comparable to the holes drilled from underground they have advantages over underground drilling that makes the trend towards surface-to-in-seam drilling compelling. First, the surface holes can be drilled years in advance of the mining operations, allowing ample time for the gases to drain, eliminating any disruption to mining. Second, the drilling operations are conducted from the safety of the ground surface.

A significant problem with both the underground and the surface-to-in-seam drilling is that no additional information about the formation is gathered during the drilling operations. If, for example, sensors were mounted on or behind the drill to monitor changing geological structure (faults, rolls, mylonite zones, dykes, etc) during the drilling operation then this new information could be incorporated to improve the performance of the mining system; this would help justify the drilling costs.

The University of Queensland is the major research partner of CRCMining. This Centre has developed a novel, water-powered drilling technique that potentially can substantially improve the performance of both the underground drills and the surface-to-in-seam drills.

Furthermore, CRCMining, with its research collaborators at the University of Sydney and CSIRO, is developing a suite of new geophysical tools that could provide information on the geological formation during the drilling process.

Figure 1 shows this new drill. It is supplied with high pressure water through a flexible hose which runs from the high pressure pump located on the surface over a take-up drum on a surface rig and connects the back of the drilling tool. The water is emitted through a number of nozzles that are aimed at acute angles off the tool axis at both the front and rear ends of the drill. The nozzles on the front are mounted in a swivel and angled in a manner that causes the front end of the tool to rotate, in a manner similar to a garden sprinkler. These are the cutting jets that excavate the hole. More than half the jet power is directed through stationary (non-rotating) nozzles at the rear of the tool. These jets provide the thrust necessary to advance the tool along the hole.

Safety Management Systems for Occupational Health – The Legislation, the Standards and the Court Rulings

Bruce Ham

ABSTRACT

The frequent reference to 'Safety Management Systems' is easy to understand in the context of the 1994 Moura Mine Disaster which precipitated a variety of systems to better manage major traumatic mining hazards. There is complexity and misunderstanding as to how it might be applied in the context of occupational health. Safety Management Systems are referred in the legislation in the context of both fitness for duty and managing the risks of hazardous exposures. In Queensland, the reference is quite specific while in other states, the reference is more general in nature.

There are a number of standards and guidelines which refer to safety management systems in general or to management of specific hazards. In some standards, the approaches are similar while in others the approaches contrast.

The changing community attitudes to occupational health and safety management are reflected in a number of court decisions which provide useful definition to contentious issues related to 'Safety Management Systems for occupational health. Legal issues include the definition of occupational disease, participation in safety management systems, privacy and anti-discrimination.

INTRODUCTION

The mining related legislation in both Queensland and New South Wales calls on operators to implement management systems to ensure adequate guards are provided for the health and hygiene risks faced by coal mine workers. While there is considerable information about risk assessment and management systems, there is little, if any practical guidance as to how health and hygiene issues might be couched within these frameworks.

There is a wealth of information, research and guidelines about health monitoring standards and monitoring of occupational exposure but many difficult issues need to be addressed to frame them in terms of management systems. These issues include the definition of meaningful policies, identifying how the context of the management systems separates small owner-operators from larger organisations in the development of systems, identifying what is an unacceptable outcome and how should the risk of that unacceptable outcome be assessed, what monitoring systems need to be implemented, what are the trigger levels for interventions and what interventions might be implemented.

It has been established that providing workers with personal protective equipment and having a health program that targets workers who are no longer fit to be employed in the mining industry does not represent an effective health and hygiene management system.

BACKGROUND

Milestones in development of health and safety management systems for occupational health include:

- A. 1930s Western Australia introduces a respiratory health program to combat high levels of silicosis in gold miners
- B. 1940s Coal Industry (Control) Acts provide for tripartite bodies to direct

- employers to undertake improvements in health and safety
- C. 1980s Development of 'Duty of Care' style legislation for general industry
- D. 1993 Coal Miners Health Scheme Order 1993 – Queensland establishes electronic health records management system
- E. 1996 (revised 2003) national fitness for driving guidelines
- F. 1998 UK Miners Respiratory Disease Case – chronic bronchitis as a dust disease
- G. 2001 Queensland regulation requires exposure risk to health to be identified and managed through a systems approach
- H. 2002 Research – Heart Disease project links health and mortality databases
- I. 2003 Analysis of health outcome data as obtained from superannuation death and total permanent disability claims
- J. 2004 Ministerial Council approves competency units for training programs in health and hygiene management systems.

Safety management systems for occupational health have two interrelated components – fitness for work and management of hazardous exposures. See (2003) examined the legal implications of being fit for work. In addition to considering a number of guidelines and court cases, See identified key attributes of work related assessments as including safety, reliability, validity practicality and utility. In general terms, these issues are covered effectively in the guidelines for 'Assessments for Fitness to Drive' produced by Ausroads (2003) which covers vehicle drivers in numerous risk categories.

Due to the relative newness of references to safety management systems for occupational hazardous exposures in legislation, guidelines, practices, court decisions and training programs are in formative stages and are explored further. Data analysis, research and education are areas for on-going activity.

LEGISLATIVE REFERENCES

Repealed Legislation

The Coal Industry Act 1948 in New South Wales and the Coal Industry (Control) Act 1948 in Queensland established the Joint Coal Board and the Queensland Coal Board respectively. These institutions developed health programs that had many of the characteristics of health management systems. They were tripartite organisations, so that a degree of agreement was necessary for the implementation of programs. They had policies/objectives that included improvement on the health of coal workers. Both Coal Boards undertook health monitoring and accumulated considerable data sets.

The legislation that gave the Queensland Coal Board sweeping powers was repealed in 1998 and the Joint Coal Board was stripped of many of its powers in amendments to its Act in 2001. These acts were conceived in the era of prescriptive legislation and attempted to impose health management systems on the coal industry. The recent introduction of duty of care legislation obliges employers to develop their own health and safety management systems. The programs developed under the Coal Industry Acts have now been superseded.

In relation to health monitoring this includes compliance with workers compensation, privacy and anti-discrimination legislation.

While the Standard indicates that objectives and targets need to be established and implemented, some caution is required in relation to the limitation of many OHS performance indicators. Of particular concern is a focus on the Lost Time Injury Frequency Rate. While a reduction of injuries is an admirable objective, there is a possibility that bonus programs based on this statistic may cause intentional under-reporting of injuries and incidents. Contractor performance monitoring puts them particularly at risk from this practice. The result causes an unidentified rise in the risk profile for the operation.

Reporting procedures should cover the following:

1. OHS performance including results of reviews and audits
2. Reporting of incidents and failures
3. Reporting on hazard identifications
4. Reporting on preventative and corrective actions and statutory reporting requirements.

The organisation should establish, implement and maintain information to describe the elements of the management system and related documentation. The program including its documentation is then implemented and periodically audited and reviewed.

CONTAM program – Western Australian Department of Mines and Petroleum Resources (MPR) (2000)

The objectives of the upgraded CONTAM system are:

1. To provide comparative occupation group, industry sector, and industry exposure data and enable trend analysis of this data
2. To provide a reliable basis for future studies into the long-term health effects of exposure of mine workers to atmospheric contaminants, and
3. To enable accurate assessment of company compliance in the maintenance of acceptable working environments.

To achieve these objectives, the new CONTAM system operates as follows:

1. 'Each mine will be required to submit a Workforce Survey Form to the MPR when requested. This form will provide the MPR with information on the number of employees, the type of work they do, and the contaminants they are exposed to.'
2. The data reported on the Workforce Survey Forms will be used to calculate the minimum sampling requirements (quota) for each mine. Mines will be informed of their quota via Quota Allocation Reports which will be distributed by the MPR. Each mine manager and exploration operation manager will be responsible for ensuring the minimum sampling requirements are met. Sampling results will then be sent to the MPR on a CONTAM Sample Record Sheet, and entered into the CONTAM system.
3. Sampling results will be used to prepare annual industry reports which will be forwarded onto each mine.

Health Surveillance program for mine employees – Approved Procedures, MPR (2002)

The objectives of the health surveillance program for mine employees are:

1. To assess the health status of all mining industry employees on a regular basis
2. To analyse collected data to detect adverse health effects at the earliest opportunity
3. To enable appropriate and timely corrective action to be taken in order to safeguard the health and well being of mining industry employees; and
4. To provide data which may be useful for future epidemiological studies.

The health assessments conducted for the Health Surveillance Program consist of work history; a respiratory questionnaire; a lung function test; an audiometric test; and in some cases, a chest x-ray.

The guidelines also require that exposure monitoring is applied to employees who work at a mine or mines for one month or a cumulative period not exceeding three months over a 12 month period.

Biological Monitoring Guidelines, – (MPR 1997)

Environmental monitoring and biological monitoring are ways of

investigating different problems and should be seen as complementary procedures. Biological monitoring provides an important complement to air monitoring and is used to:

- **Prevent** occupational diseases by identifying excessive absorption before any significant adverse health effects occur
- **Assess** the risk to employees' health; and
- **Evaluate** the effectiveness of workplace controls, such as personal protective equipment and engineering control methods.

Whereas environmental monitoring can detect the presence of a hazardous substance prior to significant exposure, biological monitoring detects uptake of hazardous substances **after** exposure has already occurred.

Queensland Coal Board Coal Industry Employees Health Scheme Instruction Manual

The contents of the 1995 Health Scheme Instruction Manual included the following:

1. Explanatory notes
2. Health Order made under the Coal Industry Control Act 1948
3. Health Assessment forms
4. Instructions to Nominated Medical Advisers
5. Medical Guidelines
6. Instructions to Manager, Examining Medical Officer, Employee and Entrant.

The explanatory notes set out the aims and objectives of the Health Scheme. The medical guidelines set out criteria which indicated that some form of employment restriction was required in the interest of safe mining practice.

Risk Management

There are numerous guidelines on risk management such as AS/NZS 4360:1999 (Standards Australia) and the Risk Management Handbook for the Mining Industry, MDG 1010, 1997 by the Department of Mineral Resources (NSW). Exposures to health hazards are different from the usual hazard identification and risk assessment process in that there may be a long latency period between the exposure and the resulting adverse health outcome. An example is the case in numerous cancer related illnesses. The other key issue is that many of the exposure related health effects can be found in a small percentage of the non-exposed population. The basis then for increased risk is not single cases but a number of cases that demonstrate worse outcomes than would be expected in the non-exposed population. Meaningful data may take years to compile and should include injury, illness and mortality data as well as exposure data.

EXPOSURE STANDARDS

Exposure standards are generally available through the National Occupational Health and Safety Commission web site (2004). Numerous authors, Davies, Glover and Manell (2001), Grantham (1994), Bos et. al. (1999) and LaDou (1994) discuss the application of exposure standards in the occupational context. The Mining Industry Safety and Health Centre (2004) has developed the web-based program to assist the industry identify relevant guidelines and standards to occupational exposures. Commonly used guidelines and exposure standards are shown in Table 1.

| Exposure | Guidelines |
|---------------------------|-------------------------------------|
| Cancer | La Dou (1994) |
| Diesel Particulates | AI0Hb |
| Dust | AS 2985-2004, AS 3640-2004 |
| Heat | AI0Ha |
| Noise | NOHSC:2009(2004), Pennington (2002) |
| Stress / mental disorders | Bos et. Al. (1999) |
| While Body Vibration | McPhee, Foster and Long, (2001) |

Table 1 – Common Exposures and Guidelines/Standards

Frequency of Monitoring

Grantham (2001) examines monitoring strategies in relation to frequency of sampling and reliability of exposure estimates. There is elevated risk when the measured exposure is within 50% of the exposure standard. He suggests that in this case, one sample per shift per 10 workers should be undertaken each month.

OUTCOMES OF MONITORING PROGRAMS

In relation to environmental monitoring, Bofinger, Cliff and Tiernan (1995) have identified that noise levels in underground operations regularly exceed the exposure standards and that respirable dust levels exceed the exposure standards in about 15% of the samples for some work groups. Mc Fee, Foster and Long (2001) identified high levels of exposures to whole body vibration in some types of mobile equipment in surface mines.

Analysis of health monitoring has received only limited attention. Ham (1999) reported on the cross-sectional analysis of the health data captured in the Queensland Coal Board Health Database. At that point of time the longitudinal data was not available but it provided bench marking for factors such as hearing loss, respiratory function, elevated blood pressure and obesity. Subsequent studies by Bofinger and Ham (2002), examined heart disease in coal miners by examining the coal miners health databases in Queensland and New South Wales and cross matching them with national Deaths Index held by the Australian Institute of Health and Welfare. The preliminary analysis indicated heart disease was no more prevalent than in the general community. There were elevated rates of cancer and traumatic injuries resulting in death.

Further work by Ham (2003), examined the death and total permanent disability data from early claims on the Queensland Coal and Oil Shale Superannuation fund. The most common reason for claims was back disorders. Common causes of death included cancer, heart disease, mental disorders and external causes (traumatic injuries). The ratios of deaths indicate that mental disorders and external causes are more common than would be found in the general population. Ham (2004a) undertook some preliminary comparisons between the Superannuation data and the heart disease/Deaths Index data, to highlight that in different age groups, there are different patterns of causes of deaths and of death rates for particular causes.

COURT RULINGS

There have not been any court rulings that consider safety management systems for occupational exposures but there are numerous cases that explore pertinent issues such as:

1. What is a health and safety management system?
2. What is the employers obligation of care?
3. How should workers be compensated for injurious caused by breaches?
4. How should an injured worker be managed? and
5. What is an unacceptable risk of an adverse health outcome?

Health and Safety Management Systems

In the Australian Industrial Court Case – Combined Forestry, Mining and Energy Union vs North Goonyella, the court ruled that the employer was not permitted to send an employee for a health assessment outside the strict requirements of the regulations (preemployment and at 5 years) unless there was in place a safety management plan for fitness for duty. (See www.airc.gov.au/documents/other/other_decisions.html - PR943615 - C2004/1550, 17th February, 2004.) The court ruled that reference to the 1995 Queensland Coal Board Coal Industry Employees Instruction Manual in the site's industrial agreement approximated such a safety management system.

Employers obligation

Whether or not the coal mine manager contributed to the death of its worker was considered by the Industrial Relations Commission of NSW in the case of *Inspector Morrison v Cumnock No.1 Colliery Pty Ltd* [2004]. The Judge considered that the 'defendant breached s 15(1) of the Occupational Health and Safety Act 1983 by failing to ensure the safety of employees working on a continuous mining machine. The conclusion was reached although the worker had instructions and had been trained to do the job safely. The judge considered that an engineering control that may have prevented the fatality had not been implemented.

Compensation

In *Hurst v Amaca Pty Ltd* [2004] the NSW Dust Diseases Tribunal considered:

→ 'What is a proper award of damages?'

The plaintiff, an electrician, brought proceedings against Amaca Pty Limited, a company formerly known as James Hardie and Coy Pty Limited. He commenced his apprenticeship in South Australia in 1958. He qualified as an electrician and worked in various employments and as a self-employed electrician during the course of his working life. In doing his work he was exposed to the inhalation of asbestos dust and fibre. For a long time during the running of the case there was concern about whether the evidence properly permitted the conclusion to be drawn that it was the defendant's product to which he was exposed.'

'The Tribunal found that a proper award of general damages for the plaintiff was one of \$175,000. Interest on two-thirds of that sum at 2 per cent was allowed. As regards loss of expectation of life the plaintiff was entitled to damages of \$20,000. Verdict and judgment was entered for the plaintiff. Including interest, future medical expenses, future and past care, the total judgment for the plaintiff was \$246,749.'

How should an injured worker be managed?

In *Smith v Capral Aluminium* [2004] Vice President Lawler of the Australian Industrial Relations Commission considered:

→ 'Whether the defendant was required to continue indefinitely the employment of the injured plaintiff.'

The worker was injured in 2001 and had subsequently been performing a 'modified duties' position, which required data entry onto a computer from handwritten data sheets. He performed these duties until 4 June 2003 when his employment was terminated by the employer, for the reason that there were no further suitable duties available. This was due to the implementation of a new computer system, which made the task performed by the worker obsolete. The worker disputed his termination and made application to the Industrial Relations Commission (IRC); but was unsuccessful in his case.

Unacceptable risk of an adverse health outcome

Rudd (1998) discussed the class action common law claim against British Coal for occupational respiratory damage caused by exposure to dusts and fumes in mining in which the U.K. Court ruled in favour of a number of former miners who suffered from chronic bronchitis and emphysema. Data based on the Pneumoconiosis Field Research programme commissioned by British Coal indicated that the risk of emphysema doubled in both smokers and non-smokers when exposed to high levels of mine dust. The case was supported by a series of studies reported by Coggan and Taylor (1998) which indicate that exposure to coal dust statistically appears to contribute to the severity of the disorders. In the end, miners without symptoms were eligible for compensation where exposure data indicated they were at significant risk of future occupational related illness.

COAL MINING COMPETENCIES AND TRAINING

In most jurisdictions, there are requirements for training programs to ensure workers and supervisors are competent to undertake their duties. In recognition of the need to upgrade standards, coal industry competencies have been developed recently in health and hygiene management systems as shown in Table 2.

| Unit | Incorporate health and hygiene factors into mine management | Implement and monitor health and hygiene management systems |
|--------------|---|---|
| Unit Code | MNCG1006 A | MNCG1007A |
| Target Level | Diploma/Advanced Diploma | Surface & U/G Coal Cert. IV & V |
| | Elements | Elements |
| 1 | Identify the fundamentals of human disease and injury | Identify the effects and symptoms associated with workplace health and hygiene |
| 2 | Incorporate health and hygiene factors into the work environment | Identify and monitor health and hygiene standards and systems |
| 3 | Establish health and hygiene protection measures for individuals | Implement and monitor health and hygiene protection measures for individuals |
| 4 | Establish control measures for operational health and hygiene hazards | Identify, implement and monitor control measures for operational health and hygiene hazards |
| 5 | Incorporate health and hygiene factors within mine audit and review systems | Audit and review systems in respect of health and hygiene measures |

Table 2 - Black Coal Competency Units on Health and Hygiene Management

TAFE NSW with funding from Department of Education and Training developed numerous qualification guides, trainers guides and assessment guides including a Trainers Guide in 'Implement and monitor Health and Hygiene Management Systems'. See Table 3.

| | |
|---|-------------------------------------|
| Health and Hygiene Management System | Chemical and Hazardous substances |
| Framework – legislation/standards | Atmospheric hazards |
| Processes to support the system | Vibration Hazards |
| The Human Body | Noise Management |
| Ergonomics and manual handling | Heat/Cold Exposure |
| The Work Environment | Ionising and non-ionising radiation |
| Health Assessments and Fitness for duty | Confined Spaces |
| Mechanisms of harm | Injury and adverse health outcomes |
| Common disorders | Rehabilitation |
| Alcohol and other substance abuse | Records collection and management |
| Stress – causes, effects and management | Monitoring and Review |
| Fatigue and shift work | |

Table 3 - Contents of Trainers Guide on Implement and Monitor Health and Hygiene Management Systems (After Ham 2004b)

DICHOTOMY BETWEEN EXPOSURE STANDARDS AND SAFETY MANAGEMENT SYSTEMS

While personal protective equipment is required where exposure limits may be exceeded, a higher level of safety management is also required.

Grantham and the Department of Natural Resources and Mines (Qld, 2004) agree that this includes both health surveillance and enhanced training and supervision. There is little advice in how to manage the risk associated with moderate and high levels of exposures in a safety management/risk assessment framework except to say the health surveillance should be implemented.

In order to place the elevated exposures into to a safety management framework, it is necessary to develop concepts for the following:

1. Comparable health outcome measures
2. Definition of unacceptable health outcomes
3. Measures for assessing the risk
4. Trigger levels for various interventions in response to rising risk
5. Development of interventions and
6. Agreement between management and workers on the monitoring, the triggers and interventions.

The first three are discussed below while the second three necessarily need to be the subject of agreement between employers and workers and their representatives.

HEALTH OUTCOME MEASURES

One of the obstacles in measuring, monitoring and focusing resources on improving occupational health outcomes is the failure to have a suitable benchmark parameter. The Global Burden of Disease approach discussed by Mathers, Vos and Stevenson (1999) draws on an international program that uses a unit called a 'Disability Adjusted Life Year (DALY) as a common measure of harm caused by various diseases and injuries. This unit has two components – years of life lost (YLL) due to premature mortality plus the equivalent of healthy years of life lost due to a disability (YLD). This provides a measure of comparing the human cost of life and quality of life lost due to mine explosions, motor vehicle accidents, stress disorders, cancers and hearing loss. In their study on the general population, cardiovascular disease and cancer were responsible for the highest years of life lost while mental disorders and the nervous system disorders caused the highest disability losses. The weightings per year for common mining related disorders are shown in Table 4.

| Weight | | Disorder |
|--------|------|--|
| From | To | |
| 0.01 | 0.05 | Mild asthma, mild hearing loss and mild vision loss |
| 0.05 | 0.10 | Low back pain, uncomplicated diabetes |
| 0.10 | 0.15 | Mild depression |
| 0.15 | 0.20 | Mild/moderate panic disorder |
| 0.20 | 0.30 | Mild/moderate obsessive – compulsive disorder |
| 0.30 | 0.40 | Deafness, severe asthma, moderate depression |
| 0.40 | 0.50 | Severe vision loss, operable small cell lung cancer |
| 0.50 | 0.65 | Paraplegia, severe chronic bronchitis, emphysema |
| 0.65 | 0.80 | Severe depression, permanent severe brain injury |
| 0.80 | 1.00 | Quadriplegia, alcoholic psychosis and severe schizophrenia |

Table 4 - Disability weightings for healthy years of life lost

The DALY is calculated as a loss from the group life expectancy. In 1996, the life expectancy for Australian males was 75.6 years. Mathers, Vos and Stevenson consider it pertinent to follow the overseas model and use a discount rate 3% per year. For example a 56 year old who contracts dust related emphysema would loose (20 x 0.5) years. After applying the discount factor, the net loss of 7.6 years

The next challenge is to define the limit of what is an acceptable risk on occupational injury. At one level, it may be argued that no injury is acceptable. While this is commendable, a safety management systems based approach requires monitoring and this monitoring is designed to identify trigger levels that signify that some probability that an acceptable risk of harm has been exceeded. What is sought is a level of evidence that occupational exposure have resulted in a statistically significant variation from the normal range of human conditions in the un-exposed population. Using a risk based approach, trigger levels might be set at say 95% confidence for a loss of 2 DALYs and say 90% for 5 DALYs.

This evidence may take a number of forms. Firstly, dose-response may be used to determine if an exposed person is particularly sensitive to an elevated level of exposure. Secondly, dose-response studies may be used to predict long term outcomes and when the trigger level is reached, exposed persons should be withdrawn from the hazardous environment. The third approach is to use studies that monitor cumulative dose and record these against final health outcomes. This is the approached used in asbestos and cancer related studies.

FUTURE DIRECTIONS

The development of new competencies is a sign that the industry realises that education to promote understanding of health management system processes is a starting point to implementing and improving health and hygiene management systems.

The application of exposure standards is a practical solution for small organisations but does not prevent susceptible persons from suffering unacceptable health outcomes. The monitoring programs and expertise available to large hazardous industries enable them to identify that susceptible persons have higher adverse reactions to hazardous exposure than is generally expected. This should provide a trigger for an intervention in which susceptible persons are moved to a low exposure work activity. It may be argued that this is required to meet the employers' obligation of care.

The understanding of the detail of the variability of responses to moderate and cumulative doses in the long term needs to be supported by the collection, analysis and reporting of cumulative exposure data that is related to health outcomes. This research will lead to dose response studies that enable early identification of normal and abnormal changes in health. This work needs to include mortality and related health outcome studies that consider what exposures lead to different outcomes than those expected in the general population. As an example, degenerative back

Safety by Managing Security Access to Operational Areas

Roy Tindale, Xstrata Copper Australia
Yong The, Compete Holdings

INITIAL SECURITY STRATEGY AT XSTRATA COPPER AUSTRALIA

Prior to implementing electronic access control systems, the primary purpose of security within the mine at Mount Isa had to do mainly with limiting access to authorised personnel.

In the interest of safety, a primary security function was to ensure that the public was kept well away from the many hazardous operations that exist within the mine site. Additionally, millions of dollars of equipment are at risk of being stolen, damaged or compromised if left unsecured or exposed to the general public.

Due to the close proximity of the town to the mine site, the risk of public access to the operations is potentially higher than that of a remotely located mine. Therefore, it was imperative that a reliable means of controlling access was implemented.

In order to do so in a cost effective manner, an electronic system of Closed Circuit Television Cameras and proximity card based Access Control equipment was deployed. The primary Access Controller chosen to do the job is a New Zealand based product called CARDAX.

By using such a system, it was now possible to control access rights to about 4000 personnel using a relatively small number of dedicated security personnel.

Cardax is also used to manage a host of operational emergency alarms such as fire, security and pollution alerts.

NEXT PHASE: ACCESS CONTROL IN UNDERGROUND MINING SAFETY

One significant advantage of using the CARDAX system is the ability to develop interfaces with the system so that software applications can be built around the access control system.

One of the first projects undertaken by Mount Isa Mines was to replace the Manual Tag Boards for underground blasting with a system that utilised the proximity cards held by each underground miner as an electronic tagging mechanism.

It was much easier to account for all personnel electronically by capturing their Proximity Card "Tags" against a Card Reader through the CARDAX system. By keeping track of all workers at the point of entry underground, it is possible to ensure that all personnel are accounted for by virtue of having tagged into a "Safe Area" prior to each "blasting".

The benefits of such a system are quickly realised. From a financial standpoint, it was justified based on the reductions of "missed firings" arising from personnel accounting mistakes. From a safety standpoint, it was an imperative measure.

Mount Isa Mines realises that the next level of improvement to Health and

Safety lies in the integration of CARDAX to other IT systems containing relevant personnel data.

TODAY: LIMITING ACCESS TO HAZARDOUS OPERATIONAL AREAS WITHIN THE MINE

The function of CARDAX was further enhanced when Mount Isa Mines undertook to bring together their Human Resource processes and Access Control to improve safety and compliance within the mining operations.

By adopting a combination of manual and automated processes, it is possible to ensure that each time an individual were to attempt entry into an operational area, the system will query a database that checks for the person's compliance status.

The system was built with convenience in mind. Managers have a user-friendly web-based interface to access the approvals database where they can nominate or remove the access rights of an individual at anytime.

Once a manager has requested for access rights to be given to an individual, the system must ensure that this person has all necessary inductions, contracts and management approvals for entry into the specific operational area. This is currently done manually but plans are in place to automate this process in future.

Apart from mitigating risks associated with hazardous areas, such a system can also prevent unauthorised startup of any process or machine, manage access to fuel, control access to and record activities in unmanned stores.

THE "BIG PICTURE" VIEW OF THE OVERALL SYSTEM

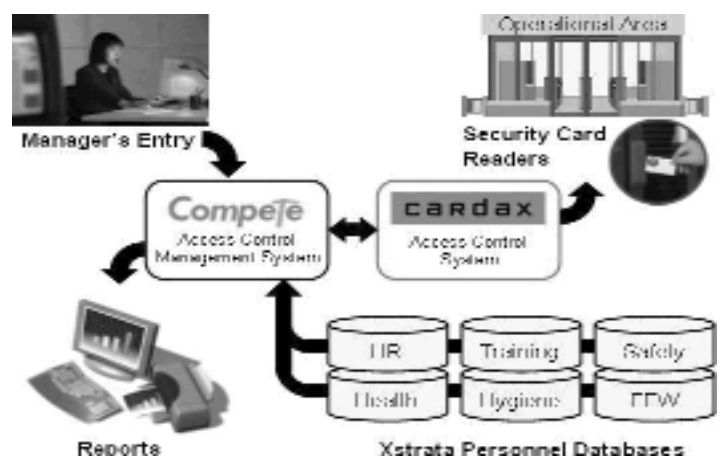


Figure 1 - High-Level Overview of Access Control Integration

PERSONNEL MANAGEMENT REPORTING

By combining the information held within the Compete software database and the Cardax events database, management can be provided with useful reports that include:

What to do when an Accident Happens

Michael Rochester, McCullough Robertson Lawyers

INTRODUCTION

1. Accidents do happen. Often they happen despite the most thorough and comprehensive safety management systems. The split second decision of one person or the failure of a piece of equipment can have serious and ongoing consequences.
2. Our legal system is designed to find the cause of an accident and ultimately attribute blame to something or someone. Therefore, ultimately, the accident and the events surrounding it are likely to end up being discussed in a court room. Although, the threat of litigation should not 'cloud' or preoccupy an internal investigation, it is nevertheless important that companies realise that the steps which they take after an accident will ultimately be subject to scrutiny by a court or tribunal.
3. Liability for any accident stretches beyond just the *Coal Mining Health and Safety Act* ('the Act'). In a case in which the writer was involved, a crane collapsed while carrying concrete. Charges for breach of occupational health and safety legislation were brought but in addition the company was the respondent to:
 - (a) Civil proceedings brought by:
 - The owner of the crane
 - The families of the deceased
 - The employees involved in the accident
 - The head contractor for delay to the construction project; and
 - (b) Other proceedings, being:
 - Criminal proceedings against a company employee for criminal negligence
 - Individual health and safety prosecutions against 2 of its employees; and
 - The coronal inquest.
4. Each of these proceedings involved the same event. However, the allegation made was different as is the standard of proof. In criminal proceedings and proceedings brought under the Act, the prosecutor must establish its case 'beyond reasonable doubt', while in civil proceedings, the plaintiff need only prove its case on the 'balance of probabilities'. Therefore it is conceivable that a company can be found guilty in one proceedings and innocent in the other.
5. In the case referred to above, the accident happened in 1996. The occupational health and safety proceedings were heard in 2003 and sentencing is to occur in September 2004. Therefore, some 8 years after the event, the company is still involved in court proceedings at great internal and external expense. In addition, the company has had to deal with media publicity and the impact upon its reputation.
6. This paper is designed to offer practical advice about how to manage the accident and subsequent legal process.

THE ACCIDENT OCCURS

7. The accident occurs, it is reported and the inspector is on site. The powers of the inspectors are wide. They may:

- (a) Enter and search coal mines and other places
 - (b) Inspect, measure, test, photograph or film any part of the place or anything at the place
 - (c) Take things or samples of things for analysis or testing
 - (d) Require persons to produce and certify documents
 - (e) Take copies of documents
 - (f) Seize evidence (other than documents)
 - (g) Obtain names and addresses of persons who are suspected of committing offences against the Act
 - (h) Require persons to answer questions to help ascertain whether or not the Act is being or has been complied with
 - (i) Require persons to provide reasonable help; and
 - (j) Require persons to attend before an inspector and answer questions. (sections 133, 939, 143, 152, 545 and 157 of the Act).
8. In addition, they have the power to direct that:
 - (a) Mine operations be suspended where the inspector believes that risk is not at an acceptable level
 - (b) Corrective action or preventative action be taken to prevent the risk reaching an unacceptable level
 - (c) The site of a serious accident or high potential incident be isolated and preserved
 - (d) A particular task only be carried out by a person with a particular competency
 - (e) Tests be carried out to determine whether the risk from coal mining operations is at an acceptable level
 - (f) A safety and health management system or principal hazard management plan be reviewed; and
 - (g) An independent engineering study about risks arising out of coal mining operations, the safety of any plant, building or structure at the mine or a serious accident or high potential incident at the mine. (sections 164 to 172 of the Act).
 9. A person to whom a directive is given must comply with it as soon as reasonably practicable. Penalties of up to \$300,000 for corporations and \$60,000 for individuals apply and individuals may be imprisoned for up to 2 years for failing to comply (section 174 of the Act).
 10. Therefore in summary you must:
 - (a) Help
 - (b) Answer questions; and
 - (c) Provide documents.

HELP

11. The extent of your obligation to help depends on whom you are.
12. A site senior executive *must* help an inspector, unless the site senior executive has a reasonable excuse. Other persons at a coal mine must give an inspector *reasonable* help unless that person has a reasonable excuse (section 142).
13. What is reasonable help? The Act does not say. The word therefore

"Getting Smarter" in the Minerals Industry

Carmel Bofinger, Minerals Industry Safety and Health Centre (MISHC), The University of Queensland

The Health Tracking project is one of five projects under the Minerals Industry Cooperation Initiative (MICI). The initiative is sponsored by seven minerals industry companies and the Minerals Council of Australia. The long-term aim of the Health Tracking project is to assess the practicality and possibility of the development of a national epidemiological system to establish the levels of risk to the workforce from occupational exposure to health hazards.

This paper covers the initial focus of the project, which was to identify and analyse the different approaches to occupational health monitoring and surveillance currently in place and identify the influence of the current situation on the potential for a national system.

Stakeholders nationally and in each state were identified and contacted with a request for information. Responses were received from legislators, companies and occupational health specialists.

The extent of the legislative requirements varies from state to state and there are differences in the philosophies behind the schemes and the data collected. The data on occupational injuries and diseases contained in the National Workers' Compensation Statistics database is presented. Limited information from other general population data and from research is also available. Companies generally considered legislative requirements to be the minimum and most companies completed additional health assessment. There is little or no correlation between health information and exposure data either at the Government or company level.

Internal and external factors to the industry were identified that have both positively and negatively influenced current health monitoring and surveillance schemes.

The image of the mining and minerals industry as hazardous to health persists in the community. In order to meet external community expectations of management of health issues, the industry needs to demonstrate proactive involvement in this management.

The establishment of an effective occupational surveillance system would permit the identification of the positive or negative health effects arising from work in the Australian mining and minerals industry and would contribute to the development of effective prevention strategies and policies.

INTRODUCTION

The Health Tracking project is one of five projects under the Minerals Industry Cooperation Initiative (MICI). MICI has five key projects, the Health Project, Lessons Learned, Professional Pathways, MIRMgate and National Minerals Industry Risk Assessment Guidelines. The intent behind the projects is to address factors impacting on the occupational health and safety risks in the industry and to demonstrate, by 2006, that cooperation and the sharing of resources and information between mining companies is achievable and valued. This will form the basis of discussions with other industry stakeholders for a broader cooperative initiative.

The National Occupational Health and Safety Commission (2000) reported

on broad issues of occupational health and safety data in Australia and concluded that the overall health burden of occupational disease was much greater than that caused by injury. Occupational disease was grossly under-reported because the current data systems were ineffective in capturing data on prevailing work environments and establishing relationships with health outcomes. There is no comprehensive system of surveillance for occupational disease or illnesses.

Surveillance is vital to the prevention of occupational diseases, injuries and fatalities. It provides information necessary to draw attention to the magnitude of workplace health and safety problems, to set research priorities and to target and evaluate interventions to improve worker safety and health.

PROJECT DETAILS

The overall aim of the Health Tracking project is to determine the potential to develop a national epidemiological system to establish the levels of risk to the workforce from occupational exposure to health hazards. This system would track workers over their working life within the minerals industry and would provide information to identify current and potential health risks.

This report covers the initial focus of the project. This was to identify and analyse the different approaches to occupational health monitoring and surveillance currently in place and identify the influence of the current situation on the potential for a national system.

The following definitions were used for the project:

- **Health monitoring/health assessment – of the individual**
Health monitoring or health assessments include the measurement of various health indicators and the collection of other information on individuals. This can be pre-employment or on-going routine assessments.
- **Health surveillance – of a group**
Health surveillance is the ongoing systematic collection, analysis and interpretation of data for purposes of improving health and safety. Occupational health surveillance can be viewed as the tracking of occupational injuries, illnesses, hazards and exposures. Occupational surveillance data are used to guide efforts to improve worker safety and to monitor trends and progress over time. This is based on the NIOSH definition (NIOSH, 2001). A surveillance system includes a functional capacity for data collection, analysis and dissemination linked to health programs.
- **Occupational Disease and Illness**
Occupational disease and illness include all health conditions which result from repeated or long term exposure to an agent(s) or event(s), and employment injuries which are the result of a single traumatic event where there was a long latency period, for example, the development of hepatitis following a single exposure to the infection (NOHSC, 2002).
- **Occupational Health**
Occupational health is the promotion and maintenance of the physical, mental and social well-being of workers by preventing and controlling

health-related agents found at US mines. Representative mines were sampled in each mineral commodity. Each mine survey included a questionnaire, chemical inventory and worksite visit.

NIOSH has also produced a surveillance report for the mining industry (NIOSH, 2000). The surveillance report results for the three most common illnesses (based on percent of illness conditions) are shown in Table 1.

| Industry Sector | Most common illness conditions | | |
|---------------------------|--------------------------------|----------------|------------------------------|
| Coal Operators | Pneumoconiosis | Hearing loss | Repetitive trauma |
| Coal Contractors | Heart attack | Pneumoconiosis | Other |
| Metal Operators | Repetitive trauma | Hearing loss | Heat related illness |
| Non-metal Operators | Repetitive trauma | Hearing loss | Dermatitis |
| Stone operators | Repetitive trauma | Hearing loss | Silicosis/ pneumoconiosis |
| Sand and gravel operators | Repetitive trauma | Heart attack | Heat related illness |

Table 1 - Illness conditions by nature of condition based on percent of reports - (USA)

Other Countries

Health surveillance is undertaken in numerous other mining countries including Great Britain, Canada, New Zealand, and South Africa.

In Great Britain, health surveillance is based on a risk management approach and compliance with health and safety law. A review of health surveillance in Great Britain indicated that legislation was the driving force behind health surveillance (HSE, 1996). Health surveillance is a statutory requirement under health and safety legislation for workers who are exposed to some well established health risks and hazardous substance eg asbestos, mine dusts.

Canada has identified the need to put in place a co-ordinated capacity for occupational health surveillance based on the current framework. The current framework has some of the key elements for a national system and the data that does exist needs to be made more accessible to users.

The New Zealand management of hazardous substances includes the need for health surveillance. Information gathered includes exposure, work and medical history, signs and symptoms.

The South African mining industry has a requirement for health surveillance. Records must be kept by the mine for each employee and an annual report prepared analysing the health of employees at the mine (SIMRAC, 2001).

ISSUES ASSOCIATED WITH OCCUPATIONAL ILLNESS OR DISEASE DATA COLLECTION SYSTEMS

The identification of occupational illness and disease is a challenging area. Many of the issues associated with this identification and the collection of relevant useful data were identified by the National Occupational Health and Safety Commission in the report *Possible Application of Disease Minimum Data Set to Future Activities relating to Occupational Disease*, (NOHSC, 2002). The issues relevant to the Australian mining and minerals industry are summarised below.

Identification of occupational illness or disease

Occupational disease and illness surveillance systems are dependent on the successful characterisation of the disease or illness. This is made difficult by a range of factors including:

- Multiple causes of the same disease and connection to exposure
- Long latency
- Diagnostic criteria.

Issues associated with data collections

It is necessary to understand the strengths and weaknesses of any data collection system and not to place unachievable requirements on such

systems. The quality of the data and the completeness of the data are of major importance. If the correct identifying information is used, there can be cross-linking with other sources of data. The data collected for routine health checks is often poor and identifying data may be missing.

Systems that are designed to cover only currently known hazardous exposures or work related disorders may limit the ability to identify new exposure-outcome connections of concern. There is a need to have systems that are flexible.

Other issues that need consideration include:

- Electronic data capture
- Privacy concerns
- Litigation potentials.

Exposure Registers

Ideally, all relevant parameters should be measured in all workers prior to potentially harmful exposures and the relevant parameters checked at appropriate intervals. Exposure monitoring should be completed and representative exposures determined for job categories.

In the case of a previously unknown occupational disease where the exposure component has not been identified, it is unavoidable that counting of cases of disease is the identifier.

However, if the disease is already known to result from a particular exposure then only monitoring disease occurrence is of little benefit in terms of practical prevention. A more useful and ethically justifiable approach is to minimise and monitor the exposure as this should help to minimise the disease. Changes in exposure can be identified immediately allowing early intervention and sensitive monitoring of prevention efforts.

SUMMARY OF CURRENT SITUATION

Mindful of the definition of health surveillance as being -

Health surveillance is the ongoing systematic collection, analysis and interpretation of data for purposes of improving health and safety

if we consider the current systems in terms of the Health Tracking Model shown in Figure 1, we can identify the limitations of the existing situation.

A. Recognition of need for health surveillance

The need for some form of **health monitoring** is well recognised and widely practiced throughout the mining and minerals industry.

Recognition of the need and requirements for health surveillance is less well recognised but is growing.

B. Identification of outcomes required

The Government schemes in place were established as a result of the history of disease in the mining and minerals industry. The focus of company schemes was generally to prevent or rehabilitate injury, or to ensure fitness for duty.

Outcomes for the schemes in terms of identifying occupational disease and illness have not been clearly defined.

C. Identification of minimum data set

As the outcomes of the schemes have not been clearly defined, the type of data collected is often unsuitable or incomplete.

There is inconsistency in the identifying data used and this limits the cross-linking to other data sets. Privacy legislation impacts on the data collected.

D. Data capture mechanisms

Electronic data capture mechanisms are limited for company schemes. Government schemes hold electronic records.

Compatible data capture mechanisms using a consistent data set need to be developed.

HSE E-Learning Induction Framework

Scott Caton, Thiess Pty Ltd

PROBLEM

Traditional site induction processes within the mining industry are often seen by participants as repetitive, time consuming and inconsistent within and across mining companies and contractors. Induction facilitators, predominantly Site Health & Safety Officers, bound by duty of care issues, are forced to deliver standard content to groups that have vastly different needs. The result is a 'one size fits all' induction process which is often viewed as a 'tick the box' process as opposed to an opportunity successfully transfer safety skills and obligations to participants.

A new induction process that is simple, maintains participants' interest and successfully delivers meaningful and relevant information about work safety and related issues to participants, therefore needed to be developed. This was further reinforced through feedback from clients, employees who participated in the traditional induction process and OHS professionals working across Thiess' projects.

Specifically, the key drivers for developing a new process were:

- Safety - the challenge for projects is to ensure necessary messages/information are delivered at the right time to support the learning requirements of the individual. An effective induction should be 'learner-centric', with an appropriate balance between providing content and context, while drawing a picture of practical site application.
- Legislation - **the** training and assessment of 'all mine workers' on mine standard operating procedures prior to commencing a particular task has impacted on the duration and content of traditional inductions. This is most apparent where individuals are required to repeat inductions across the industry (subcontractors).
- Commercial - the Thiess induction process is generally undertaken by site Health & Safety Officers. With the traditional induction, the significant time spent inducting new employees meant that Health & Safety Officers had less time to focus on other proactive site-based activities, such as field monitoring.

SOLUTION

Thiess Mining Induction System (TMIS)

The TMIS is a customised internet-based induction system that was developed in consultation with internal and external stakeholders. Its multimedia capability allows for customised learning content according to site needs and specific tasks. Key features include:

- On and off-site access (through contracted regional providers)
- Trainer facilitated (qualified)
- System assesses inductee responses and returns learner to point of error (if required)
- Auditable training and assessment records database
- Automatic identification and notification of refresher training requirements
- Cross-site recognition of content completed for people working on multiple Thiess projects
- Assessments mapped against priority risk areas in learning content
- Content mapped against Coal Surface Generic Induction, avoiding repetition

- Instructor override to facilitate traditional induction delivery
- Ability to customise communication to specific audiences/classifications
- Internet hosted content allows amendments made at one single point to be immediately implemented across all induction access points
- Multimedia content hosted on site-based servers avoids 'streaming' of data and site bandwidth issues.

The TMIS has been implemented on 80% of Thiess projects, initially piloted at Burton and then progressively implemented across remaining projects. Feedback from participants indicate:

- 95.3% satisfaction rating with the new system (appendix 1 - feedback)
- The process assists in the acquisition and retention of key information
- Less confusion among subcontractors, as content is maintained in a relatively consistent manner and does not have to be repeated across sites.

Lack of computer literacy and associated language/literacy skills of inductees was a concern during the development of the system. This was overcome by providing trainer support and ensuring the system was easy to navigate and use. Participants who had not been exposed to computers previously also indicated that the benefits associated with self-paced learning and flexible access to delivery provided a positive experience.

As the induction covers all aspects of Thiess' operations, the review/implementation process involved feedback from all areas of the site/organisation. Particularly challenging was the alignment of the system with Thiess' internal Information Technology (IT) standards and protocols.

The induction process has led to a complete review of all project Standard Operating Procedures (SOP's), which has itself facilitated improved consistency across our mining operations.

BENEFITS AND SIGNIFICANCE

It is difficult to directly draw a correlation between induction implementation and mining safety performance. However, the simplified TMIS has freed up the time of site Health & Safety Officers and led to greater focus on safety improvement initiatives. This in turn has contributed to a reduction in injury statistics by about 20% over the past 12 months.

Other benefits of the TMIS include:

- Self-paced completion of content enable individuals to focus on 'unfamiliar' areas - learner centric learning
- Standardisation and relevance of training and assessment content, reducing confusion and repetition
- Time and cost efficiencies
- Anecdotally, supervisors report a greater awareness of accountabilities and responsibilities.

To date, approximately 800 people have been inducted using the TMIS. Secondary to the objective of optimising safety performance, it is anticipated the system has collectively contributed to a saving of

Improving Maintenance Access to Heavy Earthmoving Equipment

George Robinson, West Moreton, New Hope Coal Australia

PROBLEM

Heavy earth moving equipment may be supplied with less than adequate access to key maintenance and servicing points.

The problem was identified by New Hope's engineering personnel at pre delivery inspections during fleet upgrade of the equipment listed.

New Hope's personnel collaborated with the suppliers engineering and fabrication personnel to help resolve the identified problems. Less than adequate access onto specific areas on supplied heavy earthmoving machinery for personnel carrying out maintenance/servicing tasks.

Three of the machines that have a number of changes completed are:

- Caterpillar 992G Loader
- Caterpillar D11R Dozer
- Caterpillar 854 Wheeled Dozer
- Caterpillar 24H Grader.

SOLUTION

Finding the solution to the problem was a five step process:

1. Audit all purchases of heavy earth moving equipment prior to delivery, identifying maintenance/servicing tasks and adequacy of access to the task area for personnel.
2. Complete an audit on existing equipment and prioritise the access areas to be addressed according to the hazard presented to personnel carrying out the tasks.
3. Utilise the practical knowledge and experience of our site engineering personnel to apply engineering designs to suit our requirements.
4. Auditing of the modifications to assess if any further hazards had been introduced with the modifications and the benefits in safety terms to the task.
5. Ensure all modifications are carried out to future machinery purchases before delivery.

BENEFITS/EFFECTS

Safer/easier access to specific areas of heavy earthmoving machinery.

Risk reduction while carrying out scheduled, and or breakdown tasks.

The first major benefit is the creation of a safer user-friendly work environment for all personnel that are required to access the equipment. The second is increased availability of the machines, resulting from a reduced reliance on EWPs, platforms and ladders for carrying out many tasks.

SIGNIFICANCE

Access to and around heavy earthmoving equipment to complete maintenance/servicing tasks has always been an ongoing concern of

management, supervisors and the coal face employees at New Hope.

The most significant statistic that prompted the prioritisation of a continual improvement programme, aimed at access to these areas was a review of the incident and accident reports.

An element of the continuous improvement programme was to regularly audit the safety value of the modifications being carried out. These audits revealed a marked decrease in the number of incident/accident reports involving access to equipment as the continuous improvement programme progressed. This information further fuelled the justification of the programme.

TRANSFERABILITY ACROSS INDUSTRY

Principles applied to the modifications carried out to the New Hope equipment can be transferred to almost any piece of equipment in most industries.

Where ever possible the general layout of the equipment was not interfered with but enhanced to create the changes providing a large margin of adaptability.

The utilisation of personnel with many years of practical experience over a wide range of equipment, to design and manufacture the modifications has meant practicality and safety have been enhanced while providing a user-friendly result.

These innovations are adaptable to other areas of industry where maintenance/servicing must be carried out in potentially hazardous areas

New ideas are constantly being trialed in relation to access on heavy earthmoving equipment. All of our innovations are transferable across all areas of our industry elsewhere, wherever earthmoving equipment is used.

INNOVATION AND ORIGINALITY

Several of our innovations have never been used on heavy earthmoving machinery, and others are innovative improvements on what may be available.

It is the collective advancement of these ideas that improves the overall risk reduction of completing scheduled, and or breakdown tasks.

APPENDICES

Appendix 1: Before and after photos

Isolation Indication Lights

Matthew Falzon, Goonyella Riverside Mine, BHP Billiton Mitsubishi Alliance (BMA)

THE PROBLEM

The problem was highlighted by an incident that involved the failure of an isolation device. An electrical tradesperson was carrying out an inspection in one of the MCC (Motor Control Centre) cells. To complete the task safely required operating the main isolator switch on the front of the MCC cell. Upon doing so the next step was to 'test for dead' using a testing device. While testing for dead the tradesperson found that the isolation switch did not operate correctly and therefore the electrical energy source was still present. Exposing the electrical tradesperson to electrical energy was not an acceptable practice.

THE SOLUTION

The solution to reducing the risk level for the above task was the development of a new innovation - the isolation indication lights.

The isolation indication lights package consists of three long-life high intensity red LED lamps and fuses for circuit protection. A standard labelling and layout configuration was agreed upon and a standard drawing created to reflect this.

When the isolation switch is in the OFF position the lamps go out. When the isolation switch is in the ON position the lamps are illuminated.

Any new electrical installation at coal processing plants must include the isolation indication lights and a commitment has been made to retrofit the existing MCC cells each year at the annual plant shutdown. During the last Coal Processing Plant 1 shutdown, 44 MCC cells were fitted out with the isolation indication lamps. The plan is to install the lamps at both processing plants on the Goonyella Riverside Mine lease.



BENEFITS

The main benefits of this innovation are:

- A clear indication is given that the isolation device has operated correctly and all energy sources have been isolated
- Partial failure of a device is indicated. That is if any one of contacts in the isolation device fails to open then the lamp staying illuminated will indicate this
- Standard equipment and labelling is used so that there is no confusion between plants or MCC cells.

SIGNIFICANCE

The failure of an isolation device is now clearly evident and can be addressed safely.

TRANSFERABILITY

This innovation can be easily transferred to most electrical installations across most industries. This is because the package was designed to suit the various types of MCC cell found at the Coal Processing Plants. The cells vary vastly in the age, layout and type of equipment used.



Longwall Roof Support Leg Lifting Device

Darren Morris, Rio Tinto Coal Australia, Kestrel Mine

THE PROBLEM

During longwall relocations at Kestrel Coal anywhere up to 40 longwall roof support legs are removed for refurbishment. It was identified through a risk assessment process that the method for removal of the legs with slings was particularly hazardous as it allowed for uncontrolled swinging motion when the leg was removed from the pocket. This resulted in a high potential for injury to both the worker and bystanders and equipment damage to the leg cylinder, forklift and other components involved in the lift.

THE SOLUTION

After identifying the hazards associated with the method being utilised for removing or installing cylinders from roof support legs during workplace audits and risk assessments, a Kestrel longwall contractor came up with a solution. Together with the Kestrel Longwall Projects Supervisor, they designed a device, which allowed for controlled removal and installation of the longwall roof support leg cylinders. After consulting with the on-site engineering company, design drawings were compiled and the lifting capacity of the device was certified by engineers.

The engineering solution allows for the controlled removal and installation of the cylinder via a mechanical lifting device rated for the required load (refer to pictures). This modification effectively removes the hazards to persons and equipment that had been identified in the earlier risk assessment process. It has also improved the efficiency of the overall task.

Further modification and improvements were made to the device after it was trialled on site for a period of time. This included the addition of handles on the clamping section to remove potential pinch points that were identified by operators when installing the clamp section onto the leg and retaining pins to ensure slippers on fork tynes do not move forward during the removal/installation process.

BENEFITS/EFFECTS

- Reduces potential for personal injury from uncontrolled movement of the cylinder
- Reduces potential for equipment damage from to the cylinder, forklift tynes and other components (ie slings) involved in the lift
- Improves the overall efficiency of the task – time taken to complete the task has reduced
- Cost savings due to decreased equipment damage and increased efficiency
- The device was a "one-off" cost to Kestrel of \$2,500.



SIGNIFICANCE

- The result of the achievement is elimination of the risks associated with uncontrolled movements of a large component weighing approximately 1300kg. These risks included both personal injury and equipment damage.
- After implementation of the original device design the discovery of further potential hazards were identified through Kestrel's local risk assessment and auditing processes. These were rectified with modifications made to the original design.

TRANSFERABILITY ACROSS INDUSTRY

- The device can be used in any underground longwall mine
- The concept can be used in any industry handling large hydraulic cylinders or similar items.

INNOVATION AND ORIGINALITY

- The task has been completed over the last five years at Kestrel without anyone recognising an improved method for completing the task
- A simple, yet effective, solution was found via an engineering device that allows for a safe, controlled, efficient and cost-effective method of removing and installing longwall roof support cylinders during refurbishment.

APPLICATION OF RISK MANAGEMENT PRINCIPLES

- After implementation of the device, the identification of both potential pinch points and of a potential hazard of slippers moving forward on the forklift tynes were identified through Kestrel's local risk assessment and auditing processes. These newly identified hazards were then rectified with modifications made to the original design
- The modifications after finding these additional hazards involved further engineering solutions such as the addition of handles on the clamping device and retaining pins on forklift slippers.

Night Time Identification of Water Carts

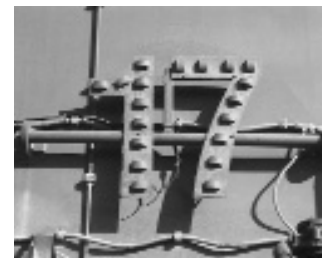
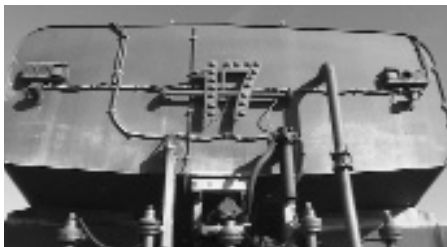
Callide Mine

THE PROBLEM

For years now we have struggled to identify Water Carts from the back at Night. Light vehicles are required to make positive radio contact prior to overtaking. Callide has 4 Water Carts on site and as such it can lead to confusion and potentially dangerous situations when light vehicles are attempting to overtake. The problem is made worse by the poor rear vision from a Water Cart particularly when the sprays are on. This makes it difficult for the operator to see a light vehicle following behind or for the driver of the light vehicle to see past the Water cart for oncoming traffic. This situation has led to several near misses. Previous attempts to address the situation at numerous safety forums had been unsuccessful. In the past Callide has tried reflective tape in the shape of the unit numbers, this works reasonably well for a few days until the tape gets covered with a film of dirt dramatically reducing its effectiveness.

THE SOLUTION

The challenge was to come up with a system that emitted light in the shape of a series of numbers that would be extremely resistant to corrosion given the arduous conditions on the back of a Water Cart and at a reasonable cost. Early in 2003 we decided to trial a system where number approximately 800mm high and 400mm wide were cut from 6mm aluminium plate and mounted on the back of the water tank, numerous amber LED clearance lights were then mounted on the numbers. These lights come with a 1m wire already attached and are fully sealed which should make them very resistant to corrosion, this has proven to be the case as we have only experienced 1 failure in more than 12 months of operation. Each light cost \$14.20 and they can be replaced individually which helps keep cost low. Another benefit of using LED lights is the low power consumption approximately .08 of an amp per light this means even if 20 lights are needed to outline the numbers and they can be connected to the tail lights without the need to change or modify the tail light wiring. The original trial was so successful and the feedback so positive from the operators that we have fitted these illuminated numbers to all of our Water Carts. These pictures show the LED clearance lights and how they have been mounted.



BENEFITS/EFFECTS

The addition of the illuminated numbers has made it extremely easy to identify a Water Cart from the rear even at a distance of 500M, this has allowed drivers following a Water Cart to call up the operator and ask if it is safe to overtake knowing they are talking to the correct operator thus greatly reducing the chance of a collision. Being able to identify the Water Carts from such a distance also alerts the driver of a vehicle approaching from behind that the road surface may be wet and slippery.

SIGNIFICANCE

At Callide there are two mining areas that require coal to be hauled around 10kms these haul roads need to be watered regularly and are also used by production employees as a means of getting to and from their work areas in light vehicles. This interaction of vehicles alone provides a high potential for an incident, add in the problems associated with overtaking an unidentified Water Cart and there is a high potential for a very serious incident. The addition of the illuminated unit numbers has removed the problem of not being able to identify the unit in front of you and significantly increasing the visibility of the Water Carts in night time hours. These LED lights have proven to be a reliable cost effective answer to a long-term problem; the acceptance of the idea from all areas has encouraged others to put forward ideas.

TRANSFERABILITY ACROSS INDUSTRY

This simple cost effective solution could be used in any industry where vehicle visibility and identification are a problem.

INNOVATION AND ORIGINALITY

I believe the combination of the cut out numbers and the LED clearance lights is an original idea as I have not seen nor have I heard of it being used anywhere else. It is innovative in the use of readily available reasonably priced reliable materials and components which when combined more than adequately addressed the problem.

APPLICATION OF RISK MANAGEMENT PRINCIPLES

When assessing the hierarchy of hazard control the initiative sits well with in the hard barrier area, with very little to nil requirements for maintenance and cleaning.

During the development of the new Water Cart number identification system there was no new hazards identified and since in use feedback has also proven the effectiveness of the design.

Potable Water on Draglines

Graham Perkins, BMA Peak Downs Mine

THE PROBLEM

- Safety – persons boarding draglines had to carry water containers that increased injury risk
- Water quality – due to the storage period of tank water it was recognised that an improved treatment system would benefit consumers
- Storage tanks were emptied at frequent intervals regardless of water quantity contained
- A group was formed comprising Dragline Superintendent Graham Perkins, Environmental Officer Sara Raleigh and Spinifex HSE Consultant Lesley Chalkley to design and implement a water treatment system.

THE SOLUTION

- A filter treatment train was specifically built and implemented to remove particulate matter, odour, taste and microbial cells. All six draglines were fitted with the treatment train.

BENEFITS/EFFECTS

- Water quality integrity
- Reduction of dragline downtime to stop for refilling and treatment purposes. Refilling is performed on maintenance days
- Reducing use of potable water by utilising all of the tanked water
- Reduction of risk injury from the manual handling task associated with transferring water containers onto draglines.

SIGNIFICANCE

- Increased dragline performance due to reduced downtime
- Water quality samples have been analysed to demonstrate results are well below that required by the Australian Drinking Water Guidelines.

TRANSFERABILITY ACROSS INDUSTRY

- The system can be used throughout site and across industry where need arises. The system engineering can be modified in capacity to suit most situations.

INNOVATION AND ORIGINALITY

- To enhance the occupational health aspects of employees.

APPLICATION OF RISK MANAGEMENT PRINCIPLES

- The hazard associated with system failure or malfunction is controlled by routine water sampling to identify water quality values. A warning light is fitted to the system and will trigger in the event of a UV lamp failure. The system is maintained on a routine basis.



Removable Return Roller Support Frame

Garry Shields, Goonyella Riverside Mine, BHP Billiton Mitsubishi Alliance (BMA)

THE PROBLEM

The problem was a high risk task within the coal processing area, changing conveyor return rollers, which was undertaken on a continuous basis for maintenance. The task had many different types of hazards including manual handling, working at heights, body positioning and equipment safety.

The method for completing the task of changing conveyor return rollers was as follows:

- Fit the work platform below the relevant work area where the roller is to be replaced
- Harness to be worn and attached to a suitable anchor point by the person working from the platform
- Raise the conveyor belt above the height of the return rollers using a lifting beam and two 3/4 tonne chain blocks
- A minimum of two people to remove the unserviceable roller using a hammer and a podger bar
- A minimum of two people to install the new return roller from the work platform
- Remove the work platform from under the belt and store away for future use
- Progressively remove old rollers and brackets from the conveyor system to the steel scrap yard.

THE SOLUTION

The solution to reducing the high risk level for the above task to a low risk task was the development of a new innovation – the removable return roller support frame.

The new method for completing the task of changing conveyor return rollers is as follows:

- The change-out of the roller can be completed from the conveyor walkway. Undo the two bolts holding the roller support sub-frame
- Lower the support sub-frame from the raised operative position to the lowered position – flat to the walkway
- Slide the roller support frame onto the walkway by pulling the handle
- Remove the unserviceable roller by conveniently lifting from sub-frame mounts
- Install the new return roller by sliding into the sub-frame mounts
- Slide the roller support frame back into the original position by pushing handle
- Lift the roller support sub-frame back into position and re-insert bolts.

BENEFITS

The removable return roller support frame innovation has met and exceeded our initial expectations. This innovation has reduced the previously high risk task of changing conveyor return rollers to a low risk task. The main benefits of this innovation are:

- Reduction in manual handling hazards
- Elimination of working at heights task
- Substitution of steel rollers with poly rollers resulting in less manual handling and the elimination of corrosion problems
- Elimination of unsafe body positioning required to complete task.

SIGNIFICANCE

The significance of this innovation to the business is in relation to reducing injuries and the costs associated with injuries. The new innovation also provides benefits due to the job being completed faster and with less people however this is a secondary benefit and was not the aim of the project.

In summary, the significance of the innovation to the company is in the following areas:

- Eliminate risk of falling from height
- Reduce manual handling risks
- Less reliance on lower level controls, eg. PPE
- Less time exposure.

TRANSFERABILITY

This innovation would be transferable to all operations/equipment with similar conveyor systems. With minor modifications to the support frame the innovation could be more widely transferred to other designs of conveyor systems.

INNOVATION ORIGINALITY

The removable return roller support frame was designed and constructed by site employees and is an original. Currently the company is in the process of obtaining a patent for this innovation.

APPLICATION OF RISK MANAGEMENT PRINCIPLES

The HSEC System at Goonyella Riverside is a risk based system and the risk management principles were considered in the evolution of this new innovation.

Initially, a risk assessment undertaken for the task of replacing conveyor rollers identified the need to find a safer method for completing the task. This began the research and investigation into what could be done.

The hierarchy of controls have been considered in this project.

Elimination – A working at heights task was eliminated as well as the need to manually handle a large platform for placing under the belt.

Substitution – Steel rollers were substituted with lighter poly rollers – 29.6kg per steel roller compared to 7kg per poly roller.

Engineering – Design of a frame to engineer out the unsafe body positioning and working at height risks.

Administration – Work Instruction altered to reflect new work method. Training/communication in this updated work instruction.

PPE – This is the least effective level in the hierarchy of controls. We have eliminated the reliance on PPE by eliminating the need for wearing safety harnesses.

A risk assessment is also required as part of our change management process. The purpose of this risk assessment is to ensure that no new risks are introduced by the changes made with this new innovation.



Safe Effective Clearing of Vibrating Feeders

Tony Engelmann, BMA Saraji Coal Handling and Preparation Plant

THE PROBLEM

What was the problem, Syntron feeders being unblocked in an unsafe manner? Why was it a problem? The amount of time taken to unblock the feeders was lengthy with a person in attendance at all times continually operating the high-pressure water lance. When the feeder became unblocked the initial kick back of the lance from coal falling onto it caused unsafe conditions. Creating a crushing, trapping effect, with a number of incidents recorded. The problem was identified and a risk assessment was conducted.

THE SOLUTION

Max designed and manufactured this device that fits into the existing feeder slots, thus positioning the operator away from the hazardous situation.

BENEFITS/EFFECTS

The device can be installed during operation, or can be left in place, once the operator has installed and activated the high pressure water he / she can remove themselves from the tunnel, noise and vibration and monitor the feed on the conveyor from outside with clear communication with the dozer operator and the control room.

SIGNIFICANCE

This device will enable the operator to significantly reduce the risk of injury in a hazardous situation.

TRANSFERABILITY ACROSS INDUSTRY

This innovative design can be adapted to any draw down or vibrating type feeder where product is prone to blockages.

INNOVATION AND ORIGINALITY

The device is simple to manufacture and apply and can be used with high-pressure air where the product cannot be wet down.

APPLICATION OF RISK MANAGEMENT PRINCIPLES

The hierarchy of control was utilised by opting to engineer out the hazard. A risk assessment was conducted prior to applying the device the only hazard identified was that the valve could be left on and forgotten. Current practice is to maintain positive communication between the dozer and control room operator, once the feeder has been unblocked the operator turns off the high pressure water notify's all concerned and turns off tunnel entry flashing light when exiting.



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