Management Systems for Hazardous Exposures -- Evidence of Failure and Opportunities for Success

B. Ham

Management Systems for Hazardous Exposures — Evidence of Failure and Opportunities for Success

B Ham[1]

ABSTRACT

Coal mining legislation makes frequent reference to 'Safety Management Systems' but there is a chronic shortage of useful guidance material as to how these might be applied to hazardous exposures. Several studies have indicated that for each death that is reported as a result of an industrial 'accident', there are five deaths that caused by occupational exposures. Because the deaths from occupational exposures do not occur on site and often well after employment has ceased, they are generally unreported. Improved access to mortality data from coroners, the Australian Institute of Health and Welfare and superannuation service providers (early claims from death and total permanent disability), has given rise to some analysis of death and disability data that provides evidence that there are emerging opportunities to develop and improve safety management systems for hazardous occupational exposures.

Issues explored include how safety management systems might be developed in relation to dusts and chemicals and other hazardous exposures to ensure the risk of disorders with long latency periods are reliably assessed and the exposures effectively managed. The current standards and guidelines which refer to safety management systems in general or to management of exposure related hazards are examined. Many standards are based on dose-response studies that provide for an acceptable percentage of workers to suffer adverse health outcomes. An alternative management system might be to apply dose-response relations to health surveillance to identify 'at risk' individuals and effectively manage health and related safety risk at an early stage.

INTRODUCTION

The question needs to be asked – 'What should we be doing now to protect our work force from the long-term effects of hazardous exposures that the Western Australian asbestos mining industry should have been doing in 1960 if they were working under our current legislation?'. In a simplistic way, the answer is not complex – we record exposures, we seek data on adverse health outcomes, we examine the dose-response relationship and implement controls which ensure the risk of an adverse health outcome is reduced to an acceptable level.

The reality is that the process is very complex, takes many years to resolve and extraordinarily difficult to implement. In terms of a threat to sustainability, the asbestos mining industry can provide a lesson well worth learning.

LEGISLATION

The Queensland *Coal Mining Safety and Health Regulation 2001*, requires mines to implement a 'safety and health management system for personal fatigue, and other physical and psychological impairment and drugs' in section 42. The regulation also establishes the Coal Mine Workers Health Scheme in sections 44 to 53. This scheme provides for medical practitioners called Nominated Medical Advisers to promote safe operations by assessing workers' fitness to undertake duties without risk to themselves or others. The Scheme also monitors changes in the health of mine workers over time. The key section that relates to hazardous exposures is section 49 which requires:

> *A coal mine's safety and health management system must provide for periodic monitoring of the level of risk from hazards at the mine that are likely to create an unacceptable level of risk.*

The New South Wales coal industry is subject to the Occupational Health and Safety Act 2000 which establishes broad duty of care on all mine operators. When new regulations are finalised, the industry will also be subject to the *Coal Mining Health and Safety Act 2002*. Sections 20 to 22 refer to the obligations of mine operators to prepare, implement and ensure compliance with health and safety management systems. More specifically Section 23 specifies the *Contents of health and safety management system:*

1. *The purpose of a health and safety management system must be to provide the primary means by which an operator ensures the health, safety and welfare of employees and others at a coal operation and of people directly affected by a coal operation, including people who are not at the coal operation.*
2. *A health and safety management system for a coal operation must provide:*
   a. *the basis for the identification of hazards, and of the assessment of risks arising from those hazards, by the operator of the coal operation;*
   b. *for the development of controls for those risks; and*
   c. *for the reliable implementation of those controls.*

REVIEW OF THE EVIDENCE

Kerr *et al* (1996) indicates that disease related deaths are grossly under-reported and that for every reported occupational related death, there may be five further occupational disorder related deaths that are unreported.

The study by Bofinger and Ham (2002) includes 13 000 mortality records of previously registered coal miners in New South Wales and Queensland for 1980 to 2000. The results for 1996 to 2000 are shown in Table 1.

The study shows elevated rates of cancers in Queensland workers and elevated heart disease in NSW miners but the most dramatic difference in the injuries from external causes where NSW is three times higher that the general population and Queensland is ten times higher than the general population. A flaw in the study design is that the age profiles of the miners do not necessarily reflect the age profile of the general population and that the study did not extend to examining age specific death rates.

As a step towards examining death rates, the birth cohort from the death data of New South Wales miners is developed as shown in Table 2. This shows that from a register of 67 785 miners, matches could be found for 12 533 miners (1900 to 2001). The limited percentage of fatalities in the 50 to 80 age groups over the period 1920 to 1950 indicates a significant level of missing data due to poor matching or migration.

1. MAusIMM, Consulting Mining Engineer and Health and Safety Advisor, 39 Victoria Crescent, Toowong Qld 4066.
Email: bruceham@optusnet.com.au

TABLE 1

Analysis of mortality data (1996 - 2000) (after Bofinger and Ham, 2002).

ICD code No	Cause of death category	Number of deaths		% of deaths		
		NSW miners 1996 - 2000	Qld miners 1996 - 2000	NSW miners %	Qld miners %	Australian population %
II	Neoplasms (cancer)	821	113	34	39	31.1
IV	Endocrine, nutritional and metabolic diseases	70	7	3	2	2.5
V and IV	Mental disorders and diseases of the nervous system	64	6	3	2	2.9
IX	Diseases of the circulatory system	940	75	39	26	35.5
X	Diseases of the respiratory system	232	12	10	4	6.4
XI	Diseases of the digestive system	69	4	3	1	n/a
XIX and XX	Injury etc – external causes	149	66	6	23	2.1
	All others	83	10	3	3	19.5
Total	All classes	2428	293		100	

TABLE 2

Birth cohort for New South Wales mortality data.

Birth years	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90+	Total deaths	Register	Deaths %
1900 - 1910	Data missing – persons died prior to data collection					714	1042	267	2023	4553	44
1910 - 1919				1	637	1819	867	10	3334	6759	49
1920 - 1929				520	1817	1357	27		3721	11 241	33
1930 - 1939			234	881	915	29			2059	13 101	16
1940 - 1949		96	331	312	21				760	13 195	6
1950 - 1959	73	171	171	6		Persons still living			421	12 968	3
1960/later	137	78							215	10 521	2
Subtotal	210	345	736	1720	3390	3919	1936	277	12 533	67 785	18

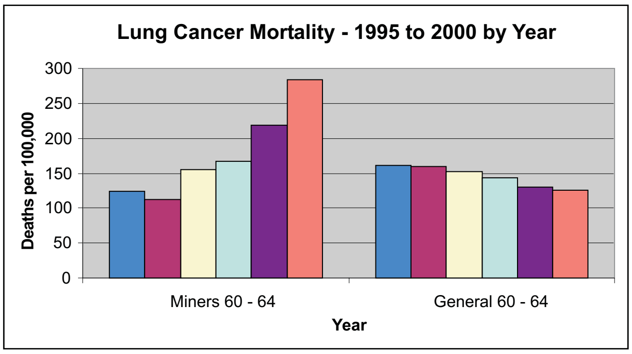

FIG 1 - Lung cancer mortality – 1995 to 2000 by year.

The birth cohort table is used to estimate a survivor population for the calculation of death rates that can be compared with published AIHW data. Rates are calculated as deaths per 100 000 of population and are undertaken by cause, year and age group. The process is used to examine specific disorders such as lung cancer as shown in Table 3 and Figure 1. The lung cancer data indicates that lung cancer is rising in the coal miners while it is declining in the general population. The difference might be attributed to less effective uptake of anti-smoking health promotion in the mining population. There is some opportunity to reduce these errors by applying standardised population techniques.

Analysis of data from the Queensland Coal and Oil Shale Superannuation Fund (QCOS) by Ham (2003) explored early superannuation claims which provided an alternative source of death data. Table 3 shows 51 deaths and 216 cases of total permanent disability. Key issues to rise out of the analysis of the QCOS data are:

TABLE 3

QCOS death and total permanent disability by cause (1998 - 2003).

Cause	Deaths	TPD	Totals	Av Age
Cancer	14	20	34	51
Circulatory disease	12	21	33	53
Ear disorders	0	3	3	
Endocrine disorders	0	3	3	
Infectious diseases	0	5	5	
Musculo-skeletal disorders	0	83	83	47
Nervous/mental disorders	9	43	52	48
Respiratory disease	0	4	4	
External causes	13	32	45	41
Other	3	2	5	
Total	51	216	267	48

1. coding of mortality data grossly under-estimates the contribution of nervous and mental disorders to fatalities; and
2. fatality data does not account for the wide spread of total permanent disability suffered by mine workers.

An alternative approach to health performance indicators is to examine the median age of death by cause and group. This overcomes reliability issues with the estimation of population when calculating mortality rates. The data is shown in Table 4.

TABLE 4

Analysis of median age from mortality data (1996 - 2000).

ICD code No	Cause of death category	Median age at death			
		NSW miners	Qld miners	Qld miners – QCOS	Australian population
II	Neoplasms (cancer)	70	61	51	71
IV	Endocrine, nutritional and metabolic diseases	72	64		74
V and IV	Mental disorders and diseases of the nervous system	71	na	48	42
IX	Diseases of the circulatory system	74	59	53	76
X	Diseases of the respiratory system	73	72		77
XI	Diseases of the digestive system	68	n/a		n/a
XIX and XX	Injury, etc – external causes	48	33	41	39
	All others	75	67		n/a

TABLE 5

Comparisons for mortality parameters.

Data element	Strengths	Weaknesses
Reported fatalities	Quick identification and action	Poor indicator of underlying problems – particularly long-term conditions Limited usefulness in terms of risk identification and management
Proportion of deaths by type extracted from industry mortality data	Targets high risk areas	Sensitive to variation in age distribution between target group and general population
Death rates extracted from industry mortality data	Targets specific age groups and causes – monitors temperal variations	Reliability issues in denominator Method issues between registered group, birth cohort and survivor cohort
Median age of death by cause	Simple and reliable	Sensitive to variation in age distribution between target group and general population

The younger ages in cancer and circulatory disease in Queensland miners may be partly explained by younger age distribution of the Queensland population. Follow-up work to correct for the age difference is warranted.

A key issue that arises out of the review of the health outcome evidence is the difficulty in measuring and quantifying adverse health outcomes. Some of the alternative approaches and their strengths and limitations are shown in Table 5.

STANDARDS ON OHS MANAGEMENT SYSTEMS

Occupational Health and Management Systems Standard – AS 4804 2001

While the Standard is lacking in detail, it provides a useful structure for the development of occupational health and safety management systems. The key components are:

- OHS policy,
- planning consultation, communication and reporting,
- documentation,
- document and data control, and
- measurement and evaluation.

The policy needs to be authorised and visibly supported by senior management and clearly state the OHS objectives and a commitment of improving OHS performance. The policy should:

- recognise the nature and scale of the organisation and its health risks;
- include a commitment to improving OHS and the OHS system;
- include a commitment to comply with relevant legislation and standards;
- be documented, implemented, maintained and communicated to all employees and contractors;
- be available to interested parties; and
- be reviewed periodically to ensure it remains relevant and appropriate to the organisation.

Planning needs to cover the identification of hazards and the assessment and control of risks. Planning also needs to take into account training, succession, contractors, legal and other requirements. 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:

- OHS performance including results of reviews and audits;
- reporting of incidents and failures;
- reporting on hazard identifications; and
- 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.

Western Australian Department of Mines and Petroleum Resources (MPR)

CONTAM program – (MPR) (2000)

The objectives of the upgraded CONTAM system are:

- to provide comparative occupation group, industry sector, and industry exposure data and enable trend analysis of this data;
- to provide a reliable basis for future studies into the long-term health effects of exposure of mine workers to atmospheric contaminants; and
- 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:

> *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.*

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.

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:*
>
> - *to assess the health status of all mining industry employees on a regular basis;*
> - *to analyse collected data to detect adverse health effects at the earliest opportunity;*
> - *to enable appropriate and timely corrective action to be taken in order to safeguard the health and well being of mining industry employees; and*
> - *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 health 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. Further information on monitoring is provided in Biological Monitoring Guidelines by Department of Mines and Petroleum Resources (WA) (1997).

Coal industry employees' health scheme

The Queensland Coal Board (1993 revised 1998) published an instruction manual to assist persons and organisations who had obligations within the health scheme. The Australian Industrial Relations Commission (AIRC, 2004) determined that when the instruction manual was referred to in an industrial agreement, it constituted part of the mines health and safety management system. Ham (2000) documented the evolution of the health scheme in some detail.

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 6.

TABLE 6
Common exposures and guidelines/standards.

Exposure	Guidelines
Cancer	La Dou (1994)
Diesel particulates	AIOH (2004)
Dust	Standards Australia (1997 and 1999) AS 2985-2004, AS 3640-2004
Heat	AIOH (2003)
Noise	NOHSC:2009 (2004), Pennington (2002)
Stress/mental disorders	Bos *et al* (1999)
Whole body vibration	McPhee, Foster and Long (2001)
Commercial vehicle drivers	Austroads Inc (2003)

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 per cent of the exposure standard. He suggests that in this case, one sample per shift per ten workers should be undertaken each month.

An alternative approach was suggested by Ham (2002) who suggested that the frequency of sampling should be determined by both the need for accuracy in the determination of exposure and the amount of variation in the regular sampling program. Using the example of respirable dust monitoring, high variation in dust estimates was acceptable if the exposures were found to be low, but for positions where exposures approached the statutory limits, more frequent sampling would be required to obtain a reliable estimate of cumulative dust exposure. Mines with high variations should undertake more sampling that mines where the range of exposure was relatively small.

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 (NTIS, 2005) have been developed recently in health and hygiene management systems as shown in Table 7.

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 8.

TABLE 7

Black coal competency units on health and hygiene management.

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 and Underground Coal Certificate IV and 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 8

Contents of Trainers Guide on implement and monitor health and hygiene management systems (after Ham, 2004b).

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	Ionizing and non-ionizing 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	

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 (1994) 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 risk assessment and safety management framework, Ham (2004a) developed concepts for the following:

- comparable health outcome measures;
- definition of unacceptable health outcomes;
- measures for assessing the risk;
- trigger levels for various interventions in response to rising risk;
- development of interventions; and
- agreement between management and workers on the monitoring, the triggers and interventions.

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 9.

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 three per cent per year. For example a 56 year old who contracts dust related emphysema would lose (20×0.5) years. After applying the discount factor, the net loss of 7.6 years.

This unit as developed to compare the impact of various disorders in a single population and to compare populations for the distribution of disease burden. Morfield (2004) discusses how the approach may be used to analyse the impact of a particular disease on a particular cohort in comparison to a control group. In this particular application, the burden of disease in the study

TABLE 9

Disability weightings for healthy years of life lost.

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

group is assessed on the basis of variation from the life expectancy of persons who suffer that particular cause of death in the control group.

WORKED EXAMPLE – BURDEN OF DISEASE FROM MORTALITY DATA

In order to demonstrate the application of life years lost with mortality data, the following example is used. Assume there is a case controlled of miners in a particular setting and an unexposed control group. There are 1000 cases in each group. In order to counter errors due to improving health standards over time, the control group would have the same birth date profile as the exposed group.

To compare the relative burden of disease in the exposed group, a comparison is made of total years of life lost (YLL total), see Table 10.

YLL (a) (Cause X) = (Control cases cause X) × (Age control - age exposed)

YLL (b) (Cause X) = (Exposed cases cause A - Control cases cause A) × (Age all control - Age exposed cause A)

YLL total (Cause X) = YLL (a) + YLL (b)

TABLE 10

Example of mortality study results (from Table 3).

Cause of death	Control group		Exposed group				
	No	Median Age	No	Median Age	YLL (a)	YLL (b)	YLL Total
Cancer	311	71	340	70	311	128	439
Heart disease	355	76	390	74	710	14	724
Mental disorders	29	42	30	71	-841	3	-838
Respiratory	64	77	100	72	320	86	406
Trauma	21	39	60	48	-189	1030	841
Other causes	220	84	80	32	11 398	-5965	5433
All deaths	1000	74.4	1000	67.4	7000	0	7005

The nature of data that can be extracted using this approach is that in the example, other causes is far the highest and warrants investigation. After that, trauma followed by heart disease would be key areas of focus while cancer and respiratory have a lower impact and would be secondary targets. The data suggests that miners mental health is better that expected in the general population. The mental health data contrasts with results found from the QCOS data in Table 3. This is an issue for future investigation.

ASSESSMENT OF RISK

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, Donoghue (2001) suggests that an acceptable occupational probability of death of is 10^{-5} per year which is one tenth of the general community risk due to motor vehicle accidents. By combining this with the concept of years of life lost, an acceptable risk (probability times outcome) to a 25 year old who has a life expectancy to 75 years is 5×10^{-4} years life lost. For example a 56 year old who contracts mild hearing loss would loose (20 × 0.01) years. After applying the discount factor, the net loss of 0.15 years lost quality adjusted. This is two orders of magnitude less that the standard suggested by Donoghue, but it is in line with the minimum payouts under the workers compensation arrangements.

The evidence indicating the risk of an unacceptable outcome may take a number of forms. Firstly, dose-response studies may be used to predict long-term outcomes and when the trigger health parameter level is reached, exposed persons should be withdrawn from the hazardous environment. A second approach is to use studies that monitor cumulative dose and assess these against expected final health outcomes to trigger some intervention. This is the approached used in radiation cancer related studies.

MANAGEMENT OF UNACCEPTABLE HEALTH OUTCOMES

The first step is to define what is an acceptable health outcome from and occupational health and safety perspective. If we work from the perspective that the mining industry should be free of occupational injury or disease (Department of Natural Resources and Mines, 2004), then it is acceptable if miners suffer injury and disease in line with community norms. This include freedom from work related disease and injury, but also includes the concept that life expectancy should not be reduced as a result of occupational exposure (Rudd, 1998).

What is unacceptable then is predictable and preventable injury or disease that can be attributed to some element of the work method, work arrangement and work environment. Lost time injuries are usually considered to be work related. It is more difficult to establish that injuries suffered outside the work environment are work related and some statistical analysis of the events, exposures and injury is needed to establish that it is a work related disorder. It is plausible to associate fatigue related travel injuries and mental disorders to extended shifts and night work.

Prolonged exposure to coal and silica dust and fumes are known to be associated with various forms of respiratory disease. The most common are coal workers pneumoconiosis (CWP) and silicosis. There is an argument low rates of CWP and silicosis demonstrate the current dust management systems are effective. The work on dose-response studies by deKlerk and Musk (1998), Coggan and Taylor (1998) and Rudd (1998) provide evidence that dusts significantly contribute to chronic bronchitis, emphysema and lung cancer that reduces life expectancy.

The problem of defining work related disease is more difficult when it comes to disorders which are common in the general community. Respiratory disease is common in the general population and is often fatal in the elderly. These disorders are exacerbated by the recreational habit of tobacco smoking. Smokers then are a higher risk group and thus it may be prudent to treat their respiratory disease risk in a different manner to the non-smoking population.

Mental disorders occur in the general population. The association of mental disorders with the work environment is more challenging and there are often few warning signs of early progression of potential serious and life threatening disorders. Guidelines on fatigue management (Department of Natural Resources and Mines, 2001) identify mental health issues such as stress, anxiety and depression as risks associated with night shifts and extended shifts but few management strategies are available to effectively manage these risks. The guideline notes that:

> *Those already suffering from digestive disorders, diabetes, heart disease, psychological problems, alcohol and drug addictions and chronic sleep disturbances face additional burdens.*

It is possible that an effective health and safety management system should provide for special arrangements for the significant number of individuals who may fall into the above groups.

The issue is that occupational disease is no longer confined to strictly exposure related disorders but includes numerous common disorders that exhibit higher rates of incidence in the coal mining cohorts that in a non-exposed population. This conclusion has some fundamental implications for the design of health and hygiene management systems. Where a specific exposure may contribute to the development of a disorder, there is a case that a health surveillance program should collate data on the cumulative exposure and assess the risk of a related adverse outcome by comparing the cumulative exposure with known dose-response statistics. Furthermore, the program should also examine health indicators that provide early warning of a pending disorder.

For disorders where there are no reliable indicators of deterioration of health, there is a case that a trigger level based on cumulative exposure should be set based on past or future dose-response studies. Such trigger levels need to be set based in epidemiological studies that reliably determine that the rising risk of an adverse heath outcome is predicted by increasing cumulative exposure. Workers, employers and regulators may set these levels by negotiation.

CONCLUSIONS

The detail of components of health and hygiene management systems are yet to be fully developed. The concept of combining health surveillance, cumulative exposure monitoring and analysis of health outcomes has merit as a basis for exposure based risk assessment and management but will be challenging to implement.

The notion of disability adjusted life-years lost provides a means of comparing short- and long-term occupational disorders of varying severity. When used cautiously and supported by good epidemiology, this process provides an effective measure of assessing and comparing disorders with long latency periods.

The emergence of new risks with long latency periods may be first indicated by subtle changes in mortality data. Several approaches have been demonstrated including age specific death rates, life years lost and proportions of fatalities.

There are opportunities to better develop concepts of the application of trigger levels to change in health parameters in health surveillance and in cumulative exposure monitoring. The process of developing these concepts requires barriers due to confidentiality, discrimination and competitive short interests to be overcome. While many of these activities may be contacted out to researchers and health professionals, The complexity of mining OHS management systems is such that high level mining OHS professionals are needed to oversee data collection, analysis and setting and implementation of trigger levels. This issue is sensitive from an industrial relations perspective and a level of tripartite participation is necessary for settlement to be reached.

BIBLIOGRAPHY

Australian Industrial Relations Commission, 2004. Decision – CMFEU v North Goonyella [online]. Available from: http://www.airc.gov.au/documents/other/other_decisions.html. PR943615 - C2004/1550 [Accessed: 17 February, 2004].

Australian Institute of Hygienists (AIOH), 2003. Heat stress standard and documentation developed for use in the Australian Environment, Melbourne.

Australian Institute of Hygienists (AIOH), 2004. A guideline for the evaluation and control of diesel particulate in the occupational environment, Melbourne.

Austroads Inc, 2003. Assessments for fitness to drive.

Bofinger and Ham, 2002. Heart disease risk factor in coal miners, Coal Services Health and Safety Trust research report, Report library.

Bos, N, Farr, T, Grassick, P, Holroyd, L and Vanderkruk, R, 1999. *Workplace Health and Safety Handbook*, Fifth Edition (Safe Work College: Brisbane).

Coal Mining Safety and Health Act, 2002. Parliamentary Counsel's Office – New South Wales Legislation [online]. Available from: <http://www.legislation.nsw.gov.au> [Accessed 9 July 2004].

Coggan, D and Taylor, A N, 1998. Coal Mining and chronic obstructive pulmonary disease: a review of the evidence, *Thorax*, 53:398-407.

Davies, B, Glover, D and Manuell, R, 2001. *An Occupational Hygiene Manual for the Coal Industry*, Revision 1 (Coal Services Health and Safety Trust).

de Klerk, N H and Musk, W, 1998. Silica, compensated silicosis and lung cancer in Western Australian gold miners, *Occupational Environmental Medicine*, 55:243,248.

Department of Mines and Petroleum Resources (WA), 1997. Biological monitoring guidelines.

Department of Mines and Petroleum Resources (WA), 2000. CONTAM procedures, Perth.

Department of Mines and Petroleum Resources (WA), 2002. Health Surveillance program for mine employees – approved procedures, Perth.

Department of Natural Resources and Mines (Qld), 2001. Guidance notes for management of safety and health risks associated with hours of work arrangements at mining operations, Brisbane, p 7.

Department of Natural Resources and Mines (Qld), 2004. Review of the health surveillance unit, Brisbane, p 60.

Donoghue, A M, 2001. The calculation of accident risks in fitness for work assessments: diseases that can cause sudden incapacity, *Occupational Medicine*, 51(4):266-271.

Grantham, D L, 1994. *Occupational Health and Hygiene – Guidebook for the WHSO*, Brisbane.

Grantham, D L, 2001. *Simplified Monitoring Strategies* (Australian Institute of Occupational Hygienists: Melbourne).

Ham, B W, 2000. The role of the health surveillance program in the Queensland coal mining industry, Thesis for the award of Master of Applied Science (OHS), School of Public Health, Queensland University of Technology.

Ham, B W, 2003. Counting the cost of injury and poor health – an analysis of QCOS data, in *Proceedings Queensland Mining Industry Health and Safety Conference*, pp 100-101 (Queensland Mining Council: Townsville).

Ham, B W, 2004a. Planning for a healthy future, in *Proceedings Coal 2004: Fifth Underground Coal Operators' Conference*, pp 49-56 (The Australasian Institute of Mining and Metallurgy: Illawarra Branch).

Ham, B W, 2004b. *Trainer Guide for Implement and Monitor Health and Hygiene Management System (NMCG1007A)* (NSW Department of Education and Training).

Kerr, C, Morrell, S, Taylor, R, Salkield, G and Corbett, S, 1996. Best estimate of the magnitude of health effects of occupational exposures to hazardous substances, Worksafe Australia.

La Dou, J (ed) 1994. *Occupational and Environmental Medicine* (Appleton and Lange: Stamford).

Mathers, C, Vos, T and Stevenson, C, 1999. The burden of injury and disease in Australia, Australian Institute of Health and Welfare, Cat No PHE 18, Canberra.

McPhee, B, Foster, G T and Long, A, 2001. *Bad Vibrations – A Handbook on Whole Body Vibration Exposure in Mining,* p 25 (Joint Coal Board Health and Safety Trust: Sydney).

Mines Occupational Health and Safety Advisory Board (MOSHA), 1999. Guideline – Mines Safety and Inspection Act 1994 – General duty of care, Perth.

Mines Occupational Safety and Health Advisory Board (MOSHA), 1999. Mines Safety and Inspection Act 1994, General duty of care in Western Australian mines [online] Available from: <http://www.doir.wa.gov.au/safetyhealthandenvironment/mining>.

Mining Industry Safety and Health Centre, 2004. Mirmgate [online]. Available from: <http://www.mishc.uq.edu.au/>.

Morfeld, P, 2004. Years of life lost due to exposure: causal concepts and empirical shortcomings, *Epidemiologic Perspectives and Innovations*, 1:5. Available from: <http://www.epi-perspectives.com/content/1/1/5>.

National Occupational Health and Safety Commission (NOHSC). Exposure standard for atmospheric contaminants in the occupational environment NOHSC.

National Occupational Health and Safety Commission (NOHSC), 2004. National code of practice for noise management and protection of hearing at work [NOHSC:2009 (2004)], Third Edition.

National Training Information Service, 2005. Coal Training Package [online]. Available from: <http://www.ntis.gov.au>.

Occupational Health and Safety Act, 2000. Parliamentary Counsel's Office. – New South Wales Legislation [online]. Available from: <http://www.legislation.nsw.gov.au> [Accessed 17 February 2004].

Pennington, N, 2002. Working safely with hearing loss, Coal Services Health and Safety Trust.

Queensland Coal Board, 1993. *Coal Industry Employees' Health Scheme Instruction Manual.*

Queensland Government, 1999. Coal Mining Safety and Health Act 1999.

Queensland Government, 2001. Coal Mining Safety and Health Regulations 2001.

Rudd, R, 1998. Coal Miners respiratory disease litigation, *Thorax*, 53:337-340.

Scannell, K, 2001. Noise awareness and hearing protection training for the Australian Coal Industry, Coal Services Health and Safety Trust.

Standards Australia, 1997.Occupational health and safety management systems – general guidelines on principles, systems and supporting techniques. AS 4804:1997.

Standards Australia, 1999. Risk management, AS/NZS 4360:1999.

Standards Australia, 2004a. Workplace atmospheres – method for sampling and gravimetric determination of respirable dust, AS 2985-2004.

Standards Australia, 2004b. Workplace atmospheres – method for sampling and gravimetric determination of inhalable dust, AS 3640-2004.