



OCCUPATIONAL HYGIENE IN THE COAL INDUSTRY – A CASE STUDY

**FINAL REPORT TO THE HEALTH & SAFETY
TRUST**

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February 2004

INTRODUCTION

Occupational hygiene issues such as respirable dust and diesel exhaust fumes are well known to those within the coal industry but many other occupational hygiene issues are not well understood and thus not adequately evaluated. Consequently, the aim of the project was to quantify the effect on the workforce of all occupational hygiene issues identified at the BHP Billiton Illawarra Coal mines in a systematic and scientific manner and to develop a management plan to control unacceptable exposures.

As such a task is a significant undertaking, a Working Group, comprising workforce and management representatives, site safety/training officers plus external occupational hygiene and medical professionals, was formed to identify potential issues, assign priorities to each issue, evaluate the level of risk, develop control strategies and to oversee the implementation of any agreed controls. This process identified nineteen (19) key issues and a procedure to evaluate each on a risk-based priority over a three to five year period.

The first issues that were evaluated were dust (respirable and inhalable), noise and hazardous substances. A statistically based monitoring programme has been implemented to monitor the workplace of all work groups within BHP Billiton Illawarra Coal operations for dust and noise. Sampling has been conducted using a random sampling schedule over a 16-week period (January – May 2003) on all shifts and days of the week.

Evaluation of the other identified issues is continuing in accordance with the level of risk identified by the Working Group.

Results obtained to date suggest significant occupational hygiene issues exist within the underground coal mining industry, eg excessive noise exposure. Measures to reduce employee exposure to excessive levels of chemical or physical agents are being investigated and implemented if effective.

PROJECT TEAM

In order to ensure all potential issues were identified and evaluated in an effective manner, a Working Group was formed to overview the project. The Working Group consisted of the following members:

S McFadden	-	Manager Health & Safety BHP Billiton Illawarra Coal (Chairperson)
P Eade	-	Management Representative BHP Billiton Illawarra Coal
G Horne	-	Local Check Inspector CFMEU
V Mann	-	HSE Systems Co-ordinator
D Moore	-	Safety Training Co-ordinator West Cliff Colliery
M McColl	-	Safety Training Co-ordinator Elouera Colliery
R Myatt	-	Safety Training Co-ordinator Appin Colliery
S Faulkner	-	Safety Training Co-ordinator Dendrobium Mine
T Howard	-	Safety Training Co-ordinator West Cliff Washery
R Fermino	-	Manager Dendrobium Washery
R Bowman	-	Coal Preparation Manager No. 1 Seam – West Cliff Colliery
G Viset	-	Occupational Physician BHP Billiton – Illawarra Coal
B Davies	-	Occupational Hygienist, AEHS Pty Ltd

INITIAL PROJECT PLAN

Following the initial meeting of the Working Group it was resolved that the size of the project dictated that a formal approach to the exercise was necessary to ensure all issues were adequately evaluated. In this regard the following project plan was agreed and implemented.

The project plan actions were:

1. Identify all potential occupational hygiene issues within BHP Billiton Illawarra Coal.
2. Evaluate each issue on a risk-based priority.
3. Where appropriate, monitor employee workplace exposures using internationally recognised exposure assessment techniques.
4. Investigate all unacceptable exposure groups.
5. Develop an appropriate management plan to control unacceptable exposures.
6. Implement and maintain effective control technologies.
7. Regularly review the process.

Using the above philosophy, a list of potential issues was identified and risk-ranked by the working party.

IDENTIFIED ISSUES

Using the knowledge base of the Working Group, a total of 19 issues were identified as having some potential impact on employees. These issues were then risk-ranked using the BHP Billiton risk table matrix (Figure 1). In cases of disagreement on risk, the issue was discussed and a consensus reached.

		CONSEQUENCE SEVERITY					Factor	
		Low	Minor	Moderate	Major	Critical		
LIKELIHOOD	1 or more times a year	Almost Certain	High 100	High 300	Extreme 1,000	Extreme 3,000	Extreme 10,000	100
	Occurs once every 1-10 years	Likely	Moderate 30	High 90	High 300	Extreme 900	Extreme 3,000	30
	Occurs once every 10-100 years	Possible	Low 10	Moderate 30	High 100	Extreme 300	Extreme 1,000	10
	Occurs once every 100-1,000 years	Unlikely	Low 3	Low 9	Moderate 30	High 90	Extreme 300	3
	Occurs once every 1,000-10,000 years	Rare	Low 1	Low 3	Moderate 10	High 30	High 100	1
		Factor	1	3	10	30	>100	

Figure 1

This process resulted in the following list of potential issues, a risk ranking with no control and current controls, together with a schedule for evaluation and control (Figure 2).

Rank	Issue	Ranking No Controls	Ranking Current Controls	Schedule For Control	
1	Dust – Respirable/Silica Dust – Inhalable	E	M	1 Year	
2	Noise	E	H	1 Year	
3	Hazardous Substances	H	H		
4	Microbiological Agents - Legionella - Recycled Water - Shower/Drinking Water - Sanitation	H	M	1-3 Yrs	
5	Organic Vapours - PUR - Steam Gas - Fuel Vapours	H	M		
6	Confined Spaces	E	M		
7	Vibration	H	M		
8	Welding Fumes	H	M		
9	Diesel Particulate	H	M		
10	Gases - Diesel Exhaust Gases - Shot Firing - Gas Drainage Drilling	H	L		
11	Soluble Oil	M	L		
12	Asbestos (old bldgs)	H	L		>3 Yrs
13	Heat Stress	M	L		
14	Radiation	M	L		
15	Synthetic Mineral Fibres	M	L		
16	Lighting	M	L		
17	Electromagnetic Fields	M	L		
18	PCBs	L	L		
19	Moulds (Fungi)	L	L		

Figure 2

Some issues (eg diesel particulate), were rated by the Working Group below that expected due to a belief that good controls were either in place or currently being implemented. Consequently, other operations repeating this exercise would have to factor in local conditions when developing their risk profile.

As the first step in the evaluation phase the Working Group decided to focus on monitoring all employee exposures to respirable dust, respirable silica, inhalable dust and noise.

Once this was completed further issues would be evaluated.

METHOD OF EXPOSURE ASSESSMENT

The principles of workplace exposure assessment were adopted (Grantham 2001, AIHA 1998) whereby the total workforce (excluding office staff) was divided up into homogeneous exposure groups (HEGs) or groups of similar exposure. The division into individual groups was arbitrary but used site knowledge and employee perceptions. A comprehensive sampling programme was developed aimed at ensuring one result in the top 10% of exposures with 95% confidence. This translated into a 16-week sampling programme covering all days and shifts of the week. In total, 1,224 individual personal samples have been collected at three coal mines and two coal preparation plants.

Details of the HEG composition and number of samples collected are provided in Figures 3 and 4.

Operation	HEG	HEG Composition
Appin Colliery	A1	Longwall
	A2	Panel
	A3	Methane Drillers
	A4	Tailgate Workers
	A5	Outbye Workers
	A6	Dyke
	A7	Surface Workers
	A8	Special Groups
Dendrobium Coal Preparation Plant	DW1	Shift Operators
	DW2	Mobile Equipment Operators
	DW3	Day Maintenance
	DW4	Management

Operation	HEG	HEG Composition
Elouera Colliery	E1	Longwall
	E2	Panel
	E3	Belts
	E4	Transport Operators
	E5	General Underground
	E6	Yard Personnel
	E7	Workshop Personnel
West Cliff Colliery	W1	Longwall
	W2	Panel
	W3	Belts
	W4	Outbye Workers
	W5	Methane Drillers
	W6	Surface Workers
West Cliff Coal Preparation Plant	WW1	Mobile Plant Operators
	WW2	Operators
	WW3	Materials Handling
	WW4	Control Room
	WW5	Haulage Drivers

Figure 3

Location	No. of HEGs	No. of Samples
Appin Colliery	8	342
Dendrobium Coal Preparation Plant	4	120
Elouera Colliery	7	294
West Cliff Coal Preparation Plant	5	174
West Cliff Colliery	6	294
Total Number of Workers Assessed	852	1,224

Figure 4

All sampling was performed by Coal Services Health personnel using the following procedures.

Respirable Dust	-	Australian Standard AS2985
Inhalable Dust	-	Australian Standard AS3640
Noise	-	Dosimetry (Larson Davis model 700)

Analysis of the respirable dust samples for respirable silica was performed by a National Association of Testing Authorities (NATA) registered laboratory.

All exposure data was corrected for extended shifts and statistically evaluated against workplace exposure standards (3.0 mg/m³ for respirable dust, 85 dBA for noise). In the case of inhalable dust a best practice standard of 10 mg/m³ was adopted as no statutory level currently exists for coal mines. The decision criterion for compliance was that the geometric mean of a parameter must be below the exposure standard of the HEG being evaluated (BHP Billiton 2002).

DUST AND NOISE RESULTS

The results of sampling for respirable and inhalable dust, together with noise exposure, are provided in Appendix 1. A summary of exposures for each HEG (Geometric Mean) are provided in Figure 5.

Mine/Operation	HEG	HEG Composition	GM (mg/m ³) Respirable Dust	GM (mg/m ³) Inhalable Dust	GM dB(A) Noise (Leq ₈)
Appin	A1	Longwall	0.8	13.9	90.3
Appin	A2	Panel	0.6	13.3	88.8
Appin	A3	Methane Drillers	0.2	3	86.9
Appin	A4	Tailgate Workers	0.3	11.6	93.2
Appin	A5	Outbye Workers	0.6	5.4	89.6
Appin	A6	Dyke	0.5	15.9	94.9
Appin	A7	Surface Workers	0.2	0.7	90.7
Appin	A8	Special Groups	0.7	6.4	83.1
Dendrobium Coal Prep Plant	DW1	Shift Operators	0.2	1.5	86.2
Dendrobium Coal Prep Plant	DW2	Mobile Equip Operators	0.1	0.4	83.9
Dendrobium Coal Prep Plant	DW3	Day Maintenance	0.2	1.2	89.3
Dendrobium Coal Prep Plant	DW4	Management	0.1	0.7	79.5

Mine/Operation	HEG	HEG Composition	GM (mg/m ³) Respirable Dust	GM (mg/m ³) Inhalable Dust	GM dB(A) Noise (Leq ₈)
Elouera	E1	Longwall	0.6	12.2	91.4
Elouera	E2	Panel	0.5	5.2	89.9
Elouera	E3	Belts	0.2	2.3	86.7
Elouera	E4	Transport Operators	0.3	2.7	88.2
Elouera	E5	General Underground	0.3	4.1	90.8
Elouera	E6	Yard Personnel	0.1	0.8	91.5
Elouera	E7	Workshop Personnel	0.1	0.8	82.9
West Cliff Coal Prep Plant	WW1	Mobile Plant Operators	0.2	0.7	89.3
West Cliff Coal Prep Plant	WW2	Operators	0.2	1.6	90.8
West Cliff Coal Prep Plant	WW3	Materials Handling	0.1	0.7	91.4
West Cliff Coal Prep Plant	WW4	Control Room	0.1	0.3	80.4
West Cliff Coal Prep Plant	WW5	Haulage Drivers	0.1	0.3	86.8
West Cliff	W1	Longwall	0.9	9.8	90.8
West Cliff	W2	Panel	0.6	13.7	90.8
West Cliff	W3	Belts	0.4	5.8	90.7
West Cliff	W4	Outbye Workers	0.7	9.4	90.6
West Cliff	W5	Methane drillers	0.5	3.4	88.9
West Cliff	W6	Surface Workers	0.3	0.9	85.1

Figure 5

The results indicate that respirable dust is not a significant issue, which is consistent with Coal Services Pty Ltd (Joint Coal Board) atmospheric monitoring and medical surveillance. Monitoring for respirable silica was only performed where abnormal conditions existed (eg mining stone roof) as the parent coal is known to be low in silica. Results of samples analysed for silica has shown levels to be well below the current exposure standard of 0.15 mg/m³ (typically less than 0.05 mg/m³). Given the level of respirable dust and silica levels it is not envisaged that this contaminant will be evaluated further and sampling will be based on maintaining an overview of exposure.

The results for inhalable dust and noise are of concern. While no statutory exposure standard for inhalable dust currently exists in the NSW Coal Mines Regulations, exposures in a number of homogenous exposure groups (HEGs) are well above acceptable levels.

Concurrent with the workplace exposure monitoring exercise, an Operational Excellence (OE) project has been investigating means by which inhalable dust levels can be reduced on the Appin longwall. Results to date are encouraging; with data suggesting modified water injection procedures will reduce inhalable dust levels on Appin longwall. This outcome will be applied to other operations and evaluated for effectiveness. Given the success of this OE project, another team has been formed to investigate inhalable dust exposures in continuous miner panels. Based on the results obtained in this exercise, it would appear appropriate for this aspect to be the subject of further research.

From the above data it would appear appropriate for further research to be conducted as to the potential health effects of inhalable coal dust and, if appropriate, the establishment of a workplace exposure standard. Guidance in this area may be possible by a review of the British Coal experience during their extensive workers compensation investigation.

The level of exposure of employees to noise within the Division is extreme and is consistent with published reports from Coal Services Pty Ltd in respect to noise induced hearing loss compensation claims. There is no doubt that noise is a major OH&S issue within the coal industry and BHP Billiton Illawarra Coal is implementing a comprehensive hearing conservation programme across its operations to minimise employee exposure. This will not be an easy task as a considerable amount of underground mining machinery is very noisy and any engineering changes will occur over years not months. The problem of culture in respect to the wearing of hearing protection will need to be overcome via education.

The first step in this education programme has been the development of a comprehensive package using data from Coal Services, Hearing Protection suppliers and this project. The programme has been termed "The Deaf Zone" and is focused on ensuring employees always wear hearing protection in specifically defined high noise areas or "The Deaf Zone". This programme is in its infancy and will be evaluated by an increase in the level of compliance with the use of hearing protection. This measure is considered acceptable as a baseline study was performed during the 16-week sampling exercise with a level of 66% compliance.

A similar 16-week monitoring exercise for dust and noise commenced at Dendrobium Mine in December 2003. Initial results indicate a similar pattern to that of the original study, with noise exposure still a major concern.

OTHER ISSUES

a) Hazardous Substances

A review of hazardous substances procedures across BHP Billiton Illawarra Coal found a degree of inconsistency and implementation at a level below that considered appropriate.

Consequently, improved procedures have been developed which are consistent with current NSW Hazardous Substances Regulations (coal mines have previously been exempt from these regulations). Trials of the procedures have been undertaken, preliminary training completed and an implementation plan developed. It is envisaged that a period of time will be required for risk assessments on all products to be completed at all sites. The schematic diagram in Appendix 2 gives an overview of the system currently in place at BHP Billiton Illawarra Coal to manage hazardous substances.

b) **Confined Spaces**

A review of confined space management procedures indicated that procedures had not been updated to the level required in AS2865-2001. Given this, it was decided that a fresh look should be taken at the issue and a contract was let to the Southern Mines Rescue Service to:

- Update the current register of confined spaces at sites.
- Review current site procedures and develop a uniform approach consistent with the requirements of AS2865-2001.
- Audit site compliance with the updated procedure.

As a result of this process approximately 300 confined spaces have been identified, photographed for records and cross checked against site registers at a total of 14 BHP Billiton Illawarra Coal operation sites (includes fan sites, bores, etc).

c) **Microbiological Agents**

- ***Legionella Pneumophilia Bacteria***

A survey conducted at all BHP Billiton Illawarra Coal operations confirmed a total of 14 systems which meet the requirements of the Public Health (Microbial Control) Regulation 2000 as requiring monitoring. All systems had ongoing regular monitoring programmes in place with results over the past 2-3 years indicating no abnormal increases in bacterial levels.

- ***Recycled Water***

Recycled water is used underground at both Appin and West Cliff Collieries. A review of management procedures indicated routine monitoring to be in place at both operations. Results to date do not indicate employees would be exposed to excessive levels of any contaminant.

d) Organic Vapours

A review of all activities likely to produce organic vapours highlighted the fact that such activities are undertaken by regular minesite contractors. Given this, partnerships have been entered into with each of these contractors where they undertake to monitor the exposures of their employees (typically the most exposed) and supply this data to BHP Billiton Illawarra Coal.

Technical guidance has been given by BHP Billiton Illawarra Coal as to the procedures to be followed and the expertise of Coal Services Pty Ltd employed for sampling by some organisations. Upon receipt of this data a decision will be made as to the need for monitoring of BHP Billiton Illawarra Coal personnel.

SUMMARY

An extensive project has been undertaken at BHP Billiton Illawarra Coal to identify and evaluate a range of potential occupational hygiene issues. In all a total of 19 issues have been identified and risk-ranked so that they can be evaluated on a priority basis.

The focus in the first year of the project has been on dust and noise. Results of monitoring to date have confirmed noise exposure to be a major occupational hygiene risk for the industry. Respirable dust exposure of employees has been generally within acceptable limits, however the levels of inhalable dust measured to date indicate a potential issue for the industry.

Where possible, control procedures are being developed and implemented as the project proceeds. Some issues (eg noise) will require a concerted industry approach to original equipment manufacturers before significant reductions in exposure occur. In the interim, comprehensive hearing conservation programmes are an absolute necessity.

It is envisaged that all 19 issues will be evaluated over a 3-5 year timeframe.

The data from this exercise has been made available for inclusion in the Health & Safety trust's Occupational Hygiene Manual. It is understood that the latest edition of this publication will be provided to the Trust in March 2004.

ACKNOWLEDGEMENTS

The Working Group wishes to express their appreciation to the Trustees of the Health & Safety Trust for their support of this project.

The assistance of Mr K Cram and Ms S Buckley of the Health & Safety Trust is gratefully acknowledged.

This project would not have achieved its objectives without the kind assistance of the management and workforce of those collieries who participated in the exercise.

A special recognition for their contribution is extended to the sampling officers from Coal Services Health (Peter Adlington, Gary Mace and Paul Livingston) who collected all the samples.

The contribution of the members of the project Working Group is also acknowledged.

REFERENCES

AIHA (1998); A Strategy for Assessing and Managing Occupational Exposures, AIHA Press 1998

AS2985 (1987); Workplace Atmospheres: Method for Sampling and Gravimetric Determination of Respirable Dust

AS3640 (1989); Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Inspirable Dust

AS2865 (2001); Safe Working in Confined Spaces

BHP Billiton (2002); HSEC Guideline – Health Exposure Assessment, Guideline No. G14, 13 December 2002

Grantham, D., (2001); Simplified Monitoring Strategies, Australian Institute of Occupational Hygienists, November 2001

APPENDIX 1

PERSONAL DUST & NOISE MONITORING RESULTS

APPENDIX 2

HAZARDOUS SUBSTANCES MANAGEMENT

Substance Evaluation

