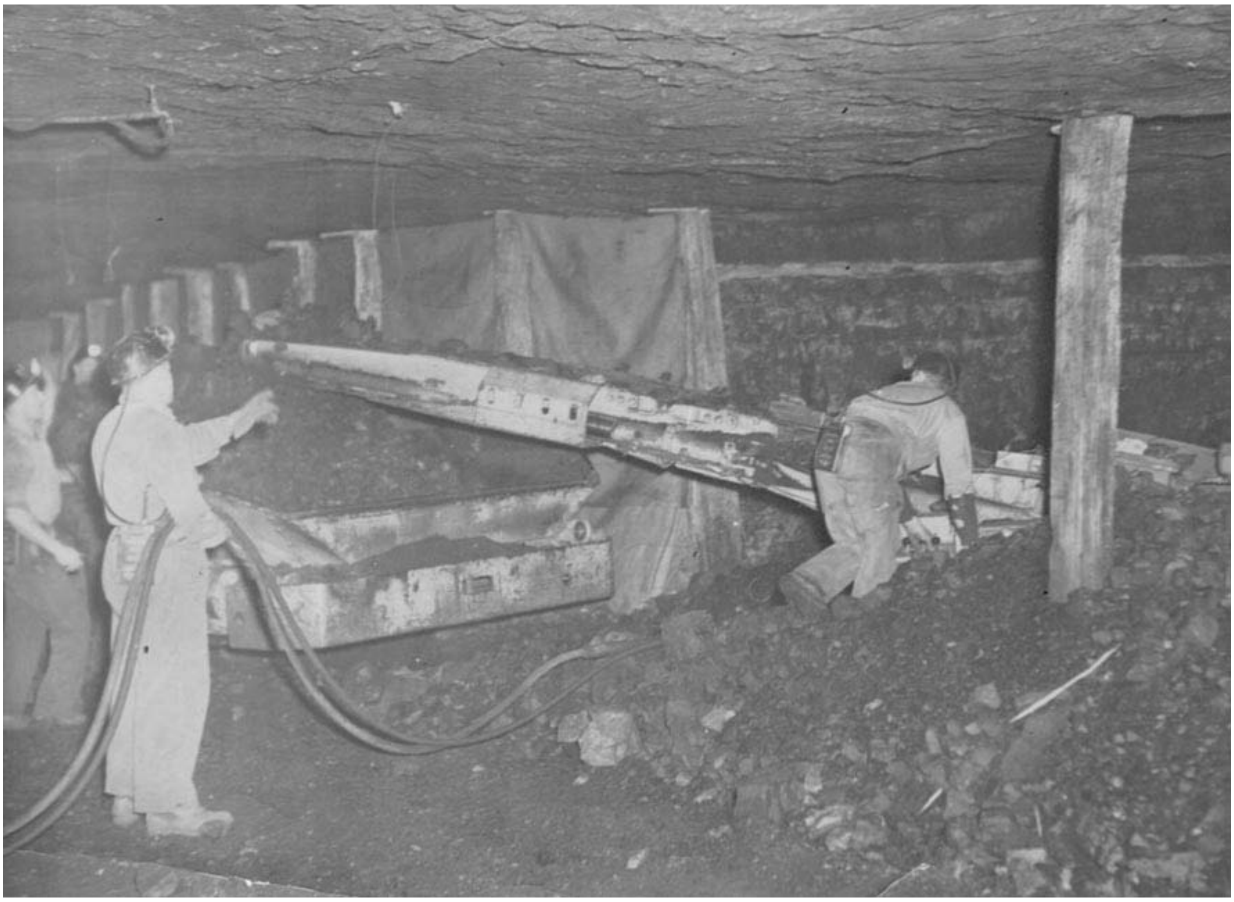
KEEPING COAL MINERS HEALTHY AT WORK



AN OCCUPATIONAL HYGIENE MANUAL FOR THE COAL MINING INDUSTRY

KEEPING COAL MINERS HEALTHY AT WORK:

AN OCCUPATIONAL HYGIENE MANUAL FOR THE COAL MINING INDUSTRY

B DAVIES: AUSTRALIAN ENVIRONMENTAL HEALTH SERVICES PTY LTD

D GLOVER: COAL SERVICES PTY LTD

R MANUELL: O H EDITORIAL SERVICES

3rd Revision - Edited by J Henderson
Henderson OH&S Services Pty Ltd

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

1. INTRODUCTION

1-01 PURPOSE
1-02 HOW TO USE THIS MANUAL

2. OCCUPATIONAL HYGIENE

2-01 WHAT IT IS
2-02 HISTORY OF OCCUPATIONAL HYGIENE IN THE MINING INDUSTRY

3. A PROCESS FOR MANAGING OCCUPATIONAL HYGIENE ISSUES

3-01 INTRODUCTION
3-02 CRISIS MANAGEMENT
3-03 A STRUCTURED APPROACH
3-04 A TYPICAL LIST OF POTENTIAL OCCUPATIONAL HYGIENE ISSUES

4. IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES

4-01 INTRODUCTION
4-02 SPECIFIC ISSUES IN THE COAL INDUSTRY
a) ASBESTOS
b) CONFINED SPACES
c) WORKPLACE CHEMICALS - DANGEROUS GOODS
d) DERMATITIS
e) DIESEL EXHAUST FUMES
f) DUSTS
g) GENERAL AIRBODY GASES
h) WORKPLACE CHEMICALS - HAZARDOUS SUBSTANCES
i) LIGHTING
j) MATERIAL SAFETY DATA SHEETS (MSDS)
k) MICROBIOLOGICAL AGENTS
l) NOISE
m) ORGANIC VAPOURS (SOLVENTS, ETC)
n) POLYCHLORINATED BIPHENYLS (PCBs)
o) PERSONAL PROTECTIVE EQUIPMENT
p) RADIATION (NON-IONISING AND IONISING)
q) SPONTANEOUS COMBUSTION
r) SYNTHETIC MINERAL FIBRES
s) THERMAL STRESS
t) VIBRATION
u) WELDING AND WELDING FUMES

4-03 HOW TO CONDUCT A WALK-THROUGH SURVEY

TABLE OF CONTENTS (Cont'd)

4-04 CASE STUDIES
- a) DUST
- b) HAZARDOUS SUBSTANCES
- c) NOISE
- d) ORGANIC VAPOURS
- e) PCBs
- f) SPONTANEOUS COMBUSTION
- g) WELDING FUMES

5. HOW TO EVALUATE IDENTIFIED ISSUES

5-01 A RISK MANAGEMENT APPROACH
5-02 MONITORING PROGRAMMES
5-03 EXPOSURE STANDARDS
5-04 QUALITY ASSURANCE (QA) SYSTEMS IN WORKPLACE MONITORING
5-05 CASE STUDIES
- a) DIESEL EXHAUST EMISSIONS
- b) DUST
- c) NOISE
- d) STATISTICALLY BASED MONITORING
- e) WHAT! NO MONITORING?
- f) WHOLE BODY VIBRATION

5-06 HOW TO SELECT A CONSULTANT

6. CONTROL STRATEGIES

6-01 GENERAL CONCEPTS
6-02 A PROCESS FOR CONTROL
6-03 CASE STUDIES
- a) DIESEL EXHAUST EMISSIONS
- b) DUST
- c) HAZARDOUS SUBSTANCES
- d) NOISE

7. USEFUL RESOURCES

7-01 INTRODUCTION
7-02 AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS (AIOH)
7-03 NATIONAL ASSOCIATION OF TESTING AUTHORITIES (NATA)
7-04 SOURCES OF RELEVANT INFORMATION OR PUBLISHED RESEARCH
7-05 STANDARDS AUSTRALIA

8. GLOSSARY

9. SUBJECT INDEX

ACKNOWLEDGEMENTS

The 3rd Revision of this Manual has been produced through the provision of a grant from the Coal Services Health & Safety Trust. The author wishes to offer his appreciation to the Health & Safety Trust and its staff for their support of this project and to the original authors of the Manual. I would especially like to thank Brian Davies for his assistance in this current revision.

A number of other individuals have also made a significant contribution previously to this Manual through various means, eg provision of information, editorial review, secretarial assistance, for which the authors are truly grateful.

Individuals who have contributed to this Manual either directly or via the provision of material include:

Bob Brough	Sean McGinn
Sue Davies	Steve McFadden
Gary Foster	Thomas Mitchell
David Grantham	Steve Pratt
Phillip Harris	Alan Rogers
Willy Linnenlücke	Tim White

The authors would also like to thank the workforce and management at the following Collieries, who participated in the evaluation phase of this Manual.

- Bulga Open Cut Mine
- South Bulga Underground Mine
- Cumnock No. 1 Mine
- Drayton Coal

Cover Photograph: Hermitage Colliery early 1950's. Source: D A Davies

SECTION	:	INTRODUCTION
SUBJECT	:	PURPOSE

PURPOSE:

The issues of control of noise and dust health hazards are two occupational health themes well known throughout the coal industry, but many other Occupational Hygiene matters such as hazardous substances, lighting, radiation, vapours from fuels or solvents, exhaust fumes, or contact with chemicals, are either addressed on a piece-meal, off the cuff or "one off" basis, ignored in the hope the problem will go away, or simply not recognised.

Useful existing information is often not utilised or collected and its value only recognised in hindsight when associated adverse health effects emerge, possibly years later. At that time there may no longer be any possibility of collecting that information which could have helped in identifying the cause of the ill-health before it took its toll.

This Manual provides a system by which such situations may be avoided and the health of workers protected more effectively. The purpose of this Manual is therefore threefold, namely:

- To provide a consistent pathway across the coal mining industry, by which mine operators and employees working together can manage a broad range of occupational hygiene issues.

- To provide up to date information to the industry and establish basic guidelines on how such information can be used to assist in issue management.

- To benefit from the previous experience of others by highlighting through case studies of how various operations have addressed occupational hygiene issues.

It should be appreciated that while this Manual has been prepared to assist management and employees to address occupational hygiene issues, it is not a substitute for the skills of an experienced occupational hygienist. For example using a noise meter may seem easy, but there are many factors which may not be apparent to the untrained person, which can significantly influence the result, and hence the protection of the hearing of those exposed to the noise source.

One of the objectives of issuing this Manual is to encourage coal miners to reappraise their OH&S policies and practices and recognise that investments in well-founded OH&S measures return good dividends for both workers and management.

The need for action in this area can be demonstrated by consulting industry insurance claim statistics. Since 1998–1999 occupational disease each year has accounted for approximately 9% of all claims made by coal industry employees to the NSW Coal Mines Insurance Pty Ltd. Of the claims for occupational disease approximately 66% were for noise induced hearing loss. This is an appalling statistic for a disease that is totally preventable. Similarly, injuries from exposure to chemicals continue to occur, again highlighting the need for the management of hazardous substances.

Both management and employees have a responsibility to reduce the incidence of injury and it is hoped that this Manual will be of assistance in that endeavour.

Comments on the value of the document arising from your use of it are earnestly requested, so the next edition can be improved and given wider applicability (see Document 1-02 page 2).

SECTION	**:**	**INTRODUCTION**
SUBJECT	**:**	**HOW TO USE THIS MANUAL**

SUMMARY:

This Manual is divided into:

Sections - the major divisions, physically separated by numbered dividers.

Subjects - divisions within a section.

Parts - divisions within a subject (not all subjects have parts)

NUMBERING SYSTEM

Each subject is identified by a unique 3-digit number.
This number has two sets of digits that are separated by dashes.

Example 1-02
Section 1 - Subject 2
Introduction - How to Use This Manual

Those subjects which are further subdivided are identified by the letters a) – z).

Example 4-02a)
Section 4 - Subject 2 - Part a)
Identification of Occupational Hygiene Issues - Specific Issues - Asbestos

Each subject may have one or more pages as noted in the bottom right-hand corner.

FINDING A SUBJECT

As the first step refer to the Table of Contents section at the front of the Manual. Find the subject you require and determine the subject number.

Example Asbestos
4-02a)

Click on the relevant subject number and you will be taken to the appropriate section.

MANUAL MAINTENANCE

This Manual will be periodically updated, with a revision date on the bottom of each page.

INPUT

It is envisaged that this Manual will be a "living" document and suggestions for improvements are most welcome. The Manual can be accessed from the Coal Services Health & Safety Trust website which can be located at http://coalservices.hstrust.com.au/ (accessed October 2008).

In particular details of incidents that could be used as case histories would be appreciated. Comments, additions, etc can be forwarded to:

The Secretary
Coal Services Health & Safety Trust
GPO Box 3842
SYDNEY NSW 2001
Telephone (02) 8270 3200
Email: trust@coalservices.com.au

SECTION	**:**	**OCCUPATIONAL HYGIENE**
SUBJECT	**:**	**WHAT IT IS**

DEFINITION:

Occupational hygiene is defined as **the recognition, evaluation and control of exposure to those products and processes hazardous to health in an occupational environment**.

RECOGNITION:

Recognition of health hazards in the workplace is the starting point for their proper control. Occupational disease still occurs in many cases because both management and employees are ignorant of the hazards associated with materials or processes in the workplace. The reasons for this are manifold (health hazards often arise from unexpected sources), yet many adverse situations are simply repetitions of well-documented events.

While it may be said by some that recognition of adverse health effects or hazards is everyone's daily responsibility, the real situation is much more complex. The onset of disease is one sure way of recognising a problem, yet in many cases the time from exposure to the first symptoms of ill health is so long that by then employees may have serious medical problems that may well have been avoided by earlier action.

A more proactive strategy involves the use of previous experience, observation and reference to existing information. It is this strategy that this Manual will follow and if successfully applied should enable the earlier recognition and control of the majority of health hazards on-site.

In those few cases where the above strategy is not successful, expert opinion and guidance may be necessary to recognise and resolve an issue. In such cases the services of an occupational hygienist with experience in the mining industry should be obtained.

EVALUATION:

Evaluation of a workplace is primarily undertaken to establish if the workplace environment and processes are safe or unsafe for employees to perform their normal duties. Other reasons exist for the evaluation process to be undertaken and these include:

- To meet regulatory requirements (eg statutory dust tests).
- To develop appropriate control measures.
- As a measure of the effectiveness of control measures.
- For research purposes.
- To comply with corporate governance requirements.
- To dispel anxiety and possible resultant industrial action.

The evaluation process can be relatively simple but sometimes detailed systematic monitoring procedures are required.

This Manual provides assistance not only in terms of highlighting those situations where experienced monitoring personnel are required for evaluation, but also means by which you can verify that the consultant has the skills to conduct the evaluation properly which in turn ensures that valid decisions about health issues in the workplace are made.

CONTROL:

Control technologies usually provide solutions to occupational hygiene issues. Once an issue has been recognised and shown to be a valid problem by an evaluation process, it must be controlled. To do otherwise could represent a case of negligence. Having stated the obvious (ie if you find a problem you need to fix it), the practical barriers associated with such remedies may be considerable.

In many cases cost is presented as a stumbling block yet many simple low cost control strategies exist which will minimise employee exposure.

Care needs to be exercised to ensure that while the initial problem is resolved, a second problem is not introduced, eg many ventilation systems are introduced to remove fumes, however the fan design is such that high noise levels result in employees switching them off thus negating the original reason for which they were introduced.

In many coal mines the best control technology may be unique to that situation or operation, however in some cases the experiences of others in resolving problems at other locations may be applied beneficially. This Manual provides a number of specific control strategies where appropriate, but more importantly will indicate the process by which suitable control strategies can be developed. Merely solving the problem is not enough and the successful implementation of a control strategy requires follow up and fine tuning. This may need education of a few members of the workforce who may view the final control technology as unnecessary or only a partial solution. The involvement of the workforce (or their representatives) in the process for development of the control technology should minimise this barrier.

SUMMARY:

Occupational hygiene is one specialist aspect of the occupational health profession which also involves other disciplines such as occupational physicians, occupational health nurses, ergonomists, etc all working together with management, unions, health and safety representatives and the general workforce in order to protect the health of coal miners. While all these people have a role to play in maintaining the health of coal miners the overall concept of occupational health is directed towards prevention first, correction second and finally repair.

It is for this reason that occupational hygiene has such an important, but sometimes unrecognised role to play in the overall management of health issues at coal mines.

Occupational hygienists operate at the leading edge of improving occupational health by their attention to early recognition evaluation and control for prevention of incipient health problems. Many prudent operators include hygienists within planning and design teams for all new processes.

SECTION	:	OCCUPATIONAL HYGIENE
SUBJECT	:	HISTORY IN THE MINING INDUSTRY

While the commencement of coal mining as an industry cannot be pinpointed with accuracy, there are references to coal mining in the Saxon Chronicles which mention activities around Peterborough, England during the 9th century. Mining during this period consisted essentially of digging surface outcrops, as the technology needed to sink shafts for access to coal deposits did not develop for several hundred years. As the centuries passed the use of coal for fuel increased dramatically, with many deposits in other countries being exploited. By the 12th century coal mining had commenced in the Rhineland, Silesia and Bohemia and by 1701 the first coal mines were active in the USA. Coal was first discovered in Australia by early explorers at Newcastle (near Nobby's, then called Coal River) with mining proceeding so rapidly after discovery that 4 000 tonnes/year were being shipped from Coal River by 1800.

As can be seen from the above abbreviated history of coal mining, the industry has been established for many centuries and continues today as a significant contributor to the global economy.

For many centuries the influence of the workplace environment on the health of workers has been recognised and sometimes investigated. History records that Hippocrates in the 4th century BC recognised the toxicity of lead, although little was done to protect workers because, being mainly slaves, they were regarded as expendable. Pliny the Elder, a Roman of note in the 1st century AD, described a protective mask, made from an animal bladder, which was used by workers in dusty trades.

In terms of the mining industry Ulrich Ellenborg in 1473 produced the first publication on occupational disease and injury amongst gold miners. He was the first to offer instruction in hygiene and other preventative measures. Perhaps a more significant step forward was made by Georgius Agricola, a German scholar who worked as a medical officer in the mining town of Joachimsthal. He was particularly concerned about the influence of dust on the health of miners, no doubt as a result of the high mortality rate of miners attributed to “consumption”. Agricola recorded considerable information in a now classic document "De Re Meticallica", published after his death in 1556. In this document Agricola included suggestions for mine ventilation and protective masks for miners, a discussion on mining accidents and accurate descriptions of various diseases including silicosis. In 1700 an Italian physician, Bernardo Ramazzini summarised the work of many authors on diseases of craftsmen and miners in his treatise "De Morbis Artificium" providing descriptions of occupational skin diseases which remain remarkably accurate today.

In the 19th century, as the industrial revolution gained momentum, considerable evidence was emerging in respect to the nature of disease experienced by miners. By the 1850’s inspectors’ reports in the UK indicated that occupational diseases accounted for more deaths than major mine disasters, which were themselves quite frequent. Parliamentary Acts introduced in the United Kingdom (UK) about this time resulted in reduced working hours, better ventilation and greater enforcement of approved mining practices. This, together with improved engineering practices, greater mining experience and the application of science, resulted in a significant reduction in mortality, but disease and injury were still excessive by today's standards. This improvement continued for some decades, however, the situation in coal mines had deteriorated by 1936 as a result of the rapid mechanisation of the industry during World War 1.

This is reflected in the Australian situation with the prevalence of pneumoconiosis (a general term proposed by Zenter in 1866 for all lung diseases caused by dust) in the New South Wales coal mining workforce in 1948 being 16%. Consequently, dust exposure and more recently noise induced hearing loss (something not experienced to any significant degree prior to World War 1), have become the focus of evaluation (dust monitoring) and control (ventilation, personal protective equipment, etc). Other occupational hygiene problems, eg diesel exhaust gases, although not well understood, have been monitored and controlled through statutory limits and ventilation requirements.

As can be appreciated from the above brief history, occupational hygiene has been an integral part of the mining industry for centuries; however its importance has grown with mechanisation and rising community expectations of better occupational health. While the focus in the past has quite correctly been on improving the controls on noise and dust exposure, the future lies in identifying potential hazards, evaluating them and applying appropriate controls before disease occurs. This Manual, in its own small way, attempts to pursue this goal.

SECTION	**:**	**A PROCESS TO MANAGE OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**INTRODUCTION**

INTRODUCTION:

Issues involving occupational hygiene, like other OH&S matters, may arise in a number of ways, eg employee complaints, an incident on-site, union concerns, site audits, industry organisation initiatives, regulatory directives or management initiated investigations. How these issues are managed depends on many factors including; the perceived severity of the complaint, the underlying industrial relations on-site, the influence of the issue on production, managerial commitment to occupational health and safety and local attitudes to the importance of good health at work.

The two principal approaches to addressing occupational hygiene issues are:

- On an immediate basis depending on the issue at hand.

- In a long term structured manner.

Cases as to the merits (or otherwise) of each approach can be argued, however the aim of this Manual is to provide guidance to mine personnel for both types of situations.

SECTION	**:**	**A PROCESS TO MANAGE OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**CRISIS MANAGEMENT**

This section covers those issues that generally occur with little or no warning but warrant immediate resolution. Unfortunately immediate resolution of occupational hygiene issues rarely occurs in practice, with more often than not an agreement between management and employees being required on the means of resolution. The following process should assist in resolving issues that arise in this manner and prevent some form of a crisis.

STEP 1 **ISOLATE AND DEFINE THE PROBLEM**

In many cases the facts of the situation are influenced by emotion or interpretation as the issue is passed up the reporting structure. Because of this there is a need to clearly identify what the issue is and the way it impacts on those involved. Section 4 details the more common issues found in coal mines. It is important that the workplace in question be physically inspected by the person(s) investigating the problem to ensure that there are no other contributing factors than those alleged to be the cause of the problem. Such an inspection should always, when possible, be made in the company of the individual who initiated the complaint, as it is important to be sure that all the conditions encountered are the same as those prevailing when the problem arose.

In defining the problem, it is important to be sure all the facts have been collected, for example which hazardous products, (if any), were involved and had each Material Safety Data Sheet (MSDS) been reviewed and recommendations for control of any exposures applied.

It is also important to be sure that no unexpected changes to the process have occurred - check production records, simulate the situation once again.

STEP 2 **EVALUATE THE PROBLEM**

Depending on the extent of the problem, evaluation may be possible using on-site resources but in some cases external expert opinion may be necessary. It is difficult to state at which time environmental monitoring (eg dusts, vapours, fibres, etc) becomes a preferred option. In many cases monitoring will not add anything to the debate in terms of its resolution, and in others the need for monitoring is obvious for without it the resolution of an industrial relations issue may be impossible. Reading the MSDS (if one exists for the material(s) involved in the process) may indicate the potential for hazardous substances which require environmental monitoring. Otherwise, general observation can provide guidance, eg fumes exist in the workplace, strong smells are evident, etc. Care should be exercised when using the nose as a monitoring tool - remember many gases are odourless and others can numb the senses. Also exposure standards for some gases could be below their odour threshold.

If atmospheric monitoring is required, seek the advice of a qualified person experienced in this area (see Section 5-06). In the first instance provide the details over the telephone, as the expert may have experienced a similar situation elsewhere and can offer an immediate resolution to the problem. If not, arrange for the expert to visit the site, inspect the situation under investigation and offer advice. A summary covering identification of the problem, the need for control and what controls are considered necessary should be provided to all involved.

STEP 3 **CONTROL THE PROBLEM**

In many cases a simple resolution for the problem may emerge from the site inspection. In others, detailed engineering modifications may be necessary. The emphasis should be on a permanent solution, not just a "quick fix", as these rarely work and may exacerbate the situation. Advice on control strategies is provided in Section 6.

STEP 4 **FOLLOW UP**

Once a workable solution to the problem has been found, the process should not be considered finished. Implementation of the designated control technology is just as important as identification of the problem. Poor implementation procedures may result in the problem giving rise for concern at a later stage. Sometimes a recommended solution has been imposed upon the workforce rather than by involving them in consultation and explanation, resulting in a reluctance on their part to modify their daily practice.

The best approach is to introduce a follow up procedure for a period of time during which the views of all involved are sought as to the effectiveness of the control strategy. A final close out inspection should be made of the area to ensure that the final solution is understood and accepted by the workers, effective, being used and routinely maintained.

SECTION	**:**	**A PROCESS TO MANAGE OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**A STRUCTURED APPROACH**

The aim of this section is to provide a structured approach to the management of occupational hygiene issues at coal mines. This approach will highlight issues requiring urgent attention and resources but still recognise the importance of apparently less urgent issues. It should be understood that for an initial period "crisis issues" may still occur, however in the long term such distractions and consumers of resources will decline to the benefit of all involved.

Given the long term approach it is important to understand that in most instances "quick fix" solutions rarely resolve a problem and may result in delays to resolution. It is better to seek a more sustainable solution, though it may take longer to develop. This may not satisfy all parties but it may ultimately be the best way to achieve a permanent solution. Sometimes temporary solutions may still be needed to ensure that the health of employees is not put at undue risk as longer term resolution is undertaken.

STEP 1 IDENTIFY HAZARDS PRESENT ON-SITE

While this may sound like a relatively easy task, experience has shown that in many cases "familiarity breeds contempt" with significant issues being overlooked. Consequently, if this structured approach is to be successful all preconceived opinions on an issue should be put to one side and the process commenced from an objective base.

As a starting point it is suggested that the group members (eg Occupational Health & Safety Committee) should have a short session with all available sources of relevant information on the issue tabled. Possible areas for consideration are:

- OH&S Committee Minutes
- Deputy/Examiner Reports
- First Aid Treatment Records
- Grievance Reports
- Mines Department Incident Notices
- Industry Association Guidelines
- Union Publications
- Audit Reports
- Section 4-02 of this Manual

and any other avenue for acquiring relevant information.

To complement the above information and to gain some perspective on the specific issue on-site, conduct a walkthrough audit of the site using the method indicated in Section 4-03 of this Manual. Remember to keep a record of the walkthrough audit and if possible photograph or video key points for records, or analysis, at a later stage. Sometimes a timed video record of an operation will be useful. Although outside expert assistance may be employed to perform this step, greater benefit is derived if the process is initially performed by site personnel. It may then be useful to confirm the list of issues by the use of outside expertise if resources are obtainable.

Once all the information has been collected it should be collated into a single document in logical alphabetical order ready for Step 2.

STEP 2 **ASSIGN PRIORITIES TO ISSUES**

This is a major step in the process as it determines the allocation of time and resources to individual issues and thus the outcome must be defendable to those individuals who see another issue at a higher level of priority.

Conduct a basic risk assessment on the first issue listed. Many methods exist within industry to complete this task, all of which are based on the premise that the risk associated with any undesirable incident is a combination of the probability of it occurring and the severity of associated consequences, or expressed as an equation,

RISK = PROBABILITY X CONSEQUENCE

If your site currently uses a risk matrix for occupational health and safety issues use that matrix for your risk ranking. If not, a general approach to the task is provided in Section 5-01 of this Manual.

Repeat this process for every issue on your list of identified issues and construct a priority list of occupational hygiene issues based on the risk rankings for your site ready for Step 3.

STEP 3 **EVALUATE THE LEVEL OF RISK**

Commencing with the highest priority issue, evaluate the actual level of health hazards for individuals working in each area. In many cases simple observation will give some insight as to the level of hazard, but in others workplace monitoring, usually atmospheric, may be required. If monitoring appears necessary it is prudent to seek expert assistance as wrong interpretation of monitoring data may give some situations a falsely serious importance or significance. Guidance on how to evaluate identified issues is provided in Section 5 of this Manual with specific advice on how to select a consultant being provided in Section 5-06.

The relationship between exposure and its impact on health should be considered when evaluating issues. If it is a fast acting irritant like ammonia don't measure the contaminant over a whole shift, or conversely if someone is exposed to a long term contaminant such as airborne quartz dust briefly and incidentally once in a while don't be overly alarmed but do expect to need a long term monitoring programme if quartz dust levels are significant.

STEP 4 **DEVELOP CONTROL STRATEGIES**

Commencing with the highest priority issue, develop a range (if possible) of control strategies. Guidance on this process is provided in Section 6 of this Manual. This may be another situation where expert advice is necessary. Having identified the need for control measures it is constructive to involve the people actually working in the area in the development discussions as past experience has shown that externally imposed solutions do not always gain full acceptance. Also in many cases simple alternatives may be clearer to those who work in an area than to visitors. Finally make a recommendation to management if change is considered necessary.

STEP 5 **OVERSEE IMPLEMENTATION OF NEW CONTROLS**

It is important to ensure that the controls considered necessary are correctly implemented and are explained to those workers expected to either use them or be subjected to their influence.

STEP 6 **ONGOING REVIEW**

As with the case described in the Crisis Management section of this Manual (Section 3-02), follow up of the application of a solution to a problem is really part of the solution and extremely important.

In the structured approach it is recommended that the effectiveness of the solution is evaluated by visual or technical means and this information is recorded in a format so others can access it at some time in the future.

It will also aid in the detection of ineffective solutions. Over time this will build a resource of workable solutions which can be applied whenever a similar problem arises.

It is good practice to conduct a final risk assessment after the chosen solution has operated for a reasonable period to be sure that all possible eventualities have been covered and the solution to one problem hasn't either created or unmasked another issue.

If this final risk assessment confirms that the issue has been resolved it should be transferred to a "maintenance list" where the situation is revisited each five (5) years (or sooner if circumstances require) to ensure that the control technology has not deteriorated and personnel are again being exposed.

The process as set out above can be summarised in schematic form as follows [Figure 3-03(I)].

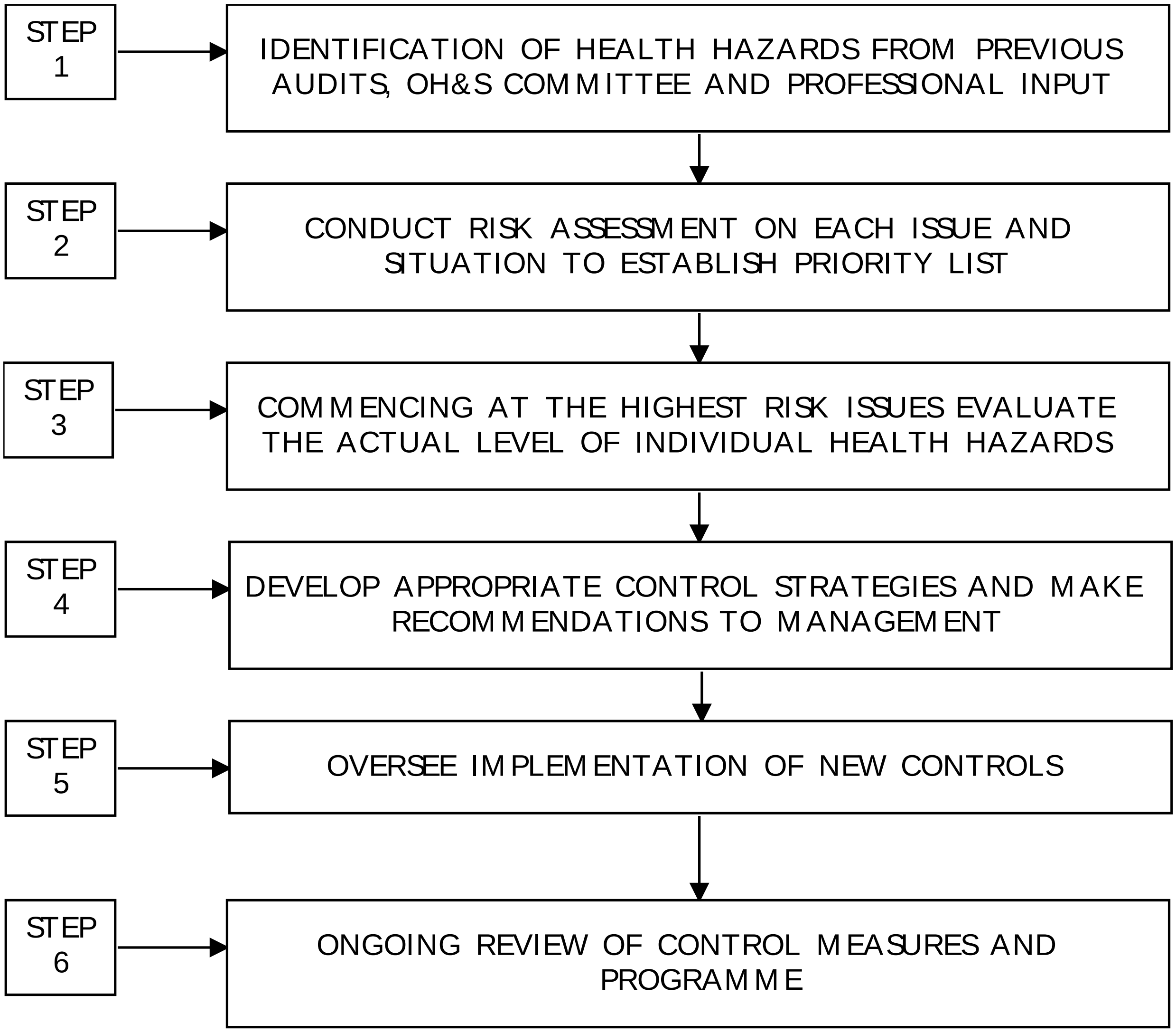

STEP 1
IDENTIFICATION OF HEALTH HAZARDS FROM PREVIOUS AUDITS, OH&S COMMITTEE AND PROFESSIONAL INPUT
STEP 2
CONDUCT RISK ASSESSMENT ON EACH ISSUE AND SITUATION TO ESTABLISH PRIORITY LIST
STEP 3
COMMENCING AT THE HIGHEST RISK ISSUES EVALUATE THE ACTUAL LEVEL OF INDIVIDUAL HEALTH HAZARDS
STEP 4
DEVELOP APPROPRIATE CONTROL STRATEGIES AND MAKE RECOMMENDATIONS TO MANAGEMENT
STEP 5
OVERSEE IMPLEMENTATION OF NEW CONTROLS
STEP 6
ONGOING REVIEW OF CONTROL MEASURES AND PROGRAMME

FIGURE 3-03(I)

SECTION	**:**	**A PROCESS TO MANAGE OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**A TYPICAL LIST OF POTENTIAL OCCUPATIONAL HYGIENE ISSUES**

A major study using the principles outlined in Section 3-03 is that carried out by BHP Billiton Illawarra Coal in 2003-2004 as part of a Coal Services Health & Safety Trust project.

The aim of the project[1] 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.

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 3-04(I)) in use at the time. In cases of disagreement on risk, the issue was discussed and a consensus reached.

[1] Occupational Hygiene in the Coal Industry – A Case Study. Health & Safety Trust Report, February 2004

LIKELIHOOD		CONSEQUENCE SEVERITY: Low	Minor	Moderate	Major	Critical	Factor
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 3-04(I)

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 3-04(II)).

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	

Rank	Issue	Ranking No Controls	Ranking Current Controls	Schedule For Control
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 3-04(II)

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.

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.

Details of specific results of this monitoring exercise can be observed in Section 5-05d.

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	INTRODUCTION

INTRODUCTION

This section provides information on specific occupational hygiene (and associated) issues commonly experienced at operating coal mines. The level of information provided should be sufficient to understand the basics of each issue. References or guidance for further reading has been provided as footnotes or at the end of each topic where applicable.

Merely reading the section on a specific issue to resolve a problem is not advised and the whole process of issue resolution (Section 3) should be followed.

One of the key elements of developing a site occupational hygiene programme is the "walkthrough survey" when thoroughly executed. This process identifies most issues that may require attention, including issues not identified in the original request.

This section also includes case studies providing practical guidance on how the information can be used, or should have been used. It is impossible to present case studies for every possible issue that may occur, however the process is similar in many circumstances and thus those case studies presented should assist in the resolution of other situations.

SECTION :	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT :	SPECIFIC ISSUES IN THE COAL INDUSTRY

a) ASBESTOS

The presence of asbestos usually raises alarm within the general and industrial communities because of adverse health effects associated with excessive exposure.

Asbestos was for many decades one of the major insulating and building materials used in the world; in the belief that its qualities of extreme thermal and chemical inertness, which made it ideal for thermal insulation, also indicated it did not cause adverse health effects.

We now know that some forms of asbestos cause cancer and so it has been either removed from many workplaces or sealed off from human contact. However, asbestos products may still be present in the workplace and thus needs appropriate management.

Asbestos is a term applied to a family of fibrous silicate minerals which are resistant to wear, heat and most chemicals. Asbestos has many forms, however three types are of major importance:

Chrysotile:	White asbestos (90% of historical use)
Amosite:	Brown asbestos
Crocidolite:	Blue asbestos

Other forms include tremolite, anthophyllite and actinolite, however these are not found or used in commercial quantities.

The presence of contaminant asbestos has been reported in a variety of mining operations throughout the world, including iron ore, gold, vermiculite, talc and nickel.

In Australia the presence of asbestos in metalliferous mines has been the subject of investigation, especially in Western Australia.[1] No evidence exists to suggest the presence of asbestos as a contaminant in Australian coal seams.

At most coal mines the potential for contact with asbestos arises from its past use in a variety of applications, as indicated in Figure 4-02(I).

	Asbestos Content	
Product	Weight (%)	Type
Heat resistant textiles (welding blankets etc)	65-100	Chrysotile
Asbestos cement products (pipes, sheets, roofing)	10-15	Chrysotile, Amosite, Crocidolite
Thermal insulation products (pipe and boiler insulation, spray insulation, gaskets)	12-100	Chrysotile, Amosite, Crocidolite
Friction materials (clutch plates, brake linings)	15-70	Chrysotile
Floor tiles (filler for PVC tiles)	5-8	Chrysotile

FIGURE 4-02(I)

The use of asbestos in Australia is now banned by regulations for all new uses. However products of the types listed above manufactured before the early 1980s are likely to contain asbestos.

In terms of health effects, long term exposure to excessive airborne levels of asbestos fibres can lead to debilitating and potentially fatal diseases. The major occupational diseases caused by inhaling asbestos fibres are:

- Asbestosis
- Lung cancer
- Mesothelioma

[1] Hewson, G S, Herbert K H, Rogers A, Sonter, M J. Occurrence and Management of Contaminant Asbestos in Western Australia Mines. Presented at MineSafe International, Perth, Western Australia 1993.

Asbestosis can be defined simply as a progressive scarring of the lung (fibrosis) caused by the inhalation of high concentrations of asbestos fibres small enough to penetrate to the deeper parts of the lungs.

The onset of asbestosis typically occurs only after an extended period of exposure (15-40 years) and is characterised by shortness of breath (as a result of the fibrosis of the lung) with a resultant decrease in the oxygen exchange capacity which can ultimately lead to heart failure.

Asbestosis is a disease affecting asbestos miners, weavers and processors, eg manufacturers of brake linings and building products, and insulation laggers working with loosely bound forms of asbestos.

Smoking and asbestos are a potent mixture which may lead to lung cancer. The cancer (Bronchogenic Carcinoma) is malignant and presents little hope of recovery except with early detection and surgical removal and cessation of both exposure and smoking.

Mesothelioma is a cancer of the pleura or peritoneum (the membranes that line the chest cavity and abdomen) which is invariably fatal, usually within 12-18 months of diagnosis. While mesothelioma is a rare disease, cases are known to occasionally occur within the normal population without any apparent link to asbestos. Most cases have occurred in the asbestos mining industry, the preparation of ingredients for the manufacture of asbestos cement products or among insulation workers. Crocidolite exposure has been reliably linked to this disease, however, cases are also attributable to amosite, with the situation in respect to chrysotile being less certain.

The risks associated with asbestos depend almost solely on exposure to airborne fibres. No onset of disease has been observed following skin contact. Ingestion is suspected in a few cases where heavy exposures have occurred.

In essence, although all asbestos-containing products present a health hazard, significant or measurable risk to health only materialises when workers are exposed to airborne fibres. Consequently if airborne asbestos fibre levels are adequately controlled, the material can be managed so as to remove (or control) the hazard.

When asbestos is thought to exist on-site, the following process should be followed.

STEP 1 **ESTABLISH THE PRESENCE OF ASBESTOS**

The surest way to establish the presence of asbestos on-site is to have it identified by an approved laboratory. The National Association of Testing Authorities (NATA) can provide a list of approved laboratories capable of performing the required analysis. Section 7-03 lists the contact numbers for NATA offices in all states or individual laboratories can be located from the NATA website located at: www.nata.asn.au/ (accessed October 2008).

Usually the selected laboratory should provide guidance in how to collect a suitable sample, but in the absence of that information the following procedure should be followed.

- Aim to collect a representative sample. (Do not use power tools as these can generate airborne asbestos contaminated dust).

- Collect enough material to ensure all types of material present are sampled (eg collect sample from surface to bottom if layers present). Record the specific location where the sample was taken.

- Approximately 100-250 g of material is sufficient.

- Carefully divide the sample into two equal portions and place each portion in new plastic bags. Seal, label and date the bags. Retain one for reference purposes and despatch the other in a suitable transportation container, which prevents crushing or contamination. Request confirmation from the chosen laboratory of safe arrival.

Once the presence (or absence) of asbestos is confirmed it is possible to proceed.

STEP 2 **ASSESSMENT**

Asbestos presents a risk only when it is airborne as very small particles or fibres. Thus asbestos which has been incorporated in a stable, non-friable matrix, such as asbestos cement sheeting, presents no risk to health provided the matrix is stable and no airborne dust is produced. Asbestos-containing materials that are of concern from a health standpoint are friable ones liable to disturbance, such as sprayed on thermal insulation or lagging on pipes. A record or register of the location of asbestos-containing materials and their condition should be kept on the premises and referred to by the relevant people, eg maintenance personnel, prior to working in any area where asbestos may be disturbed.

STEP 3 **CONTROL**

In the case of stable and inaccessible asbestos products, these should be identified, labelled and left alone until removal is necessary for other reasons. However, when the assessment has revealed a likelihood of exposure to asbestos fibres, procedures are needed to ensure that employees are not unnecessarily exposed.

These steps include encapsulation, enclosure or sealing of the asbestos material, and labelling in an adequately permanent manner or complete removal.

When removal of or interference with the identified asbestos-containing material is deemed necessary (eg poor condition, industrial relations reasons, company policy), it should only be undertaken by a licensed asbestos removalist.

Details of approved companies can be obtained by contacting the various State OH&S authorities (eg WorkCover NSW).

The asbestos removal industry has a poor history for compliance to statutory requirements and it is wise to ensure that only licensed removalists with a proven record of good performance are employed. As a final step insist that the asbestos removalist provide proof of disposal in an approved asbestos waste disposal facility.

Remember, most State Governments have statutory reporting requirements in respect to the removal and disposal of asbestos. Be sure to check what needs to be done prior to commencing the removal.

In those rare cases where it may be necessary to work with asbestos products on-site, care should be taken if cutting or milling is necessary. Power tools must NOT be used; hand tools only, with appropriate dust suppression methods and respiratory protection for those working with asbestos-containing material should be used.

Asbestos is likely to be on-site in building materials (eg asbestos containing fibro cement sheeting) at coal mines established prior to the mid 1980's. The presence of asbestos does present a hazard, however the risk of adverse health effects is minimal if the asbestos is in good condition and fibres are not generated so that inhalation can occur.

Remember, adverse health effects only occur after repeated exposure to high concentrations of airborne asbestos fibres and skin contact is not a major issue. A site asbestos management plan (ie register labelling, removal policy, etc) is a major tool in addressing the concern of employees in relation to asbestos.

ASBESTOS BANNED IN AUSTRALIAN WORKPLACES

An Australia-wide ban on all new uses of asbestos and materials containing asbestos started on 31 December 2003.

It will be illegal under the laws of each state and territory to use, re-use or sell any products containing asbestos, including automotive brake pads and gaskets.

The same prohibitation applies in the Australian government sector and it will be complemented by a Customs regulation banning imports and exports.

The ban does not apply to asbestos products and materials that are already in place, but when they are replaced, non-asbestos alternatives must be used.

Any stockpiles of asbestos-containing products must be safely disposed of under the applicable state and territory regulations.

The few exemptions to the ban are restricted in scope and will operate for a limited time. They only apply where there are much greater risks to safety if asbestos is not used. Protection from exposure is still required in these cases.

FURTHER READING

1. Code of Practice for the Management & Control of Asbestos in the Workplace [NOHSC: 2018(2005)], Canberra 2005.

2. Principles of Occupational Health & Hygiene. An Introduction, Ed C Tillman, AIOH, 2006.

b) CONFINED SPACES

Each year a number of people lose their lives unnecessarily when working in confined spaces. In most incidents little attention is paid to assessing the situation and many foolish people enter confined spaces without knowing the nature of the environment in the confined space. In other incidents they inadvertently generate toxic gases, by which they are overcome, during their work activities within the confined space.

To reduce these incidents, statutory authorities in all States have produced either regulations or codes of practice to control work in confined spaces. As a result of a joint venture between Standards Australia and NOHSC an Australian Standard on confined space entry (AS/NZS 2865-2001 was produced[1] and is the common denominator for regulatory control used by OH&S authorities across Australia. This section concentrates on this Australian Standard and attempts to highlight those procedures that should be adopted before entry to any confined space at a minesite is undertaken. Guidelines[2] for safe working in confined spaces have also been produced by Standards Australia

What is a Confined Space?

Under AS/NZS 2865-2001 a confined space is defined as an enclosed or partially enclosed space which:-

a) *is at atmospheric pressure during occupancy;*

b) *is not intended or designed primarily as a place of work;*

c) *may have restricted means for entry and exit; and*

[1] AS/NZS 2865 - 2001 Safe working in a confined space.
[2] HB 213:2003 – Guidelines for working in a confined space.

d) may

i) have an atmosphere that contains potentially harmful levels of contaminant;

ii) not have a safe oxygen level; or

iii) cause entrapment of workers.

In relation to coal mines, examples of confined spaces would include (but are not limited to)

- Open topped spaces such as pits or degreasers, trenches deeper than 1.5 m
- Pipes, sewers, septic tanks
- Boilers, pressure vessels, fuel tanks
- Washery tanks, pipework, etc
- Access tunnels beneath coal dumps, etc
- Coal storage bins (above and below ground)

Assessment of Confined Spaces

It is a requirement under AS/NZS 2865-2001 that for any proposed work, an employer must identify all confined spaces and the hazards associated with working in those confined spaces. This is normally accomplished by means of a risk assessment conducted by a competent person(s). As a minimum, the assessment needs to take into account:

a) the nature of the confined space;

b) the work required to be done;

c) whether it is necessary to enter the confined space;

d) the range of methods by which the work can be done;

e) the hazards involved and associated risks;

f) the actual method selected (and in particular whether the method will alter the atmosphere in the confined space) and equipment proposed; and

g) emergency and rescue procedures.

Risk Factors

As part of the risk assessment, various factors[1] need to be considered and these include:

a) arrangements for rescue, first aid and resuscitation;
b) the number of persons occupying the space;
c) the number of persons required outside the space to maintain equipment essential for the confined space task, to ensure adequate communication with and observation of the persons within the confined space, and to properly execute rescue procedures;
d) all proposed operations and work procedures, particularly those that may cause a change in the conditions in the confined space;
e) the soundness and security of the overall structure and the need for illumination and visibility;
f) the identity and nature of the substances last contained in the confined space;
g) the steps needed to bring the confined space to atmospheric pressure;
h) the atmospheric testing to be undertaken and the parameters to be assessed before the entry permit is issued;
i) all hazards which may be encountered (for example, entrapment of workers);
j) the status of fitness and training of those persons involved in confined space work;
k) adequate instruction of those persons in any work procedure required including rescue operations, particularly those which are unusual or non-typical, including the use and limitations of any personal protective equipment and mechanical or other equipment to be used;
l) the availability and adequacy of appropriate personal protective equipment, protective clothing and rescue equipment for all persons likely to enter the confined space;

m) where signs:
   i) comply with AS 1319-1994[3]
   ii) indicate that entry is permitted only after a responsible officer has signed the entry permit, in a manner appropriate to the persons at the workplace;

n) the need for additional protective measures, for example:
   i) prohibition of hot work in adjacent areas,
   ii) prohibition of smoking and naked flames within the confined space and, where appropriate, the adjacent areas,
   iii) avoidance of contamination of breathing atmosphere from operations or sources outside the confined space, such as from the exhaust of an internal combustion engine, and
   iv) prohibition of movement of equipment such as forklifts in adjacent areas and,
   v) prohibition of spark generating equipment, clothing and footwear,

o) whether cleaning in the confined space is necessary; and

p) whether hot work is necessary.

Typical Programme Elements

If, after all the above checks are completed satisfactorily, entry into a confined space is considered necessary the following elements of a confined space entry programme need to be applied.

- Training - This is of paramount importance and should include a mock rescue.

- Entry Permit System

- Atmospheric Monitoring - Problems may arise, eg if gas monitoring equipment is not calibrated before use, or is not configured for the gases present (does not have a

[3] AS 1319-1994 Safety signs for the occupational environment.

H_2S sensor if used in a sewer for example) or its use and interpretation of results are not well understood by those using the instrument.

As a minimum, the following atmospheric conditions should be observed

Oxygen:	Not less than 19.5% Not more than 23.5%
LEL:	Less than 5% before entry is possible but may rise as high as 10% after entry before evacuation is necessary, provided continuous monitoring and respiratory protection are used.
Toxic Gases:	Are maintained below relevant exposure standards. (The current exposure standards are now published on the Australian Safety & Compensation Commission website: http://hsis.ascc.gov.au/SearchES.aspx (accessed October 2008) if none exist in State regulations).

- Communications System - Including designated sentries, etc.
- Personal Protective Equipment - Must meet appropriate standards (for respiratory protective devices see AS/NZS 1715:1994[4] and AS/NZS 1716:2003[5]).
- Rescue and Emergency Response Procedures.
- Signage and barricades.

[4] AS/NZS 1715:1994 Selection, use and maintenance of respiratory protective devices.
[5] AS/NZS 1716:2003 Respiratory protective devices.

If all the above elements are in place then it is likely that confined space work can proceed without undue risk to those involved.

Useful Work Practices to Prevent Accidents

The following work practices should minimise the possibility of accidents occurring on-site involving confined spaces, however the development of comprehensive procedures and their implementation, will allow required work to take place in confined spaces.

To prevent accidents:

- Survey the workplace to identify all the confined spaces on-site.
- Where possible, barricade the confined spaces before working in them. If barricades are not possible suitable means to prevent entry prior to finalisation of the requirements of the entry permit must be in place.
- Prevent unauthorised entry to confined spaces.
- Signpost the confined spaces to warn of dangers in these areas.
- Modify work practices and/or engineering controls where possible so that entry into a confined space is not necessary.
- All pipes, etc to the confined space should be blanked off or spool pieces removed before work commences.
- All electrical and mechanical gear to be locked off and tagged with 'DO NOT OPERATE' signs as part of the requirements for a confined space entry permit.

- Recognise and document the particular stages in the production process during which toxic gases may accumulate in a confined space.

- Schedule work to be done in a confined space outside these high risk periods. The full procedure should still be adhered to even in apparently low risk periods.

- Seek professional assistance if site personnel are not experienced in confined space entry procedures. Numerous organisations provide on-site training.

c) WORKPLACE CHEMICALS:-

The Australian Safety & Compensation Council (ASCC) has declared National Standards and Codes of Practice, along with guidance material, for hazardous substances and dangerous goods. These documents form the basis of a nationally consistent regulatory approach for the control of workplace dangerous goods and hazardous substances.

These Standards, Codes of Practice and the Hazardous Substances Regulatory Package can be accessed at the ASCC website located at: www.ascc.gov.au/ascc/HealthSafety/HazardousSubstances/ (accessed October 2008).

DANGEROUS GOODS

Dangerous Goods are substances or articles that, because of their physical, chemical or acute toxicity properties, present an immediate hazard to people, property or the environment.

The criteria used to determine whether substances are classifies as dangerous goods are contained in the Australian Dangerous Goods Code[1] which itself is aligned closely with the criteria of the United Nations' Recommendations on the Transport of Dangerous Goods – Model Regulations[2] and the Australian Standard AS 1940-2004 - The storage and handling of flammable and combustible liquids[3].

The ADG Code contains a list of substances classified as dangerous goods.

1 Australian Dangerous Goods Code – Road and Rail – 7th Edition, Commonwealth of Australia.
2 Recommendations on the Transport of Dangerous Goods – Model Regulations – 13th Edition, United Nations.
3 AS 1940-2004 The storage and handling of flammable and combustible liquids. Australian Standard 1940-2004.

Dangerous goods are divided into nine classes:

Class 1	-	Explosives
Class 2		Gases
Class 3	-	Flammable Liquids
Class 4	-	Flammable Solids
Class 5	-	Oxidising Agents and Organic Peroxides
Class 6	-	Poisonous (toxic) and Infectious Substances
Class 7	-	Radioactive Substances
Class 8	-	Corrosives
Class 9	-	Miscellaneous Dangerous Substances

These classes can be further sub-divided to reflect the variations in properties of the materials, eg Gases.

Class 2 - Gases

Gases that are compressed, liquefied or dissolved under pressure. Some gases have subsidiary risk classes; flammable or corrosive.

Class 2.1 Flammable Gases: Gases that ignite on contact with an ignition source.
Examples: Acetylene, Hydrogen, LPG (Liquefied Petroleum Gases).

Class 2.2 Non-Flammable Gases: Gases that are neither flammable nor poisonous.
Examples: Nitrogen, Medical Air, Argon.

Class 2.3 Poisonous Gases: Gases liable to cause death or serious injury to human health if inhaled.
Examples: Ammonia, chlorine, carbon monoxide.

Each class or sub-class has been assigned a label as illustrated in Figure 4-02c(I).

FIGURE 4-02c(I)

Depending on a materials classification under the Dangerous Goods Regulations (or the quantity of material in some cases), specific requirements exist under different legislations:

To assist emergency services personnel **placards** provide useful information about dangerous goods on the premises. If the quantity of dangerous goods is above the “placarding quantity” threshold a HAZCHEM placard must be displayed at the entrance to the premises. Other types of placards are also required at each location where dangerous goods are stored or handled.

The **manifest** provides emergency services personnel with information about the quantity, type and location of dangerous goods on the premises. It enables them to respond appropriately to serious incidents.

If the quantity of dangerous goods on the premises is above the manifest quantity a manifest must be prepared and maintained that covers the whole premises. The manifest must be readily available to emergency services personnel and to workplace inspectors.

Notification of dangerous goods on site in excess of the manifest quantity threshold must be notified to State regulatory authorities (eg WorkCover NSW) to assist in the provision of emergency responses and planning.

Determining Quantities

To determine whether you have to placard, to prepare a manifest and notify of dangerous goods on your premises:

- List all dangerous goods on the premise
  - include location and type of storage
  - separately list each class, sub-class and, where applicable, packing group

- Calculate the total quantity of dangerous goods on the premises
  - calculate the total capacity of each dangerous good in each storage location, including those in process and empty containers (drums and tanks)
  - dangerous goods loaded onto vehicles for transport should be included in the calculations of the quantities, except dangerous goods in transit (shipping documents will cover these)
  - check the quantities for mixed classes of dangerous goods

Diesel fuel is a C1 combustible liquid and:

- has a lower threshold quantity when stored with other fire risk dangerous goods

- has a higher threshold quantity when stored and handled separately from other dangerous goods – separation may be achieved by either distance or barrier

- WorkCover would consider storage of diesel fuel to be separate if kept over 50 metres from other fire risk dangerous goods – eg for rural on farm storage. In this situation it would be accepted that the quantity requiring placarding would be 10,000 L and the quantity requiring preparation of a manifest and notification would be 100,000 L.

Coal mines are covered by the Dangerous Goods Regulations and are subject to inspection at any time.

Even if licensing of a product is not required, it must be handled and stored correctly. A specific example of this is products of a class 3 sub-group C2, ie combustible liquids with a flash point of greater than 150°C, eg lubricating oils.

Even though a licence is not required for these products they must be stored in accordance with AS 1940-2004 which spells out the requirements for spill containment, segregation, fire extinguishers, etc.

While most coal mines are aware of their responsibilities in respect to highly dangerous goods on site, such as explosives, experience has demonstrated that a similar level of awareness does not exist in respect to other dangerous goods. A classic example is the treatment of compressed gas cylinders with cases of unrestrained cylinders, unapproved storage facilities, etc being common throughout the Mining Industry in general (not only coal). In many instances the storage conditions of combustible liquids on site (especially waste or used oils) is far below that expected by AS 1940.

It is strongly suggested that Operations conduct an audit of their site in respect to the storage and handling of dangerous goods. Most State Governments have specialist personnel who can assist in this area with the provision of advice or information. Specialist private consultants are also available to assess sites upon request.

Guidance as to the requirements for the use, storage and handling of dangerous goods can be obtained from the National Dangerous Goods Frameworks' two key documents (ie The National Standard and the National Code of Practice) located on the ASCC website located at: www.ascc.gov.au/ascc?healthSafety/HazardousSubstances/ (accessed October 2008).

The National Standard sets out the requirements to ensure the effective control of the storage and handling of dangerous goods.

The National Code of Practice provides advice on compliance for those who have duties under the National Standard. It also provides specific information and guidance for the storage of dangerous goods in minor quantities, and in consumer packages supplied by retailers.

Specific advice on the transportation of dangerous goods by road or rail is available in the Australian Dangerous Goods Code.

Proposed Revisions to the Workplace Chemicals Regulatory Framework.

In the current workplace chemicals framework, hazardous substances and dangerous goods are dealt with using two different regulatory instruments, even though both instruments apply to the same substances in many cases. While many requirements under the hazardous substances and dangerous goods regulatory framework are the same, there are a number of inconsistencies. These inconsistencies create confusion in the workplace and add to the regulatory burden on business.

Several years ago the National Occupational Health and Safety Commission (NOHSC), the predecessor to the ASCC, agreed that the hazardous substances and dangerous goods regulatory frameworks should be combined into a single system be based on the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

The main concepts of the proposed framework are therefore:

- To consolidate the requirements for workplace hazardous substances and dangerous goods into a combined framework

- To integrate the classification, labelling and safety data sheet requirements of the hazardous substances and dangerous goods frameworks, using guidance from the GHS.

The ASCC has released Draft National Standards and Codes of Practice for the Control of Workplace Hazardous Chemicals for public comment and are currently reviewing the submissions received from Industry, Unions, and State and Territory Governments.

d) DERMATITIS

Occupational diseases of the skin have plagued mankind since antiquity but little was written about them until 1700 when Ramazzini published his classical text entitled “De Morbis Artificum” (A Treatise of the Disease of Tradesmen).

Occupational diseases of the skin are common for at least two reasons: first, the skin has a large surface area available for contact exposure; and second, the work environment contains innumerable natural and artificial materials capable of exerting chemical, physical, mechanical, biological or photoreactive insults on the skin. Causative agents therefore are diverse, but chemicals (hazardous substances) are by far the most frequent offenders.

Primary Irritants

Primary irritant chemicals cause most occupational dermatitis. These agents will cause dermatitis by direct action on the normal skin at the site of contact if they are permitted to act in sufficient intensity or quantity for a sufficient length of time. Thus, normal skin will almost always react to a primary irritant if the above requirements are met. Strong irritants such as sulphuric acid, sodium hydroxide, or methyl bromide produce an observable effect within a few seconds, depending upon their concentration. Conversely, weak or marginal irritants such as acetone and mineral oil may require several days or months before a clinically recognisable change occurs.

Allergic Sensitisers

It is generally agreed that allergenic materials cause 20 percent of occupational contact dermatitis. Practically any chemical can act as a sensitiser, but certain groups are more powerful than others are. Some examples are epoxy monomers and their amine hardeners, most polyurethanes, potassium dichromate, nickel, formaldehyde and certain wood dusts.

Sensitisers differ from primary irritants in their mode of action and in the effects they cause within the skin. Most sensitisers do not produce demonstrable changes on first contact or perhaps for many weeks or months. The sensitiser induces certain specific cellular changes in the skin so that after a period of incubation (five to seven days or more) further contact with the same or a closely chemically related agent on the same or other parts of the skin results in an acute dermatitic reaction.

The essential differences between primary irritation and allergenic sensitisation, therefore, are time and a different mechanism of action. Another difference, which may be noted, is that an irritant usually affects a number of workers whereas a sensitiser generally affects a few. This, of course, does not apply to potent sensitisers.

Also, recovery from dermatitis caused by primary irritants is usually complete, given adequate treatment, but allergenic sensitisation is likely to be long lasting, if not permanent.

Photosensitisers

Photosensitivity is the capacity of an organ or organism or certain chemicals and plants to be stimulated to activity by ultra violet light (UV) or to react to (UV) light.

Photosensitisers are divided into “phototoxic” and “photoallergic” materials. Several derivatives of coal tar, eg anthracene, phenanthrene, and pitch are known photosensitisers.

Photobiologic effects such as melanosis or photodermatitis are associated with specific chlorinated hydrocarbons, certain essential oils such as bergamot, and a number of plants such as limes, wild parsnip and fennel.

Phototoxicity, like primary irritation, can affect anyone; however, heavily pigmented skin is more resistant. Similarly, photoallergens, like allergic sensitisers, affect fewer people.

Mechanical and Biological Causes

Work processes, or variations of them may produce some degree of mechanical trauma involving friction or pressure resulting in an abrasion. This breaking of the skin provides a route of entry for bacteria, fungi, etc, resulting in skin disease.

Experience has shown coal miners suffer a higher level of dermatoses than other occupations. An examination of insurance records suggests that most cases involve contact dermatitis, which should be preventable through changes to work practices, substitution of substances and attention to appropriate personal protective equipment. The use of aggressive, abrasive cleaners by mine personnel both on the job and in the bathroom may also be a contributor to the prevalence of this disease within the industry.

The last area that appears to be highlighted in insurance incident reports is the impact of mine water on individuals, especially if it gains ingress to boots. Failure to dry inside footwear or feet in these situations and then continue to walk for the rest of the day in wet socks and boots may cause an abrasion and provide an entry route for bacteria.

A few simple steps will reduce the chances of contracting dermatitis. These are:

- Do not handle any chemicals, solvents, cements, etc with bare hands. Always use personal protective equipment and if splashed with a material, wash it off with water immediately. If splashing or spraying is likely, wear a face shield.

- Use cleaners in moderation. Over-use of these agents does little to improve the cleaning action but does increase the risk of disease by the removal of natural fats from the skin.

- If the insides of boots get wet with mine water, dry the feet, socks and the inside of the boots before walking any distance. Padded and double acrylic socks have been found to be the most suitable for mining activities.

- Practice good personal hygiene. Do not use abrasive skin cleaners.

e) DIESEL EXHAUST FUMES

Diesel exhaust emissions have given rise to increased anxiety in coal mines in respect to adverse health effects ever since diesel equipment was introduced in the early 1950's. As a result of this anxiety, numerous research projects have taken place in the United States, Canada, Europe and Australia. Some of these research projects have focused on the effect of exposure to diesel exhaust emissions while others have concentrated on understanding the composition of diesel exhaust emissions and developing appropriate control technologies. A complete review of the literature relating to diesel exhaust emissions is beyond the scope of this Manual, but a summary of the main issues is provided in this section. More detailed information on diesel particulate can be found in the Australian Institute of Occupational Hygienists' publication on diesel particulate.[1]

Composition of Diesel Exhaust Fumes

Diesel exhaust has been shown to contain thousands of gaseous and particulate substances, some of which are known to exhibit some form of biological activity. While the major gaseous components found in air (nitrogen, oxygen, argon, carbon dioxide, water vapour) comprise approximately 99 percent of the mass of diesel exhaust, much smaller quantities of other gases and vapours such as carbon monoxide, nitric oxide, nitrogen dioxide, sulphur dioxide and hydrocarbons are also present. This complex mixture is in a continual state of flux because a normally aspirated diesel engine draws in a constant charge of air, and various load conditions are met by changes in the quantity of fuel injected into this air and ignited in the combustion chamber.

[1] A Guideline for the Evaluation and Control of Diesel Particulate in the Occupational Environment, AIOH, 2004.

Therefore the composition of exhaust gas from a diesel engine changes constantly as the fuel/air ratio is altered to meet variable demands for power.

Particulate matter is also found in the exhaust of diesel engines. Diesel particulate matter is a complex mixture of compounds composed of non-volatile carbon, large numbers of different adsorbed or condensed hydrocarbons, sulphates and trace quantities of metallic compounds.

Over recent years attention has focused on diesel particulate matter for a number of reasons. Firstly, research has shown that diesel particulate matter is almost entirely respirable, with about 90 percent by mass having an equivalent aerodynamic diameter of less than 1.0 µm. This means that the particles can penetrate to the deep regions of the lungs, where, if retained, there is a possibility that they may participate in some form of biological activity. The role of elemental carbon (the central carbon core) in diesel particulate has gained significant prominence in relation to possible adverse health effects and is the focus of regulatory attention in many countries.

Emissions have been shown to be influenced by such factors as engine type, duty cycle, fuel quality, engine maintenance, intake ambient conditions, operator work practices and emission controls.

Because of this variability it is difficult to define a typical diesel exhaust, however it is clear they do contain some compounds which require appropriate control procedures to minimise worker exposures. These compounds include:

- Carbon monoxide
- Oxides of nitrogen
- Sulphur dioxide
- Aldehydes
- Hydrocarbons
- Diesel Particulate

Health Effects

Carbon Monoxide (CO)

CO is a chemical asphyxiant, which if inhaled in sufficient concentration, will be fatal. Approximately 80-90% of inhaled CO binds with the haemoglobin in the blood, resulting in a severe reduction in the oxygen carrying capacity of the blood. Consequently regulations under the Coal Mines Regulation Act provide for limits to minimise exposure and thus keep the oxygen concentration of the blood above an acceptable minimum level. Research has suggested that the normal population contains a significant proportion of people who may suffer from undetected cardio-vascular disease and on this basis the exposure standard has been reduced to 30 ppm to better protect for this possibility. The NSW Department of Mineral Resources has adopted exposure standards promulgated by the Australian Safety & Compensation Commission (ASCC) which are updated at their website at: http://hsis.ascc.gov.au/SearchES.aspx (accessed October 2008).

Operators in other States may wish to adopt a similar approach.

Oxides of Nitrogen (NO_x)

This is a general title to cover five compounds containing oxygen and nitrogen. The two major compounds found in diesel exhaust emissions are:

Nitric Oxide (NO)

The toxicological pathway for NO is uncertain. It is possible that NO may act as a chemical asphyxiant similar (but much less severe), to carbon monoxide, however human studies have not supported this belief.

Much of the literature suggests that NO is relatively non-toxic when compared with nitrogen dioxide. No effects have been reported in humans alone, however mixtures with other Nitrogen Oxides (eg NO_2) have resulted in adverse health effects.

Nitrogen Dioxide (NO_2)

Inhalation of high concentrations of NO_2 will induce pulmonary edema, which may be fatal. The incidence of chronic effects from long exposure at low concentrations is less well defined, however cases of emphysema and chronic bronchitis have been reported.

Aldehydes

Small amounts of aldehydes occur in diesel exhaust, some of which are known to produce irritant effects especially in regard to the eyes. Some aldehydes have been implicated in more serious health issues, however the low concentrations normally found in diesel emissions significantly reduce the likelihood of any such occurrences.

Hydrocarbons

These result from the presence of unburnt fuel and thus their composition is continuously varying, depending on load. While it is true that some hydrocarbons can have adverse health effects, the concentrations usually present should not present a risk.

Sulphur Dioxide (SO_2)

Sulphur dioxide causes irritation of the mucous membranes, which probably results from the action of sulphurous acid formed when the highly soluble gas dissolves in the body fluids.

Short term exposure causes bronchoconstriction which results in an increase in flow resistance or difficulty of breathing.

Diesel Particulate (DP)

The potential for adverse health effects in humans arising from excessive exposure to diesel particulate has been the subject of intense scientific debate for many years and due to areas of uncertainty may well be for many more. Notwithstanding this debate there is sufficient evidence to suggest diesel particulate is a potential carcinogen and thus various regulatory authorities around the world are moving to control employee exposure to this contaminant.

Between 1957 and 1999, 47 epidemiological studies have been reported in the literature where the prevalence of lung cancers in workers has been evaluated in respect to exposure to diesel particulate matter. Many of these studies have been discounted due to issues with study design, but in 1955 the US based Health Effects Institute (an industry-government funded organisation) reviewed 30 such studies and concluded the data was consistent in showing weak associations between increased risk of lung cancer and exposure to diesel exhaust.

A statistical analysis of all epidemiological data reported in the literature was undertaken by two independent researchers in 1998 and 1999 with both groups reporting a causal association between increased risk of lung cancer and exposure to diesel exhaust.

The US Mine Safety & Health Administration in their review of the data suggested that a mean concentration of 0.64 mg/m^3 Diesel Particulate (approximately 0.32 mg/m^3 Elemental Carbon (EC)) for a period of 45 years occupational exposure would result in a doubling of the risk of cancer compared to that of unexposed miners.

In May 2002 the US Environmental Protection Agency (EPA) concluded that lung cancer was evident in occupationally exposed groups but was unable to determine a degree of potency.

At this point in time most overseas regulators are focussing on EC as the measure of workplace exposure to diesel particulate. Research is ongoing with respect to particle size and total surface area.

In recent years greater focus has been placed upon the non malignant health aspects associated with exposure to diesel particulate. Perhaps the most definitive statement on this aspect was made in 2002 when the EPA concluded that:

(i) Exposure to diesel emissions (including particulate) may give rise to eye, throat and bronchial irritation, light headedness, nausea, cough and phlegm.

(ii) Based on animal evidence the potential for existed for chronic respiratory disease.

Other research has suggested that the irritant effect of exposure to diesel emissions which has traditionally been attributed to aldehydes in fact arises from the fine diesel particulate which impacts the mucus membranes causing a local irritant effect and at high concentrations a stinging sensation and lachrymation.

In summary it is reasonable to state based on the totality of the scientific literature most informed professionals would recognise that diesel particulate is a potential carcinogen.

As a well defined dose response relationship between exposure and health outcomes currently does not exist there is little doubt that this area will be the subject of further research and debate.

Given the current state of knowledge there is sufficient evidence to indicate that an 8-hour time weighted average exposure standard of 0.1 mg/m^3 (measured as elemental carbon) should provide adequate protection against irritant effects and also minimise any risk of lung cancer.

Control of Emissions

Considerable research has been conducted throughout the world on specific measures to control diesel emissions. In Australia, BHP Billiton– Illawarra Coal was a leader in this area and participated in a committee established by the NSW Minerals Council to develop strategies to address this issue. This resulted in a guideline[2] that spells out how various operators have addressed the issue of minimising diesel exhaust emissions.

More recently BHP Billiton[3] has published a management guide which brings together best practices from both the coal and metalliferrous mining sectors.

A comprehensive overview of the topic is also provided in the AIOH publication[1]. This publication can be obtained through the Australian Institute of Occupational Hygienists www.aioh.org.au/ (accessed October 2008).

[2] NSW Minerals Council: Diesel Emissions in Underground Mines; Management & Control, October 1999.

[3] BHPBilliton: Diesel Emissions Management, January, 2005.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**SPECIFIC ISSUES IN THE COAL INDUSTRY**

f) DUST

Atmospheric dust can give rise to a number of lung disorders or diseases. One of these diseases is pneumoconiosis, a term proposed by a researcher in 1866 as a general term for lung diseases caused by dust inhalation. In fact various types of pneumoconiosis can be induced by over-exposure of workers to the dusts of many agents, including:

Hematite (iron oxide)	-	Siderosis
Antimony (compounds)	-	Antimony Pneumoconiosis
Barium (compounds)	-	Baritosis
Tin (compounds)	-	Stannosis
Asbestos	-	Asbestosis
Silica	-	Silicosis

Many of these pneumoconioses are benign and merely show up as shadows on workers' X-rays.

Other pneumoconioses, such as asbestosis, berylliosis (from the dust of beryllium) and of course coal workers' pneumoconiosis, are much more harmful and lead to the development of fibrosis of the lungs.

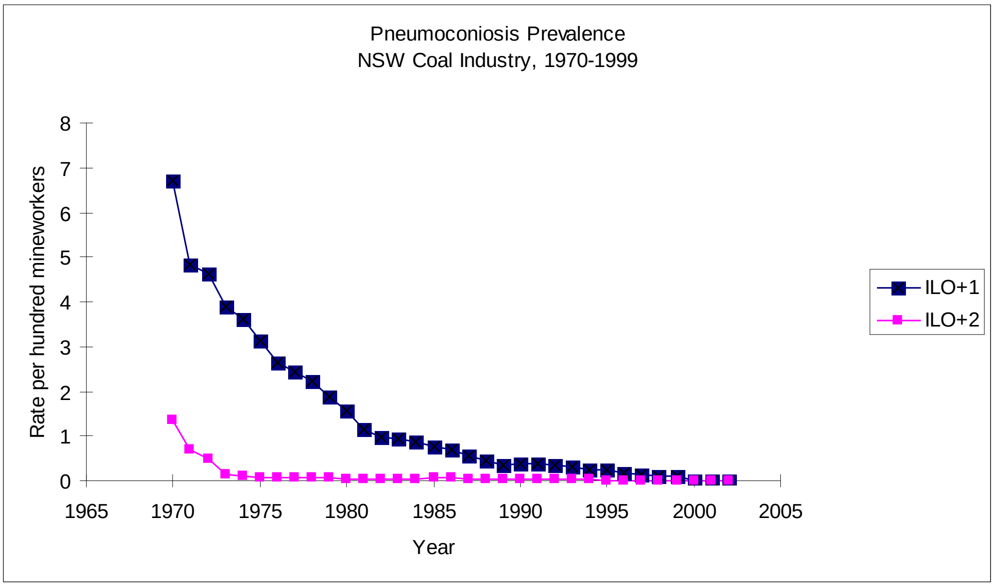
Coal workers' pneumoconiosis results from the gradual accumulation of coal dust particles within the lung tissue, usually over a period of many years. Most of the dust that is inhaled does not lodge in the lungs. The larger particles are trapped in the nose and throat and the very smallest particles are exhaled in the same breath.

Only the particles in the 0.5 to 7 micrometre size range (respirable dust) are deposited and the lungs have special clearance mechanisms to remove most of these particles over the course of the next few days or weeks.

The respirable dust which is not cleared aggregates to form nodules which can be seen at post mortem or on a chest X-ray examination. Generally, at least 20 to 30 years of exposure is necessary to produce any significant degree of disease.

In 1780 the first successful attempt to distinguish between pneumoconiosis and tuberculosis was provided by Ackerman, but this distinction was not appreciated at the time. By the early 1800's considerable evidence was emerging regarding the nature of disease experienced by workers in mining operations (especially with respect to lung disorders). It is interesting to note that in the UK by 1852, occupational diseases (mainly lung diseases) extracted a bigger toll on miners' lives than major mine disasters, which were themselves quite frequent at the time. As a result of a series of Acts in the UK parliament in the 1850's, the position improved, but respiratory disease remained a major hazard in the Coal Mining Industry.

In Australia a similar picture developed with coal workers' pneumoconiosis being a major problem in the coal industry; as demonstrated by the fact that in 1948 16% of the NSW coal mining workforce displayed some level of this disease.



The ILO classification of x-rays is a method of grading based on x-ray appearance and may be in practical terms interpreted as the following:

ILO+1 = People with diagnostic features of dust exposure but no clinical symptoms

ILO+2 = People with more severe dust exposure than above and likely to have symptoms

TABLE 4-02f(I)

Improvements over the years (Table 4-02f(I)), were mainly due to major alterations to the mining practices and ventilation systems used in underground coal mines. Despite the introduction of mechanisation to the industry in the 1950's, the incidence of coal workers pneumoconiosis continued to decline and although some problems with dust control have occurred since the introduction of longwall mining in the 1960's, most have been resolved following extensive monitoring programmes and the introduction of appropriate engineering and procedural controls.

In all cases, pneumoconiosis can be prevented provided exposure to respirable coal dust is maintained below statutory levels.

Another factor in exposure to respirable dust is the possible presence of silica (quartz). This can result in silicosis if exposures are significant. It is thought to play a role in the development of lung cancer, although the pathway and mechanism for this are not known. There are sound health reasons for keeping exposure to silica as low as possible, and while this may not present a problem in most coal mines (because the free silica in the coal is low), those mines with stone intrusions into the seam or where the brushing of the floor, etc is common, may have a more serious problem which needs management if exposures are to be kept below statutory levels. Some stemming materials in open cut mines has been found to contain very high levels of silica. Alternatives to the use of silicious materials in these applications is prudent so as to reduce the exposure of blast crews.

In most states, specific ventilation, monitoring and exposure levels are provided in legislation, which should be observed in order to minimise the occurrence of lung disease.

One emerging issue is that of inhalable dust (the total of all dust size fractions inhaled). This comes about from concern first raised in the British Coal Workers compensation case and at this stage the potential health effects of inhalable dust are unclear. Work by some researchers (see Section 5-05d) has indicated that workers on longwalls and in continuous miner panel may be exposed to elevated levels of this dust fraction.

A Review[1] of health effects associated with exposure to inhalable coal dust did not find any conclusive evidence of adverse health effects from long term exposure to coal dust in addition to those already established for general dusts. The proposed introduction of a recommended standard of $10mg/m^3$ was supported with recommendations of further sampling of inhalable dust, characterisation of particle size distribution and medical surveillance of respiratory symptoms for possible correlation with inhalable dust levels.

[1] Jennings, M., & Flahive, M., (2005): Review of Health Effects Associated with Exposure to Inhalable Coal Dust, October 2005.

The Standing Dust Committee of Coal Services Pty Ltd has investigated this issue and airborne dust limits were gazetted under the NSW Coal Mine Health and Safety Regulations in December 2007[2].

The following limits have been set for the concentration of airborne dust:

(a) Specified Limits for Respirable Dust – Underground Mines:

The specified limit for quartz-containing dust is 0.12 milligrams of respirable quartz and the specified limit for respirable dust, other than quartz-containing dust, is 2.5 milligrams. These limits are with respect to the mass of respirable dust per cubic metre of air sampled and apply only to the underground parts of underground mines.

The limits below for open cut mines apply to the surface parts of underground mines.

(b) Specified Limits for Respirable Dust – Open Cut Mines:

The specified limit for quartz-containing dust is 0.1 milligrams of respirable quartz and the specified limit for respirable dust, other than quartz containing dust, is 2.5 milligrams. These limits are with respect to the mass of respirable dust per cubic metre of air sampled.

These limits also apply to coal preparation plants.

[2] New South Wales Government Gazette No 185. Coal Mine Health and Safety Act 2002, Coal Mine Health and Safety Regulation 2006, Notice – Airborne Dust Limits, Collection and Analysis, 21 December 2007

(c) Specified Limits for Inhalable Dust – All Coal Operations.

The specified limit for inhalable dust is 10 milligrams. This limit is with respect to the mass of inhalable dust per cubic metre of air sampled.

Criteria is also set out for arrangements for the regular collection and analysis of samples, by a licensed person independent of the operation, of airborne dust from the breathing zone of people whose health may be affected by the dust for:

a) Frequency of sampling, places and persons to be sampled
b) Determination of respirable dust
c) Determination of respirable quartz
d) Determination of inhalable dust
e) Sampling

Coal Services have just released a new and revised booklet[3] on Airborne Dust in Coal Mines that poses questions and provides the answers to the commonly asked questions about this topic.

[3] Coal Services Pty Ltd, Airborne Dust in Coal Mines: Respirable Dust, Respirable Quartz and Inhalable Dust, October, 2008.

g) GENERAL AIRBODY GASES

Airbody gases play a major role in the health and safety of the coal mining industry. Mine gases have in the past been responsible for significant loss of life in Australian and overseas coal mines, be it by poisoning, asphyxiation or blast injuries due to explosions.

Detailed discussion of mine gases is beyond the scope of this Manual, however the following overview prepared by Mr Wilhelm Linnenlücke, provides some insight into the issues associated with these gases. More detailed information should be obtained from the local Mines Inspectorate and/or Mines Rescue Service. An excellent account of gases that occur or are produced in coal mines can be found in the Mines Rescue Board publication "Emergency Preparedness and Mines Rescue"[1].

Air

Air is colourless, odourless and tasteless and has a specific gravity of 1, so in underground mines denser gases such as carbon dioxide will usually concentrate in low pockets and lighter gases such as methane accumulate along roofs. Although air itself is non-flammable, it will support combustion.

The approximate composition of air is:

Oxygen	20.93	percent
Nitrogen	78.11	percent
Carbon Dioxide	0.03	percent
Inert Gases	0.93	percent
Water Vapour	Variable, depending on humidity	

[1] Mines Rescue Service (1999): Emergency Preparedness and Mines Rescue.

However, most of the time in the mining industry the composition of air is loosely referred to as 21% oxygen and 79% nitrogen.

Oxygen is essential for all human and animal life, thus care must be exercised to ensure that adequate supply to workers is provided through appropriate ventilation.

Oxygen (O_2)

Oxygen makes up 21% of the air breathed by humans and deficiency may lead to asphyxiation. The minimum oxygen level required in New South Wales coal mines is 19%.

Oxygen has a specific gravity of 1.11, is colourless, odourless, tasteless and non-flammable, but a supporter for combustion and/or explosions.

The percentage of oxygen in the atmosphere can be measured with instruments using electrochemical sensors.

Nitrogen (N_2)

Nitrogen is the other major component of air (approximately 79%).

It has a specific gravity of 0.97, is colourless, odourless, tasteless and is non-poisonous, but does not support life and is non-flammable and incombustible in air or oxygen.

Nitrogen is also the major constituent of blackdamp and afterdamp (see later in this Section).

Unfortunately, no simple, direct means of detection of nitrogen for use in coal mines is readily available and analysis by gas chromatography affords the only method for detecting and measuring nitrogen.

Hydrogen

Hydrogen has a specific gravity of 0.07, is colourless, odourless, tasteless, combustible and highly explosive between 4 - 74% in air. It is regarded as the most dangerous of all flammable gases because of its wide explosive range and the almost absence of ignition lag.

Hydrogen is non-toxic but is an asphyxiant. It is a combustible gas and will burn with a bluish flame in air or oxygen forming water vapour. The flame may be almost invisible in some situations.

Hydrogen may be found behind seals for a few days after a mine fire is sealed off.

Two-thirds of the gas evolved during battery charging is hydrogen, therefore underground battery charging stations should be well ventilated to prevent any build-up of gas.

No simple means for the detection of hydrogen in coal mines is readily available.

Methane (CH_4)

Methane is a compound of carbon and hydrogen and thought to have been produced from the decay of vegetation at the same time as coal was formed, some hundreds of million years ago. Like a sponge soaked full of water, coal can in some circumstances be full of methane under pressure, and the methane be freely given off when mined.

Methane has a specific gravity of 0.55. Owing to its low density it tends to rise to the roof and higher parts of mine workings. It is colourless, odourless, tasteless and non-toxic, but it is an asphyxiant. Methane burns in air with a blue flame, forming carbon dioxide and water vapour.

Methane is highly explosive between 5.3% and 14% when mixed with air. It also has a lag of ignition that may vary from one-third of a second to eight seconds, depending on the percentage and temperature of the gas present.

Methane is the most common of flammable gases encountered in mining. Over centuries it has been the cause of very many mine explosions with the loss of countless lives. Where miners use the term “gas” it is generally methane to which they refer.

Ventilation is the most important control in mining for the dilution of methane, with particular attention to roof layers necessary.

Roof layers can be very dangerous as they may be only a few centimetres thick and hard to detect. Once ignited they act like a fuse, spreading quickly and may then ignite a larger accumulation of methane, such as goaf gas.

Methane can issue from coal seams, floor strata (due to a seam below) or from blowers. It may also be given off in outbursts, displacing the normal atmosphere and resulting in asphyxiation of workers.

Methane is generally detected with a Methanometer, however other techniques such as infrared analysers and gas chromatographs are also effective. Most coal mines employ a continuous monitoring system for the detection of methane.

Carbon Dioxide (CO_2)

Carbon dioxide has a specific gravity of 1.53. Owing to its high density it tends to accumulate on the floor and lower parts of mine workings. It is colourless, has a slight pungent smell and soda water taste. It is non-explosive and will not support combustion.

Although carbon dioxide is regarded as a non-toxic gas in low concentrations, it is an asphyxiant at high concentrations and readily displaces oxygen.

Carbon dioxide is also regarded as a "hot gas" due to its low thermal conductivity, thus heat is not conducted away as rapidly as in normal air so a person standing in it feels warm about the lower limbs. The exposure standard limit in coal mines is 0.5% (5,000 ppm).

Carbon dioxide is produced by complete combustion of any carbon based fuel. It also occurs naturally in coal deposits.

Carbon dioxide can be detected by a portable infrared analyser, gas chromatograph, detector tubes and portable instrumentation.

Carbon Monoxide (CO)

Carbon monoxide has a specific gravity of 0.97, is colourless, odourless and tasteless. It is combustible and explosive with a very wide explosive range between the LEL of 12.5%, and UEL of 74% in air. Carbon monoxide is formed during the incomplete combustion of any carbonaceous material, which occurs in mine fires, mine explosions or spontaneous combustion. Diesel exhaust emissions also contain carbon monoxide.

Carbon monoxide is encountered in mines and is considered to be particularly dangerous because it is extremely toxic but impossible to detect by smell or taste. Many persons have lost their lives in low concentrations of this gas without ever being aware of its presence.

While methane is regarded as being the cause of many disasters, carbon monoxide is the actual killer of countless lives. This was also the reason for the introduction of Carbon Monoxide Filter Self Rescuers in 1968 in NSW coal mines.

The way the gas acts is by displacing oxygen from the blood, thus depriving the brain and other vital organs of oxygen. The red blood cells have a higher affinity for CO than for O_2 (200 to 250 times greater). It accumulates in the blood and forms a stable compound called Carboxyhaemoglobin. 0.2% CO mixed in air is fatal in less than 1 hour, even at rest. Death rapidly occurs when the blood is saturated to 80% or more.

Early symptoms include shortness of breath and palliation on exertion; headache increasing in severity; judgement disturbed, loss of power in the legs. As exposure continues, mental confusion and collapse occur followed by unconsciousness and possible death.

The ASCC recommend an exposure standard of 30 ppm for carbon monoxide.

Carbon monoxide can be detected with carbon monoxide detector tubes or portable analysers. Most coal mines employ a continuous gas monitoring system for the detection of carbon monoxide.

Hydrogen Sulphide (H_2S)

Hydrogen sulphide has a specific gravity of 1.19 and is colourless, but has a sweetish taste and a powerful unpleasant odour resembling that of rotten eggs. It is explosive with a LEL of 4.5% and UEL of 45% in air.

It is a toxic gas, which irritates the eyes, the lungs and respiratory tract, but in particular it has a narcotic effect on the nervous system. The exposure standard for New South Wales coal mines is 10 ppm, but most managers observe much lower limits because of its pungent odour.

The gas is formed by decomposition of animal or vegetable matter containing sulphur. Small amounts may also be evolved from stagnant water containing rotting vegetation or bacteria. Hydrogen sulphide can also be produced by the heating of coal or strata containing sulphides.

Levels of hydrogen sulphide at 1 ppm can be detected by smell, however, nasal sensitivity decreases rapidly with exposure and increased concentration levels. Detector tubes are used in coal mines for detection of this gas.

Sulphur Dioxide (SO_2)

Sulphur dioxide has a specific gravity of 2.26, is colourless, incombustible and non-flammable but has an acid taste and a pungent "burning sulphur" smell.

It affects the body by irritating the eyes and respiratory passages. The exposure standard for New South Wales coal mines is 2 ppm.

Sulphur dioxide is formed in mines when a heating or fire occurs in coal containing sulphur.

Detector tubes are used in coal mines for detection of this gas. Its typical odour can be detected by smell at 3 ppm, which is above the exposure standard.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide has a specific gravity of 1.6 and if sufficiently concentrated has a reddish brown colour, an acrid smell and acid taste. It is non-flammable, incombustible, but will support combustion.

Nitrogen dioxide is extremely poisonous and the effects are treacherous, because in the early stages of exposure a person will feel ill and cough violently. They may then appear to recover, however several hours later the symptoms of bronchitis and pneumonia may develop and death may follow.

The exposure standard for nitrogen dioxide in New South Wales coal mines is 3 ppm.

Note: Any atmosphere in which nitrogen dioxide is noticeable by either smell, irritation or colour should be regarded as dangerous.

The gas is formed in working places immediately after shotfiring, (blasting of nitroglycerine, especially when these are incompletely detonated), thus good ventilation is essential to rapidly dilute and disperse the gas.

Detector tubes are used in coal mines for detection of this gas, however, portable analysers offer improved accuracy.

Black Damp

Generally referred to as an oxygen deprived atmosphere and is a mixture of gases, which may range from almost pure carbon dioxide to almost pure nitrogen. Therefore its composition varies widely, however most samples taken indicate 10 to 15% carbon dioxide and 85 to 90% nitrogen.

Black Damp is very dangerous due to lack of oxygen.

Before the introduction of Oil Flame Safety Lamps many miners lost their lives in unventilated areas, because coal had absorbed most of the oxygen in the atmosphere, or because a release of Black Damp occurred, displacing the available oxygen.

Instruments such as oxygen meters and Oil Flame safety lamps are used for the detection of this gas as they will indicate the depletion of oxygen.

Choke Damp

This refers to atmosphere containing large amounts of carbon dioxide, which causes choking when inhaled. Choke Damp is generally formed when large amounts of carbon dioxide are released suddenly, such as in carbon dioxide outbursts.

Like Black Damp, the main danger of this atmosphere is displacement of oxygen.

Detection is by means of continuous monitoring systems, detector tubes or by measuring the depletion of oxygen in the atmosphere.

Fire Damp

Fire Damp is a term used for an explosive atmosphere, generally methane in the flammable limit range, but it may also include hydrogen and carbon monoxide, especially after mine fires and/or explosions. Like methane it can be very dangerous due to its wide explosive range.

The presence of this gas can be detected by continuous gas monitoring, Oil Flame Safety Lamps and Methanometers.

After Damp

After Damp is an atmosphere found in coal mines after an explosion and/or a major fire.

After Damp is composed of nitrogen, little oxygen, carbon dioxide, carbon monoxide and water vapour. Methane and hydrogen may also be present in some cases, which can lead to secondary explosions.

The water vapour usually renders the atmosphere very humid. However it is the carbon monoxide content which makes it lethal to breathe, accompanied with lack of oxygen.

Special gas monitoring teams have been trained to monitor for the presence of After Damp using a mobile laboratory.

White Damp

White Damp is a term for a lethal atmosphere containing carbon monoxide, which is also a part of After Damp.

Stink Damp

Stink Damp is an atmosphere containing hydrogen sulphide, the smell of which resembles that of rotten eggs.

Illawarra Gas

Illawarra Gas is a mixture, which ranges from almost pure methane to almost pure carbon dioxide. If found predominantly on the floor then the term Illawarra Bottom Gas is applied (when it consists mainly of CO_2).

This gas was the cause of four miners losing their lives in November 1965, in an Illawarra mine. Until then very little was known of Illawarra Gas or Illawarra Bottom Gas.

At that time there was a large amount of carbon dioxide mixed with methane and due to its density being heavier than air, the mixture was accumulating on the floor, people had treated it as Black Damp. A faulty brake on a shuttle car provided the source of ignition and the whole area became ablaze.

This mixture can be detected with portable infrared analysers or approved oxygen/methane detectors provided the limitation(s) of sensors are understood.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**SPECIFIC ISSUES IN THE COAL INDUSTRY**

h) WORKPLACE CHEMICALS

The Australian Safety & Compensation Council (ASCC) has declared National Standards and Codes of Practice, along with guidance material, for hazardous substances and dangerous goods. These documents form the basis of a nationally consistent regulatory approach for the control of workplace dangerous goods and hazardous substances. These Standards, Codes of Practice and the Hazardous Substances Regulatory Package can be accessed at the ASCC website located at: www.ascc.gov.au/ascc/healthSafety/hazardousSubstances/ (accessed October 2008).

HAZARDOUS SUBSTANCES

Hazardous substances are materials which, if they gain entry to the body can produce an adverse effect. This is in contrast to Dangerous Goods in which a chemical or physical property (flammable, explosive, corrosive, etc) may be of concern. Many hazardous substances are also classed as dangerous goods.

Most people would immediately think of materials such as acids or poisons as hazardous substances, however the range of materials is far greater and includes some dusts, cleaning agents, sealants, solvents, etc. Hazardous substances are not limited to those substances obtained from a supplier and delivered in a labelled container with an MSDS (see Section 4-02j). It is not only the substance itself that may be the problem but the method of use, eg the generation of toxic atmospheres in inadequately ventilated spaces.

A substance is deemed to be hazardous if it meets the classification criteria specified by NOHSC[1].

To assist in classification, the ASCC provides the Hazardous Substances Information System (HSIS), which is an online database containing classification information on approximately 4,000 substances that have been classified in accordance with the Approved Criteria and located at:
http://hsis.ascc.gov.au/SearchHS.aspx (accessed October 2008).
However the HSIS data base is not a comprehensive source of classification information for workplace substances. If a substance is not included in the HSIS database, this does not necessarily mean that the substance is not hazardous.

Legislation

All States within Australia have adopted legislation covering hazardous substances. In an attempt at uniform legislation throughout the country, State legislation is based on Model Regulations and Codes of Practice developed by NOHSC/ASCC, which in turn are modelled on the UK's Control of Substances Hazardous to Health Regulations 1988 (COSHH).

The model regulations have two principal components:

- Information provisions
- Assessment and control provisions

The information provisions address the delivery of specific information on topics such as Approved Classification Criteria Labels, MSDS, etc that a supplier must provide through the employer to employees. The assessment and control provisions require employers to identify hazardous substances in the workplace, make an assessment of the

[1] NOHSC (2004). Approved Criteria for Classifying Hazardous Substances {NOHSC:1008(2004) 3rd Edition (Approved Criteria).

health risks, which arise out of the work activity and then initiate appropriate control action. Specific requirements as regards record keeping are also regulated.

In respect to the mining community, different approaches have been adopted in the various states. In Western Australia specific legal requirements are laid down in respect to hazardous substances in the Mines Safety and Inspection Regulations. In other states, eg NSW, under the OH&S Act, mine managers are required to provide a healthy and safe work environment, which includes the provision of information to employees on the materials they are using. Specific requirements are listed in the NSW OH&S Regulations[2]. Thus, there is a clear legal responsibility for employers to address the issue of hazardous substances.

Proposed Revisions to the Workplace Chemicals Regulatory Framework.

In the current workplace chemicals framework, hazardous substances and dangerous goods are dealt with using two different regulatory instruments, even though both instruments apply to the same substances in many cases. While many requirements under the hazardous substances and dangerous goods regulatory framework are the same, there are a number of inconsistencies. These inconsistencies create confusion in the workplace and add to the regulatory burden on business.

Several years ago the National Occupational Health and Safety Commission (NOHSC), the predecessor to the ASCC, agreed that the hazardous substances and dangerous goods regulatory frameworks should be combined into a single system be based on the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

[2] NSW Occupational Health and Safety Regulation 2001.

The main concepts of the proposed framework are therefore:

- To consolidate the requirements for workplace hazardous substances and dangerous goods into a combined framework

- To integrate the classification, labelling and safety data sheet requirements of the hazardous substances and dangerous goods frameworks, using guidance from the GHS.

The ASCC has released Draft National Standards and Codes of Practice for the Control of Workplace Hazardous Chemicals and are currently reviewing the submissions received from Industry, Unions, and State and Territory Governments.

Health Effects of Hazardous Substances

Hazardous substances, which are used in the workplace without proper exposure controls, may harm the health of all those exposed. These adverse health effects can be immediate or appear days, weeks, months or even years after exposure.

Some hazardous substances produce few, if any, obvious symptoms until the onset of illness. In the case of asbestos exposure, symptoms of illness usually do not show up until 20 or 30 years later.

Some chemicals may have both short-term effects (perhaps coughing) and long-term effects (such as cancer) which do not appear until years after exposure. For example, some chlorinated solvents can produce headaches, nausea and vomiting soon after exposure and in some cases increase the risk of cancer in the long term.

The symptoms of exposure to hazardous substances, such as metal fumes given off by welding, may be very similar to everyday diseases caused by bacteria and viruses. For example, metal fume fever can easily be mistaken for the onset of a cold or influenza.

The symptoms of exposure are divided into two general groups, short-term (acute) and long-term (chronic) health effects.

Acute Health Effects

Acute effects are immediate, usually resulting from a single high dose exposure. For example, coughing following exposure to irritating fumes or skin irritation from contact with acid.

For example, the acute effects of gross exposure to most solvents include:

- Irritation of the eyes.
- Irritation of the skin and breathing passages.
- Headache, nausea, vomiting, loss of co-ordination, dizziness, mental confusion, weakness and, if severe, narcosis and possible coma.

Acute effects are usually obvious and short-lived, but can lead to permanent damage to health, or in some cases, death.

Chronic Health Effects

Chronic effects occur days, weeks, months or even years after exposure. The exposure responsible for the effect may have been a series of high dose exposures over a short period of time, or repeated low dose exposures over a longer period of time. The effects may be unsuspected or undiagnosable for many years.

For example, the chronic effects of exposure to methanol (wood alcohol), over a long period are dermatitis, blindness and liver damage.

Local Effects

Local effects are caused by a substance, which acts only on the part of the body it contacts. For example, acid burns on skin are a local effect.

Systemic Effects

Systemic effects are damage caused to parts of the body away from the point of contact. This usually means the chemicals are carried away from the point of absorption in the blood to other parts of the body. A headache caused by inhaling solvent vapour is an example of an acute, systemic effect.

Routes of Entry

The possibility of adverse health effects depends on the substance gaining entry to the body and then causing some adverse change internally. This can be achieved in three main ways:

- Inhalation.
- Skin or eye contact.
- Ingestion.

By far the most common of these routes is inhalation. Many substances can adversely affect the skin. Ingestion is normally associated with failure to practice good personal hygiene. It can occur from eating and drinking on the job without first washing the hands and face.

The way the different physical forms of a substance enter the body influences how health is affected. For example, solvents can affect the skin causing dermatitis but if the vapours are inhaled, narcotic systemic effects can occur.

Once a substance has entered the body the resultant effects depend on:

- The toxicity (capacity to cause harm).
- Level of exposure to the substance (dose).
- Individual susceptibility.
- Ability of the body to either get rid of the substance, or to metabolize it to a form in which it may be excreted.

Toxicity

Toxicity is the ability of a substance to produce injury or death in a living organism. The more toxic a substance, the greater the possibility that a small dose of that substance will damage health. More stringent exposure controls are needed for more toxic substances.

Some substances may not appear to be very toxic simply because they do not have noticeable acute (short-term) health effects. However, they may have serious chronic (long-term) health effects if exposures are repeated over a longer period of time.

Dose

Dose is a combination of exposure and frequency of exposure. Dose depends on:

- How much of the substance is involved in the exposure.

- How often the exposure has occurred (often or just once in a while).

- The length of each period of exposure (minutes, days, weeks or years).

This can be expressed as an equation:

Dose = amount of a substance × duration and frequency of exposure

Consequently dose (or exposure) is the determining feature in respect to adverse health effects for it does not matter how potentially toxic a substance is**, provided the exposure (dose) is kept below safe levels adverse health effects should not occur.** The classic example of this is sodium cyanide (NaCN) solutions used in electroplating shops. Sodium cyanide is extremely toxic, however steps are taken via ventilation, spill containment, education, sound work practices, etc to minimise exposure, hence it is rare that problems occur with cyanide poisoning in plating shops.

Hazard Identification

The three basic sources of information about potential hazardous substances are the HSIS database, labels and Material Safety Data Sheets (see Section 4-02j).

All containers of products brought on site should be labelled and if the product contains a hazardous substance the label should provide information on:

- The identity of the substance it contains - the product name, chemical name, its UN number (in the case of dangerous goods), or in the case of a mixture, its ingredients.
- The dangerous goods diamond where relevant.
- Signal word(s) chosen from a standard list of phrases, eg ‘hazardous’, ‘poison’, ‘warning’ or ‘dangerous poison’.
- Risk information chosen from a standard list of phrases, eg ‘flammable’, ‘causes burns’.

- Safety information chosen from a standard list of phrases, eg ‘keep locked up’, ‘do not breathe dust’.
- Directions for use.
- First aid, emergency procedures and local contact number.
- Name of manufacturer or supplier and local contact phone number.
- Toxicity information given in the form of: ‘very toxic’, ‘toxic’ or ‘harmful’.

Material Safety Data Sheets (MSDS) provide more detailed advice, and information on their use is provided in Section 4-02j. In some instances it may be necessary to consult the supplier or an occupational hygienist for more complete information or advice.

Assessing the Risk of Using a Hazardous Substance

For each hazardous substance identified on-site, there is a need to assess the potential for adverse health effects to employees using the substance. This can be addressed in a number of ways (see Section(s) 4-04 and 5-01), however the principle remains the same, ie:

Risk = probability x consequence

The level of risk in respect to a substance depends on:

- Associated toxic effect.
- Strength of toxic effect.
- Likelihood and frequency of exposure (eg daily, weekly or monthly).

- Concentration of exposure (eg high or low).

- Duration of exposure (eg one minute or 10 hours).

- Route of entry (whether you breathe it in, absorb it through your skin or swallow it).

- Amount (or dose) taken into the body.

The relationship between toxic effect and risk can be demonstrated using the example of typing correction fluid used in offices. Some contain solvents (trichloroethylene) which, if inhaled, can cause headache, dizziness, liver damage, vomiting and even death. However they are usually used in such small amounts that ordinary use of these substances is unlikely to cause injury or disease since exposure is low. Therefore in normal usage the risk presented by correcting fluids is considered to be insignificant.

When evaluating risk there are four basic questions that should be considered:

- Are the risks significant?

- Are the risks significant now and not adequately controlled?

- Is there uncertainty about the risks, because there is not enough information about the hazards? For example, has the exposure been accurately measured?

- Are the risks significant but effectively controlled?

If these questions are answered objectively then it should be possible to determine the overall risk of using a substance in a workplace.

In evaluating risk there may be a need to determine an employee's level of exposure to a particular substance. Some indication of the need for workplace exposure monitoring can be obtained by observing the following:

- Evidence of contamination, such as dust or fumes, visible in the air or a beam of light or deposited on surfaces.
- Substances on a person's skin or clothing.
- Odours, leaks, spills or residues.
- Direct contact such as handling powder with unprotected hands.
- Employees' experience or symptoms of exposure.
- Warnings on MSDSs.

In cases where workplace monitoring is considered necessary it is wise to consult an occupational hygienist to validate this opinion and to conduct the monitoring.

Controlling Risk of Adverse Health Effects

Information on how to control the risks of adverse health effects are provided in Section 6.

In general the hierarchy of hazard control listed below should be used to develop an appropriate exposure control strategy.

- Elimination of dangerous substances.
- Substitution of products with lower toxicities.
- Isolation from human contact and the ventilation system.
- Engineering controls.
- Work procedures.
- Personal protective equipment (PPE).

Once the strategy has been developed it should be reviewed at regular intervals to ensure its effectiveness.

Training

For any process to be effective there is a need to fully inform the workforce about the materials they are working with and the procedures they should follow for their safe use. This is a legislative requirement in most States and can best be performed through the provision of information (MSDS) and adequate training.

While training should be designed to meet the needs of the site operation and its workforce, topics that may be covered include:

- Information on the hazardous substances used in the workplace.
- How hazardous substances enter the body.
- How hazardous substances affect people.
- How to read labels and MSDS.
- Where to locate resources and information and who in the workplace to ask.
- The workplace assessment process and how employees can contribute.
- Safe working practices.
- Air monitoring procedures.
- Control measures and how to maintain them.
- Use, limitation, fitting and maintenance of PPE.
- Cleaning up chemical spills and safe disposal of waste.

- Health surveillance procedures (where relevant).
- First aid procedures in the event of exposure to hazardous substances resulting in acute effects.
- Emergency procedures and drills.
- Reporting procedures for accident and illness.
- Specialist training, eg for confined spaces.
- Employees', employer's and suppliers' legal obligations.
- How to use the computer to access data where computer stored MSDS are used.

Managing Hazardous Substances at Coal Mines

While the approach to management of hazardous substances at coal mines will vary depending on size, culture, etc, the following sets out the minimum criteria that operations should employ for the safe use of these products.

It must be stated that some operations, depending in which State they are located, may have more specific legal requirements to observe.

For the adequate management of hazardous substances on-site the following elements are considered necessary:

- Managerial commitment through a written policy statement on the management of hazardous substances on-site.
- A register of all hazardous substances on-site.
- MSDS for all hazardous substances on-site.
- A process for assessing the risks of using hazardous substances on-site and for the development of appropriate controls. This should include a means of

providing appropriate information on substances to the workforce.

- A process for training employees in the safe use of hazardous substances.

- An emergency response plan.

- An ongoing site audit system.

A number of operations have incorporated the above elements into their normal operational procedures, as illustrated in Section 4-04. There is little doubt that hazardous substances is one of the key issues facing the mining industry and those operations seeking best practice need to consider appropriate mechanisms for the management of hazardous substances on-site.

Proposed Revisions to the Workplace Chemicals Regulatory Framework.

In the current workplace chemicals framework, hazardous substances and dangerous goods are dealt with using two different regulatory instruments, even though both instruments apply to the same substances in many cases. While many requirements under the hazardous substances and dangerous goods regulatory framework are the same, there are a number of inconsistencies. These inconsistencies create confusion in the workplace and add to the regulatory burden on business.

Several years ago the National Occupational Health and Safety Commission (NOHSC), the predecessor to the ASCC, agreed that the hazardous substances and dangerous goods regulatory frameworks should be combined into a single system be based on the Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

The main concepts of the proposed framework are therefore:

- To consolidate the requirements for workplace hazardous substances and dangerous goods into a combined framework

- To integrate the classification, labelling and safety data sheet requirements of the hazardous substances and dangerous goods frameworks, using guidance from the GHS.

The ASCC has released Draft National Standards and Codes of Practice for the Control of Workplace Hazardous Chemicals for public comment and are currently reviewing the submissions received from Industry, Unions, and State and Territory Governments.

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	SPECIFIC ISSUES IN THE COAL INDUSTRY

i) LIGHTING

Humans have battled with the dark since time began, yet it is only in the last 100 years or so that we have been able to produce artificial light without relying on a flame. The first practical electric lamp was invented by Edison in 1879 and it lasted 45 hours. He was granted the patent for the first light bulb in 1880, and the principle of that patent (incandescence) still applies to many of today's modern lamps.

What is Light?

Light is a form of non-ionising electromagnetically transmitted radiant energy. It occupies a small part of the whole electromagnetic spectrum, covering the wave-length window from 380 to 760 nm (1 nm = 10^{-9}m). Ultra-violet light, with wave-lengths below 380 nm and infra-red light, with wave-lengths above 760 nm, are invisible, but detectable from, for instance sunburn or heat effects. Light travels through space at a velocity of approximately 300,000,000 ms^{-1} (187,000 miles per hour). Nothing travels faster than light. It takes about 8.3 minutes for light from the sun to reach the earth.

Types of Lamps

Filament Lamps

There are two basic forms of filament lamps, Incandescent and Halogen. The former have good colour properties, ie, colours remain almost the same as when seen in sunlight, but are not very efficient. Halogen lamps are much more efficient and also possess good colour properties.

Discharge Lamps

Certain elements, particularly gases, when ionised (or electrically excited by the passage of an electric current), release electrons or photons (may be regarded as small packets of light energy) as they resume their stable state. If that energy is absorbed on fluorescent materials, light of a different wave length will be emitted by the fluorescent material. This is the principle on which fluorescent lamps operate. The five common types of discharge lamps are:

Fluorescent tube:
Applies an electrical discharge to mercury vapour to produce UV radiation which is converted to visible light by the fluorescent powder coating on the inside of the lamp wall. They are very efficient and are available in a range of good colour properties.

High pressure mercury fluorescent:
Good efficiency and reasonable colour.

Metal halide:
A variation on the above by the addition of metal halides (sodium, thallium or indium) which almost doubles the light output and improves colour.

High pressure sodium:
More efficient than high pressure mercury lamps, but the colour properties are poorer.

Low pressure sodium:
Produces light of a single wavelength (in the yellow region) to which the eye is very responsive. This makes it very useful when colour discrimination is not important but high efficiency is needed, such as fog lights on roadways.

General Health Effects

Inadequate illumination can be very irritating, but involuntary defence mechanisms usually prevent excessive light from entering the eye; except for lasers (see section 4-02p on Radiation). Too little light may present safety hazards, but there is no evidence that poor light causes eye stress or trouble. Suggestions that long term exposure to fluorescent light induces melanomas have been disproved. In older type fluorescent units there may be PCBs present in ballasts, so care should be taken when handling these.

Lighting for Safe, Comfortable Operations

Like Noise, Lighting has plenty of amateur 'experts' available to provide advice which is usually based on a meagre understanding, or even a misunderstanding, of the subject. The common solution to perceived lighting problems is to provide more light. Sometimes this works, but often it simply makes things worse, because the basic problem has not necessarily been lack of illumination, but possibly one of glare, or too much contrast, or the use of inappropriate methods of illumination for say, rotating machinery which may appear to freeze motion instead of making it more apparent. Some appreciation of the complex principles involved is needed as well as knowledge of the regulations and other guides.

At the surface, fixed lighting is the principal means of illuminating tasks and operations at night-time other than vehicular activity, but underground the miner's personal safety lamp, the cap-lamp, is the main source of illumination for individually performed tasks, along with lamps installed on major mobile equipment such as miners, shuttle cars etc. Cap-lamps and vehicular lamps have been developing over many years and are so specialised that they are not considered in this Manual in any detail.

Regulations and Standards

There are not many regulations specifying lighting for the coal-mining industry. Regulations under the Coal Mining Regulation Act (NSW) covering miners Safety Lamps and Lighting in Underground mines were issued in 1984.

Concerning fixed lighting, Clause 31(1) of Part 4 states:

"The manager of a mine shall ensure that suitable and efficient fixed lighting is provided in all installations at the mine where persons are required to perform regular work and in particular at the following places underground":

- entrances to each shaft or other outlet
- places where vehicles are generally coupled or uncoupled, or regularly attached to or detached from a haulage rope
- fixed loading points where vehicles are loaded
- conveyor belt transfer points
- any engine room, fixed electrical substation, or workshop
- any other place where the district inspector, in a notice served on the manager, so directs.

Clause 31(3) requires lighting to be arranged to minimise glare and eyestrain.

Although the sentiments expressed in this regulation are reasonable enough, they are not quantified in any way; placing a heavy responsibility on managers to determine what illumination is adequate for work to be performed safely and effectively, and without causing "eyestrain".

As part of an assessment process it might be considered that inadequate lighting may have potential to contribute to accidents, or incidents such as stepping in mine water pools which may lead to undesirable foot conditions, making a lighting survey warranted.

Guidance is provided by Australian Standard 1680[1], in one or several of its 4 parts. Illuminance levels, in Lux, are provided for general use and some specific tasks. Table 4-02i(I) is extracted from various references and should be used as a guide only. However, illumination is only part of the total issue and reflectance, glare, contrast, visual acuity and other aspects need consideration as well.

For those seeking more technical information on lighting, the following ACARP reports may be consulted:

- Design and Engineering of Lighting Systems for the Coal Face.
  Vol 1; Main Report. Vol 2: Supplementary Information.
  Report C0726. December 1986. W. B. Bell and C. R. Daly, (University of NSW) ISBN 0642127220

- The Design of a Caplamp for Better Vision.
  Report P1082. December 1992. C. R. Daly and W. B. Bell (University of NSW)

[1] AS/NZS 1680.0:1998 – Interior lighting – Safe movement.
AS/NZS 1680.1:2006 – Interior and workplace lighting – General principles and recommendations.
AS/NZS 1680.2.1:2008 – Interior and workplace lighting – Specific applications – Circulation spaces and other general areas
AS/NZS 1680.2.2:2008 – Interior and workplace lighting – Specific applications – Office and screen-based tasks.
AS/NZS 1680.2.3:2008 – Interior and workplace lighting – Specific applications – Educational and training facilities
AS/NZS 1680.2.4:1997/Amdt 1:1998 – Interior lighting – Industrial tasks and processes.
AS/NZS 1680.2.5:1997 – Interior lighting – Hospital and medical tasks.
AS 1680.3-1991 – Interior lighting – Measurement, calculation and presentation of photometric data.
AS/NZS 1680.4:2001 – Interior lighting – Maintenance of electric lighting systems.

Some General Observations

Fixed lighting should be reasonably even, without sudden changes and should be aligned to avoid high contrast or glare.

Like moths, humans are attracted, or distracted, by bright lights (phototropic) so illumination should be focussed on the task to be performed, with surrounding areas less brightly lit.

Economic factors are important and inappropriate choice of lighting systems can prove very expensive.

American mine lighting regulations are designed to provide for four aspects in particular:

1. To provide adequate illumination to permit work to be performed safely,
2. To enable miners to perceive incipient hazards in their field of vision,
3. To avoid glare in the miner's environment,
4. To permit minimum maintenance (to reduce the need for personnel in higher risk areas)

Shuttle cars and other vehicles are generally well equipped for lighting their own path, but may not always be adequately visible to those at right angles to their track. Some side illumination is desirable.

The traditional miner’s lamp will doubtless continue to be the main source of light for individuals on foot, but good fixed lighting should be provided to supplement these point sources, for caplamps do not provide good peripheral illumination (and therefore good side vision) in these days of high mine mechanisation. At the risk of stating the obvious, adequate control of dust and water mist is an integral part of ensuring illumination is appropriate for the task in hand.

Since many technical factors, including intrinsic safety, appropriate voltage systems, corrosion resistance, portability etc., which cannot adequately covered in this Manual, need consideration in reviewing underground lighting, a qualified lighting engineer should be consulted for the task of designing or reviewing mine lighting systems.

ACTIVITY	ILLUMINANCE (Lux)	DESCRIPTION, FREQUENCY	EXAMPLES
General Surface Industrial Activity			
General movement	40	Rarely	Corridors, walkways
Rough work	80	Visual tasks	Change rooms, loading docks, storage of material
Simple tasks	160	Coarse detail	Casting concrete, canteens, rough bench and machine work,
Ordinary work	240	Large detail	Food preparation
Moderately difficult	320-400	Fine detail	Typing, office work
Surface Activities In The Mining Industry			
Coal preparation	160		
Engine winding	160		
Bathhouse	80		
Rescue room	160		
Lamp maintenance	160		
Underground Activities In The Mining Industry			
Entrances and exits to cage shafts	20		
Engine rooms	20		
Conveyor transfer points	20		
Travel assembly points	20		
Offices	80		

TABLE 4-02i(I)

j) MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets (MSDS) are used internationally to provide the information necessary to allow the safe handling and use of hazardous substances at work. MSDS contain basic health and safety information, which is essential in the development of a workplace programme for the safe use of hazardous substances. Minimum information in an MSDS will include:

- Manufacturer's and/or supplier's details.
- Product identification information.
- Health hazard information.
- First aid treatment.
- Precautions for use.
- Safe handling information.
- An Australian contact point.

Under state and federal regulations, manufacturers and importers are responsible for the preparation of MSDS for all hazardous substances that they supply. Suppliers of hazardous substances are responsible for the provision of the MSDS which the manufacturer or importer has prepared. Employers in general may not alter a supplier's MSDS but can incorporate a supplier's MSDS into a revised format to suit site needs (eg for incorporation on computer programmes). An employer can add subsidiary information, eg type of PPE to be used, to a MSDS if it enhances the document. All MSDS should be provided in English, suit Australian requirements, and be revised and re-issued at periods no greater than five years. Manufacturers should also review and, if necessary, re-issue a MSDS:

- Whenever there is a change in the formulation of the product that may affect its properties, health and/or safety hazard risk.

- Whenever there is new health and/or safety information on the product.

- To reflect new regulations or standards.

MSDS are used to:

- Find out about the hazards of a substance and highlight possible routes of entry.

- Find out how to use the substance safely.

- Implement exposure control measures to protect employees.

- Plan job training.

- Develop a workplace chemicals management plan.

MSDS within Australia are usually provided in a basic format described by the NOHSC[1], however there is no legal requirement for such action. There are some minimum requirements; the key ones being a statement of hazardous nature and Australian contact details.

International agreement via the Globally Harmonised System for the Classification and Labelling of Chemicals has been achieved on a universal format and although it will take years for this to flow on to all products, it is a useful step in the right direction. The GHS incorporates the use of a 16 header MSDS format which is extracted in part from the National

[1] NOHSC (2003) National Code of Practice for the Preparation of Material Safety Data Sheets, 2nd Edition, {NOHSC: 2011(2003)].

Code of Practice for the Preparation of Material Safety Data Sheets and is described briefly below:

Section 1 Identification of the material and supplier
- Product (material) name
- Other names
- Recommended use
- Supplier name, address, telephone number and Australian emergency contact number

Section 2 Hazards identification
- Hazard classification, including a statement of overall hazardous or dangerous nature
- Risk phrases
- Safety phrases

Section 3 Composition/information on ingredients

Pure substances
- Chemical identity of pure substance
- Common name(s), synonym(s)
- CAS Number(s)

Mixtures or Composite Materials
- Chemical identity of ingredients
- Proportion of ingredients
- CAS Number for ingredients

Section 4 First aid measures
- Description of necessary first aid measures according to routes of exposure
- Indication of medical attention and any special treatment needed

Section 5 Fire Fighting Measures

- Suitable extinguishing media
- Hazards from combustion products
- Precautions for fire fighters and special protective equipment

Section 6 Accidental Release Measures

- Emergency procedures
- Methods and materials for containment and clean up

Section 7 Handling and Storage

- Precautions for safe handling
- Conditions for safe storage, including any incompatibilities

Section 8 Exposure Controls/Personal Protection

- National exposure standards
- Biological limit values
- Engineering controls
- Personal protective equipment

Section 9 Physical and Chemical Properties

- Appearance
- Odour
- pH
- Vapour pressure
- Vapour density
- Boiling point/range
- Freezing/melting point (specify which)
- Solubility (specify solvent eg water)
- Specific gravity
- Information for flammable (explosive) limits in air, and
  - flash point
  - upper and lower explosive limits
  - ignition temperature

Section 10 Stability and Reactivity

Chemical stability
Conditions to avoid
Incompatible materials
Hazardous decomposition products
Hazardous reactions

Section 11 Toxicological Information

Health effects from likely routes of exposures and symptoms related to the physical, chemical and toxicological characteristics as determined by the classification, including:
(a) acute and chronic effects
(b) possible routes of exposure
(c) range of effects after exposure
(d) dose, concentrations or conditions of exposure likely to cause injury
(e) delayed effects, and
(f) relevant negative data

Section 12 Ecological Information

Ecotoxicity
Persistence and degradability
Mobility

Section 13 Disposal Considerations

Disposal methods, including disposal of containers
Special precautions for landfill or incineration

Section 14 Transport Information

UN Number
UN Proper Shipping Name
Class and subsidiary risk(s)
Packing Group
Special precautions for user
Hazchem Code

Section 15 Regulatory Information

Any other regulatory information not provided elsewhere in the MSDS, including;

- Standard for Uniform Scheduling of Drugs and Poisons (SUSDP)
- Any applicable prohibitions or notification/licensing requirements
- Agricultural and Vetinerary Chemicals Act
- Industrial Chemicals (Notification and Assessment Act)

Section 16 Other Information

Date of preparation or last revision of the MSDS

The quality of MSDS in past years has been variable, with both good and poor MSDS being supplied, or in some cases refused, with materials. The advent of broad-based State legislation (Section 4-02h) has altered this somewhat and the quality is rapidly improving. The failure of a supplier to provide a MSDS in most States is now illegal, however provision has been made for the protection of trade secrets. Remember, the power to purchase and use a product rests in your hands, thus, if a supplier refuses to provide a MSDS, or provides one of poor quality, it raises questions as to the integrity of the supplier. (It is amazing how suppliers respond to the prospect of a lost sale.)

MSDS invariably include jargon that may make their interpretation difficult. The following Glossary, reproduced with minor changes from the NSW WorkCover publication[2] on hazardous substances.

[2] NSW WorkCover, Understanding Hazardous Substances in the Workplace, March, 1996.

HAZARDOUS SUBSTANCES GLOSSARY

Acute toxicity is a toxic effect that occurs immediately or shortly after a single exposure.

ADG Code is an abbreviation for the full title of the book "Australian Code for the Transport of Dangerous Goods by Road and Rail", prepared by the Federal Office of Road Safety. This provides the classification of dangerous goods.

Allergic reaction is an over-reaction by the immune system to an antigen. Symptoms may take the form of a rash, asthma, weeping eyes and sneezing and in severe cases can be life threatening.

Anhydrous means substances that contain no water.

Antidote is a treatment for poisoning; in contrast to supportive treatment that maintains bodily functions.

ASCC is the Australian Safety and Compensation Commission (which has replaced NOHSC) and whose principle role is to develop national OH&S and workers' compensation policy and promote consistency in legislation developed by states and territories.

Asphyxiants are substances that can deprive you of oxygen, or the body's ability to use oxygen. An inert gas such as helium can displace and/or replace the available oxygen in a poorly ventilated area to the point that it is not present in sufficient quantity to support life. Carbon dioxide (CO_2) can have the same effect, and has led to a number of deaths in empty fermentation vessels.

Australian Standard or AS are published by Standards Australia.

Australian Standard/New Zealand Standard are published by Standards Australia/Standards New Zealand.

Auto-ignition temperature is the lowest temperature at which spontaneous combustion of the substance begins in the absence of a flame or spark. The lower the auto-ignition temperature, the greater the risk of fire.

Biological exposure index is a measure representing a warning level of biological response to a substance or agent, or warning levels of the substance or agent, or its metabolites in the tissues, fluids or exhaled air of an exposed employee.

Biological monitoring is measuring the amount of a toxic substance or its products in the body. Usually it is the measurement of toxic substances or their metabolic products in blood, urine, or exhaled breath.

Boiling point is the temperature at which a substance changes from a liquid to gas. Normally measured in degrees C (Celsius) at atmospheric pressure.

Bulk density is the weight of a unit volume of powder, usually expressed in grams per cubic centimetre or g/cm^3. Apparent density is an alternate, but less commonly used term for bulk density.

Cancer is a malignant tumour that can spread to other parts of the body (metastasis), as distinct from a benign tumour that does not. (Although leukemia and some other malignant diseases are not solid tumours, they meet other criteria for cancer and are usually included under this definition.)

Carcinogen is an agent that is responsible for the formation of a cancer. Some hazardous substances can cause cancer. Carcinogenic substances may be classed as:

- Known carcinogen (Category 1) - when this effect has been shown in humans.
- Possible carcinogen (Category 2) - when this effect has been shown in animals or is suspected in humans.
- Suspected carcinogen (Category 3) - when this effect is suspected in animals.

Carcinogenesis is the process of causing cancer.

Carcinogenic means capable of causing cancer.

CAS No. or Chemical Abstracts Service Number is a unique number assigned by the Chemical Abstracts Service, (Columbus) to a specific chemical entity. This is often referred to as the CAS or Registry Number. If the exact chemical name is not known it is a good way of identifying the chemical.

Chemosis means excessive swelling of the eye lining.

Chronic toxicity is where a toxic effect of a substance occurs after repeated or prolonged exposure.

Chronic effects are those that may occur with prolonged low dose exposure or some time after exposure has ceased.

Combustible means capable of burning.

Combustion is the process of burning.

Commercially confidential information is information, such as chemical identity or exact composition of a product, which the manufacturer does not want to divulge to the public or competitors.

Correct shipping name is the name for identifying substances classified as Dangerous Goods under the ADG Code (refer to the ADG Code for further information).

Corrosive is the term for a substance that can cause the destruction of, or damage, to, materials or living tissue on contact. The criteria for determining whether a substance is classifiable as a corrosive are found in Section 2 of the ADG Code.

Dangerous goods are substances which are either specifically listed in the ADG Code, or meet the classification criteria of Section 2 of the ADG Code. Some are also classified as hazardous substances.

Dangerous Goods Class is the Class allocated to a substance under the ADG Code.

Decanting is the transferring of substances from one container to another. For example by pouring from a large container into a small one for ease of use.

Density is the ratio of mass of a substance to its volume. It is usually measured at 20°C and expressed in grams per cubic centimetre (g/cm^3).

Dermal means of the skin, and is normally used in the context of substances absorbed or administered via the skin or affecting the skin.

Dermatitis is inflammation of the skin (see Section 4-02d).

Dust (see Section 4-02f)

Embryotoxic agents are substances with the potential to induce adverse effects in offspring during the first stage of pregnancy between conception and the foetal stage.

Epidemiological relates to the study of the relationships between the causes and distribution of disease in human communities.

Evaporation rate is a number (butyl acetate = 1.0) that describes how rapidly a substance (usually a liquid) evaporates - or changes from a liquid into a gas or vapour. Many organic liquids (eg toluene) evaporate more rapidly than water at ambient temperatures.

Exposure Standard (see Section 5-03).

Fire Point is the lowest temperature in degrees Celsius (°C) at which a liquid first evolves vapour at a sufficient rate to sustain burning for at least five seconds.

Flammable means capable of being ignited and burning in air. Flammable liquids are defined as having a flash point not greater than 61°C.

Flash Point is the lowest temperature in °C at which a liquid will produce enough vapour to be ignited. Flash points can be either closed cup (inside the container) or open cup (near the surface of the liquid). The lower the flash point the higher the risk of fire and normally the greater the volatility.

Generic name is the name applied to a category or group of chemicals or products. It may have a strictly scientific origin, such as “azo dyes” or “halogenated aromatic amines”, or a commercial origin, such as “Valium”.

Genotoxic agents are substances that can damage the genetic material of an organism. These substances may also be mutagenic but not necessarily.

Genotoxin is a substance capable of causing damage to genetic material, such as DNA.

Harmful describes the effect of a substance that may enter the body (eg inhalation, ingestion or penetration of the skin) and pose at least some hazard to health.

Hazard is the intrinsic capacity of a chemical or substance to cause harm.

Hazardous substance means a substance that has the potential to harm the health of persons. It can be a single chemical entity or a mixture. The criteria for identifying a hazardous substance are detailed in the NOHSC publication[3] {NOHSC: 1008(2004)] 3rd Edition.

To assist in this classification, the ASCC provides the HSIS online data base (see Section 4-02h) containing classification information on approximately 4,000 substances.

Hazardous ingredient means any hazardous substance that is an ingredient.

Identification using an MSDS means the section of the MSDS providing information on the name of a product, other names, use, properties and chemical composition.

Immiscible means liquids, which if mixed together, will readily separate and not form a homogeneous mixture (eg oil and vinegar).

Incompatibility is where a substance reacts chemically in an unintended manner with another substance creating a hazard.

Inflammation is a condition involving swelling, redness and usually pain of a part of the body.

Ingredient is any individual substance (including impurities), in a mixture.

[3] NOHSC: Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008(2004)], 3rd Edition, October 2004.

Ignition means catching fire.

Inhalation means breathing in (and Exhalation breathing out).

Interaction is the modification of the toxic effects of one hazardous substance by another. Effects can be amplified (increased) or mitigated (reduced). These are also known as synergistic effects and antagonistic effects.

Irritant means a substance that produces local irritation or inflammation on contact with tissue and membranes, such as skin or eyes, or after inhalation, produces local irritation or inflammation of nasal or lung tissue.

Label is the set of information on a container that allows the contents to be identified. It should provide sufficient information so that the substance can be safely used. The NOHSC publication “National Code of Practice for the Labelling of Workplace Hazardous Substances” gives specifications.

LC_{50} is the concentration of a substance (usually in air) that is estimated to produce death in 50% of a population of exposed experimental animals by inhalation over a specific time period (usually 24, 48 or 72 hours). It may be expressed as ppm or mg m^{-3}

LD_{50} is the dose of a substance that produces death in 50% of a population of exposed experimental animals. LD_{50s} may be estimated after swallowing (oral), by injection (parenteral) or after application to the skin (dermal). It is usually expressed as mg per unit body weight.

Lesion means damage to body tissue as a result of disease or trauma.

Lung damaging agents are substances that can harm the lungs, including those that do not produce any immediate irritant reaction. Asbestos dusts that over time cause fibrosis and asbestosis are one example. Dusts that fall into this group may become more dangerous if they are contaminated with some sort of allergen - which is frequently of bacterial fungal or plant origin. Contamination of dusts with bacteria fungal spores can lead to invasion of damaged lungs which is very difficult to treat; diseases such as farmers' lung are caused in this way.

Material Safety Data Sheets (MSDS) provide information identifying a substance by describing the properties and uses of the substance with details of the chemical/physical properties. They also set out health hazard information, precautions for use, and safe handling information. The NOHSC publication[4] on (2003) "National Code of Practice for the Preparation of MSDS" should be referred to for technical advice and guidance on MSDS.

Mixture is the physical combination of chemicals resulting from deliberate mixing.

Mutagens are substances that can cause changes to the DNA in genes (heredity carrying material). Mutagenic substances may also cause cancer (which means they are also carcinogens). Mutagens may be:

- Proven - where this effect has been shown in humans.
- Possible - this effect has been shown in animals or is suspected in humans.
- Suspected - when this effect is suspected in animals.

Mutation is a change in the genetic material of cells.

[4] NOHSC: National Code of Practice for the Preparation of MSDS, [NOHSC:2011(2003), April 2003.

Mutagenesis is the process of producing a mutation in the genetic material of cells.

Narcosis is the alteration to consciousness ranging from sleep to deep coma.

Necrosis is changes to cells or tissues associated with their death.

NICNAS is the 'National Industrial Chemicals Notification and Assessment Scheme', administered by NOHSC and disseminates information on OH&S, public health and environment, for all new chemicals.

Ocular means of, or affecting the eye.

Oedema (edema) is an excessive accumulation of fluid in the tissue spaces of the body due to increased leakage of fluid from the surrounding circulatory system, eg a blood blister. It is also caused by the inadequate removal of fluid by the lymphatic vascular system.

Olfactory identification limit is the minimum concentration of a substance in the air capable of being detected by the human sense of smell. It is usually expressed in parts per million (ppm).

Oral means ingested through the mouth.

Oxidising material or Oxidant is a substance that may start a fire in other materials or stimulate the combustion of other materials therefore increasing the violence of a fire.

Oxidising property is a property of substances that liberate oxygen or cause an oxidation process thus promoting the likelihood of combustion.

Packaging Group as defined by the ADG Code, means the division of Dangerous Goods of classes 3, 4, 5, 6.1, and 8 into three groups, according to the degree of danger they present, for packaging purposes: I (great danger), II (medium danger) and III (minor danger).

pH is an index which indicates if a substance is neutral, acidic or alkaline (alkaline is also known as basic). Distilled water is neutral with a pH value of 7. Acids (eg vinegar) have a pH below 7. The lower the value, the stronger the acid. Alkalis or bases (eg caustic soda in solution) have a pH above 7. The higher the value, the stronger the base. Substances with extreme pH values, that is strong acids and alkalis, will always act as irritants or corrosives.

Physical state/form refers to whether a product is in the solid, liquid, or gaseous state at room temperature (20°C).

Physicochemical properties criteria refer to the basis on which a substance is evaluated with respect to its physical and chemical characteristics, such as flammability.

Polymerisation refers to the ability of a substance (monomer) to chemically combine into a polymer and the conditions under which this change can take place. Heat or an expansion of volume, or both, resulting from polymerisation can cause containers to break and any residual products to be spilled. Control of conditions to avoid unwanted polymerisation is necessary.

ppm means parts per million - often used as a measure of concentration of contaminants in the air (by volume). % means parts per hundred, by way of comparison 0.1% = 1,000 ppm.

Product name is the name shown on the product label, which may or may not be identical to the trade name. It may bear no resemblance or relevance to the actual chemical composition of the substance.

Primary anaesthetics are substances, such as gaseous nitrous oxide, which depress the central nervous system and which can progress through drowsiness, unconsciousness to cessation of breathing and death.

Reactivity is an indication of how ready a substance is to undergo a chemical change.

Respiratory system. The lungs and airways are involved in the process of getting oxygen into the body and expelling waste gases such as carbon dioxide.

Risk means the likelihood that a substance will cause harm in the circumstances of its use.

Route of exposure. The way a person is exposed, eg breathing in, swallowing or skin or eye contact.

Schedule is a listing of substances known as the 'Poisons Schedule' which require special labelling and precautions. These poisons are scheduled in the "Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP)".

Sensitisation is where a person develops increasingly pronounced allergic responses to a substance through repeated exposure.

Signal words are words used on labels of scheduled poisons to indicate the relative severity of hazard. They are, Dangerous Poisons, Poison, Caution or Warning.

Solubility is a measure of how easily a substance dissolves in a solvent (usually water). Solubility in water is usually expressed as g/L. Other units include g/100 cm^3, % w/v or ppm in water. It is important in determining the site of action in the respiratory and gastro-intestinal tracts. Highly soluble substances such as ammonia and formaldehyde can rapidly affect the upper respiratory and/or gastro-intestinal tracts.

Substances of low solubility, such as phosgene and nitrogen dioxide, can affect the bronchi before irritation of the upper respiratory tract occurs.

Subsidiary risk is a risk in addition to the Class assigned to Dangerous Goods. It is determined under a requirement to have a subsidiary risk label under the ADG Code.

Substance is a term generally used to apply to any naturally or artificially occurring chemical, whether it is a liquid, solid, gas or vapour. Other terms used to describe substances include: 'chemicals', 'materials', 'mixtures', 'products' and 'preparations'. Substances may be made from simple or complex chemicals, or even a mixture of the two. The definition of substance does not include articles.

SUSDP is an abbreviation for "The Standard for the Uniform Scheduling of Drugs and Poisons". This lists all "scheduled" poisons under the "Poisons Regulation".

Systemic poisons are substances that can affect organs or tissues in the body distant from the site of entry to the body. For example carbon tetrachloride absorbed through the skin or breathed in through the lungs can go on to affect the liver. Mercuric chloride affects the kidney (nephrotoxicity). Carbon disulfide affects the nervous system (neurotoxicity). Benzene affects bone marrow cells and hence the formation of white blood cells (haemopoietic toxicity or haematotoxicity).

TC_{50} is the concentration of a substance that produces a toxic response in 50% of a population of experimental animals exposed to it on inhalation of the substance for a short period of time (ppm or mg m^{-3}).

TD_{50} is a dose of a substance that produces a toxic effect in 50% of a population of experimental animals. It is usually expressed as milligrams per kilogram of body weight.

Teratogens are substances which when absorbed by a pregnant female, damage the developing embryo. Teratogens are classified as either:

- *Proven* - where this effect has been shown in humans.
- *Possible* - where this effect has been shown in animals or is suspected in humans.
- *Suspected* - where this effect is suspected in animals.

Toxicity is the capacity of an agent, substance or process to cause harm to living tissue or a living organism. Toxicity is the effect of a substance which, following inhalation, ingestion or penetration of the skin, may involve serious, acute or chronic health effects and even death. A toxic effect usually refers to functional (systemic) damage but may be developmental in respect of tissue and skeleton in the case of the embryo. The damage may be permanent or transient.

Tumour is a growth of abnormal mass of tissue in which the growth of individual cells is uncontrolled. A tumour can be either benign (non-malignant) or malignant (cancerous). A benign tumour is one that is localised and neither spreads nor causes cancer. Benign tumours are therefore easily treated and rarely fatal. With a malignant tumour, cells break off and spread through the body causing cancer. This process is called invasive spread or metastasis.

Malignant tumours can be treated if they have been detected before invasive spread has begun. Otherwise the prognosis can be poor.

United Nations (UN) numbers apply to substances classified as Dangerous Goods. They are assigned to one substance or to a group of substances with similar characteristics. A UN number is not necessarily unique to one chemical, and may cover a group of chemicals with similar hazardous properties.

Vapour density is a number that tells you whether the vapours of a substance are heavier or lighter than air. If the vapour density is greater than one (the density of air), the vapour will tend to stay near the floor, unless there is reasonably strong air movement.

Vapour pressure means the pressure characteristic at any given temperature of a vapour in equilibrium with its liquid or solid form. The higher the vapour pressure, the more readily the substance tends to evaporate and therefore the more likely it is to be in the air.

Volatile means able to pass readily into the vapour (gaseous) state or vaporise.

w/v, weight per volume is a measure of the concentration of a substance dissolved in another.

w/w, weight per weight is a measure of the concentration of a substance dissolved in another.

All States have legislation on hazardous substances. If not as specific regulations they are covered under the OH&S Act. As a minimum, mine operators should have a MSDS for each hazardous material on-site, conducted an assessment as to the potential health effects of its use, and taken appropriate steps to ensure their safe use.

k) MICRO-BIOLOGICAL AGENTS

Microbiological agents (mainly bacteria, moulds and fungi) are minute life forms that occur throughout the living surface layers of the planet (Biosphere). Many of these organisms assist humans in their daily life pattern, eg fixing nitrogen, producing oxygen among other gases, maturing cheese; however others pose a serious health risk to all those exposed to substantial numbers of the organism.

In the case of coal mines it is possible that exposure to some microbiological agents of significance could occur under rare circumstances. The agents thought most likely to occur on-site include bacteria and microfungi. With respect to bacteria, the highest risk of exposure occurs with the bacterium *Legionella pneumophilla* which if present in high concentrations may cause Legionnaires disease. This disease is so named after an outbreak of respiratory illness in 1976 when 182 persons contracted a pneumonia-like illness. They were all in or near the Bellevue Stratford Hotel, Philadelphia (USA) which at that time was the headquarters for a conference of the American Legion (similar to the RSL). Twenty-nine (29) infected persons died and it was some time before the offending bacterium was identified and preventative strategies developed.

Legionella bacteria can be found in most fresh water environments, in natural and constructed water sources and in the soil, hence their description as ubiquitous.

Legionella pneumophila will survive between -80°C and +60°C and in laboratory cultures actively multiplies between 20-45°C, however the optimum range is 35-37°C - human body temperature.

For the rapid multiplication of this bacterium to levels dangerous to health, specific conditions are required, namely:

- A wet environment.
- The presence of oxygen and carbon dioxide.
- High microbial substrate concentration, including algae, slime, etc.
- A favourable temperature range.

The biological process for the rapid growth of bacteria to dangerous levels is essential before the host water is considered potentially hazardous for causing Legionnaires disease (people still need to be exposed). **The mere presence of the micro-organism in water is not necessarily a cause for concern.**

In respect to mine operations, the main area where *Legionella pneumophila* could increase in sufficient concentration to cause concern would be in air conditioning cooling towers. In these cases poor or irregular maintenance may result in high concentrations of bacteria which is transported in the form of an aerosol as part of the fine mist (or drift) associated with cooling towers. If susceptible persons breathe in this mist, and the bacterial concentrations are sufficiently high, the onset of disease may occur. Cooling towers regularly maintained, as per AS/NZS 3666[1], are not known to have been associated with an outbreak of Legionnaires disease.

In NSW, operators of premises are required under the Public Health (Microbial Control) Regulation to register all cooling systems with their local council.

[1] AS/NZS 3666.1:2002: Air handling and water systems of buildings – Microbial control – Design, installation and commissioning.
AS/NZS 3666.2:2002: Air handling and water systems of buildings – Microbial control – Operation and maintenance.
AS/NZS 3666.3:2000: Air handling and water systems of buildings – Microbial control – Performance-based management of cooling water systems.

Commonly used hot water systems, which maintain water temperature levels at or above 60°C, would not normally become sources of high levels of Legionella. However, if not properly maintained, and water temperatures are allowed to fall below 60°C, central hot water systems and connecting pipes may become sources of high levels of Legionella.

Another possible source of bacteria on mine sites is the cooling water used on lathes, etc in workshops. Many of these systems employ a water emulsifiable lubricant to aid cutting, which can provide a source of nutrients for bacteria. For this to occur the main supply tank would need to be poorly maintained, used irregularly and there be a warm ambient environment. Under these conditions bacteria may multiply and the aerosol generated during cutting be inhaled by the operator, with possible adverse health effects. In these cases the bacterium would almost certainly not be Legionella pneumophila, however prevention is the same, ie good maintenance. Some soluble cutting oils contain a biocide that reduces the level of bacteria in the system, but if the system is poorly maintained or allowed to become contaminated these products will be ultimately ineffective. Good housekeeping is an effective deterrent.

The other form of microbiological agent that may, in rare cases, be of concern is microfungi. In certain cases the inhalation of the spores of specific fungi can lead to respiratory disease. This is not uncommon with outdoor agricultural workers exposed to materials such as mouldy hay, which gives rise to the disease “Farmers Lung”. The origins and effects of fungi found in old mine workings for example, are not known, and while it is very unlikely that problems will arise, given the limited opportunity for exposure, nevertheless due caution should be exercised when entering very old workings in which significant colonies of fungi exist. Particulate respirators may be desirable if it is necessary to work in these conditions.

Many microbiological agents exist in the universe, however the probability of mine workers being exposed to concentrations of these agents likely to affect their health is extremely low.

SECTION :	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT :	SPECIFIC ISSUES IN THE COAL INDUSTRY

I) NOISE

One of the major issues facing the mining industry is the issue of Noise Induced Hearing Loss (NIHL). In NSW the major cause of industrial disease compensation claims lodged each year can be attributed to noise. It is interesting to note that prior to World War I, few cases of this condition were observed (others such as pneumoconiosis certainly were), but following mechanisation of the industry, cases of hearing loss attributable to noise have escalated.

Noise is sound caused by a vibrating object. The vibrating object sets air particles in motion and this motion causes sound pressure waves that are detected by the human ear.

Noise can be:

- Steady like the sound of a fan.
- Changing like traffic passing on the highway.
- Impulsive like a hammer hitting a metal object.

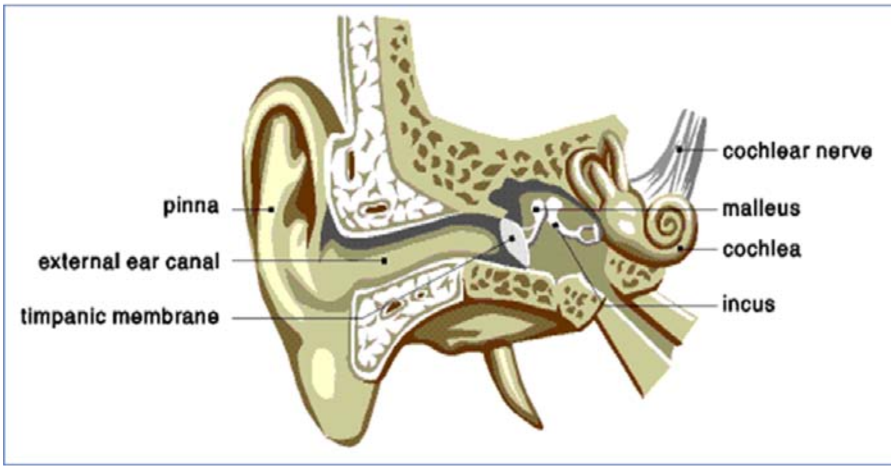
Noise in the form of sound pressure may travel a long way from its origin before it is registered by the human brain. It passes through air, solid matter, fluids and nerves. The contact point on the human body for this process is of course the ear.

The ear and auditory system is more complex than is generally believed.

It consists of four main parts: the external ear, the middle ear, the internal ear and the central auditory pathways. The first two are relatively uncomplicated.

The *external ear* consists of the *auricle* (or pinna - the part you can see and scratch) and the *external auditory canal.* It is separated from the middle ear by the *drum* membrane. The middle ear contains three little bones - *malleus* (hammer), *incus* (anvil) and *stapes* (stirrup). These convey the sound into the complicated mechanisms of the internal ear. They also have two small muscles attached to them, which help protect the inner ear from loud sounds. The *internal ear* includes two separate organs in charge of two main functions of the ear: the *cochlea* (the auditory organ) and the *vestibulum*, the balance organ.

If we follow sound waves from their source to the brain by hitting, for example, a nail with a hammer, sound waves are generated and pass through the air to the ear of the hearer. There they are received by the auricle and funnelled into the auditory canal. They cause the eardrum to vibrate, and the vibrations are transmitted through the three bones of the middle ear - from the malleus, via the incus to the stapes - and on to a second membrane in the internal ear called the "oval window".



Then the sound waves enter the winding passages of the cochlea, vibrating a system of fluids, until they reach the central auditory system: the so-called Corti's organ in the centre of the cochlea.

In Corti's organ there are thousands of sensory hair cells that respond to individual frequencies.

The sensory cells transform the sound waves to nerve impulses that are transmitted by the auditory nerve to the central auditory pathways and the brain. Finally then, we perceive and hopefully understand that we have heard something, the sound of a hammer hitting a nail, rather than a thumb!

It's the tiny sensory cells that are affected when we are exposed to excessive noise. They can be damaged or disappear entirely - and they can never be restored. **NIHL is irreversible.**

The intensity or loudness of noise is described by a unit called the decibel (dB). The term was named in honour of Alexander Graham Bell, the inventor of the telephone.

The amplitude or sound intensity scale used is from 0 to 140 dB. It is a special logarithmic scale and therefore noise levels cannot be added or subtracted in the normal arithmetic way. For example, add a 60 dB noise to another 60 dB noise and you wind up with 63 dB, not 120 dB.

Another important characteristic of noise is **frequency** or pitch. Frequency is the number of sound waves per second, measured in hertz (Hz). The higher the frequency, the higher pitched the sound.

Since human ears respond to some frequencies more than others do, a correction factor known as "A-weighting" is applied to the noise level (dB). The result is dBA.

The national standard[1] for exposure to noise in the occupational environment is an eight hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8h}$, of 85 dB(A) which is typically shortened to 85 db(A).

For 12 hour shifts this is reduced to 83 dB(A).

Hearing ability or acuity is greatest during childhood. Typically, the range of audible frequencies heard by a young person is from 20 to 20,000 Hz. (Dogs, bats and dolphins on the other hand can detect much higher frequencies.) As one ages however, the ability to hear the higher frequencies declines somewhat. This effect, due to aging, is called **presbycusis**. It usually doesn't become noticeable until the later years, when you can't hear high frequency sounds like a watch ticking or your children asking to borrow money.

If you are exposed to excessively loud noise levels for many years, you can experience hearing losses above that due to aging. The damage cannot be repaired. Hearing loss depends on how loud the noise is and the length of time you are exposed.

When you are exposed to high levels of noise the sensory hairs in the cochlea tire or become fatigued. The result is temporary hearing loss. Normal hearing will return, after a period of 16-24 hours away from the noise. This is similar to walking across a front lawn. The blades of grass lie down for a while but will return to a normal position in a short time.

If continual or repeated noise exposure occurs, prolonged over-stimulation of the hair cells will gradually injure or destroy them. This is the cause of permanent hearing loss. This is similar to walking across the front lawn day after day along the same path. Eventually the grass will be destroyed and, likewise, hearing loss will be permanent.

[1] NOHSC (2000): National Standard for Occupational Noise, [NOHSC:1007 (2000)].

At first, the higher frequency sounds disappear. This may go unnoticed at first, but gradually lower and lower frequency sounds disappear. Think of removing the highest tone musical instrument from an orchestra and then starting to remove the lower toned instruments. Eventually it won't sound like an orchestra any more.

Once the hair cells are injured or destroyed, they cannot be repaired or replaced. Hearing aids cannot repair the damage that has occurred. It is irreversible.

Certain people exposed to high noise levels may complain of ringing or a hollow buzzing in the ears (tinnitus). This may be a temporary or a permanent problem.

Impulse or impact noise is a momentary sharp noise that, if sufficiently loud, can cause serious damage to hearing. Examples of equipment that cause impulse noise are pile drivers, gunfire, explosive charges, etc. Care must be exercised to ensure that the number of impacts per day (8 hours) is maintained below appropriate limits.

In all cases workers should never be exposed to impact noise levels in excess of the national standard[1] of 140 dB (C) peak SPL.

Prevention, by reducing the noise exposure by implementing mechanical or administrative controls or using personal hearing protection, is the only way to minimise noise induced hearing loss.

Episodes of high noise occur in all coal mines, however they need to be identified, evaluated and appropriate steps taken to control them at their source, and/or initiate a personal hearing protection program.

This will undoubtedly take time and thus each site should develop and observe a hearing conservation program. This will involve evaluating noise exposures, monitoring employee exposure, assessing any loss of hearing of individuals and the introduction of a range of control strategies including hearing protection.

In assessing the possible loss of hearing, some reliance is placed upon the screening audiometric test.

The object of the audiometric test is to determine the sound pressure levels (or thresholds) at which you can just hear pure tone test frequencies. The tone generator is called an audiometer. The audiogram is either a printout or graph of hearing thresholds for each ear for each pure tone at varying intensities. It is reviewed by the audiologist to determine whether or not your hearing has changed.

This reflects the effectiveness of noise controls or hearing protection, and will also indicate loss of hearing due to presbycusis or industrial sources.

Specific information on the measurement of noise and successful control strategies are provided in other sections of this Manual (5-05c, 6-03d), however the importance of a comprehensive approach to noise reduction cannot be over-emphasised. **If adequate steps are not taken to address this issue it will continue to be one of the main causes of ill-health amongst coal miners**.

By way of illustrating the size of the problem, a survey in NSW in 1990[2] of the coal industry revealed that 56% of NSW coal miners have compensatable hearing loss, compared to 28% in the general population. This level of impairment is actually an improvement on past years with a similar survey in 1976 indicating 66% of mine workers with compensatable hearing

[2] Joint Coal Board, Occupational Health and Rehabilitation, Technical Bulletin, May 1991 "The Occupational Diseases and Injuries Prevalent in the NSW Coal Mining Industry".

loss. Irrespective of this, claims lodged for industrial deafness in NSW still account for a significant amount of all compensation claims for occupational disease.

This is obviously a situation that the industry can ill afford to bear and is intolerable in terms of the permanent damage to mine workers' hearing.

Section 5-05 provides some insight into the reasons for this high incidence of disease and supports the need for concerted hearing conservation programs at all coal mines.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**SPECIFIC ISSUES IN THE COAL INDUSTRY**

m) ORGANIC VAPOURS

Organic vapours usually arise in the workplace as a result of the use of organic solvents. Solvents have a wide application within industry because of two characteristics:

- They dissolve a wide range of materials (which are often insoluble in water).
- They evaporate into the atmosphere easily.

It is this second characteristic that leads to many problems of exposure which can be further exacerbated if the activity takes place in a poorly ventilated space or involves heated or warm components. Organic solvents are found in coal mines in a broad range of products from degreasers to cleaning products and paints. The organic chemicals in these solvents, and the sources for associated organic vapours in the atmosphere, include hydrocarbons (xylene, toluene, mineral turps and white spirit), chlorinated hydrocarbons (trichloroethylene, perchloroethylene, 1,1,1 trichloroethane), ethanol and other alcohols, esters (ethyl acetate), ketones (acetone, MEK).

The range and combinations of these types of chemicals that occur in commercial products are endless, with reference to the MSDS (Section 4-02j), being one way of establishing what each product actually contains.

Health Effects

The range of health effects resulting from excessive exposure to solvents and their vapours is nearly as large as the number of solvents in use today.

In all cases the extent of any health effects is dependent on the duration and frequency of exposure and the concentration in air of the substance involved.

Vapours of many organic solvents can be irritating to the respiratory tract, or can affect specific organs of the body, eg liver (carbon tetrachloride), kidney (trichloroethane), cardio vascular system (trichloroethylene). In many cases severe damage can be done to the central nervous system (brain and spinal cord), ranging from alcohol-like intoxication to narcosis (stupor) and in some severe cases eventually death from respiratory failure.

Some specific organic solvents are either the cause of, or suspected of involvement in, cancer. The best known compound in this category is benzene and thus petrol (which contains up to 5% benzene) should never be used to clean anything and only used as a fuel.

These types of compounds are the basis for many of the cases of skin disorders found within the mining workforce. Skin contact often causes drying, cracking, reddening and blistering in the affected area. This condition is commonly referred to as dermatitis (Section 4-02d).

It is also possible for solvents to be absorbed through the skin. They can cause eye irritation, although permanent eye damage is rare.

Detailed toxicological descriptions of the many organic solvents and their vapours likely to be experienced at mine sites are beyond the scope of this Manual, however the following general guidance is provided for their effective management.

- Identify which solvents are on-site and assess the risks associated with their use. (See Sections 4-02h and 4-02j.)

- Keep all employee exposures as low as is reasonably practicable by appropriate control measures including changing to less volatile solvents where possible.

- Always ensure adequate ventilation is available.

- Do not spray solvents (thus producing much more vapour and aerosol) if brushing, dipping or rolling is possible.

- Do not apply to heated surfaces.

- Eliminate the use of solvents if possible (eg use water based paints if this is practical).

- Do not use solvents in confined spaces without taking adequate precautions (eg ventilation, breathing apparatus, workplace monitoring).

- Be extremely careful when cleaning out sludges which may contain solvents (degreasing tank sludge) as movement of the sludge may release massive concentrations of organic vapours.

One other aspect of organic solvents that should be noted is the potential for the production of extremely dangerous compounds in the event of a fire or exposure to excessive heat. For instance chlorinated hydrocarbons can produce phosgene in the presence of a welding arc. Thus, any metal products cleaned with these types of products should be allowed to dry before welding. This is only one example of this aspect, and caution should be exercised when using solvents near ignition sources, both from an explosion and toxic vapour perspective.

n) POLYCHLORINATED BIPHENYLS

Polychlorinated biphenyls or PCBs, are synthetic chemicals that can be either solid or liquid and range in colour from clear to pale yellow. PCBs are very stable, non-flammable, non-corrosive compounds with excellent thermal and dielectric properties. These properties have in the past resulted in PCBs being widely used in electrical transformers and capacitors.

Health Effects

The scientific literature in respect to PCBs is considerable, focusing on both past disasters and possible future effects. Perhaps the worst documented case was a 1968 incident in Japan when over 1,000 people consumed rice oil severely contaminated with PCBs that had leaked from a ruptured transformer in a food processing plant. Over an extended period of time the exposed people ingested large amounts of PCB and they and their offspring developed various medical problems. This was originally an industrial incident, in which no employees suffered, but became a large public health problem. People went on using the contaminated rice oil because the source of the contamination remained undetected for a long time. In summary, the following points can be made in respect to health effects and PCBs:

- No conclusive evidence has been found to link PCB exposure occupationally with cancer.

- PCBs are of moderate toxicity, but accumulate in the tissues of living things rather than being quickly metabolized, or processed, and excreted.

- The principal clinical symptoms are chloracne, skin pigmentation, necrosis of the liver, teratogenic effects and problems with the nervous system.

- The chloracne effects are distinctive and serve as a good indication of gross exposure.

- Because of their stability they persist in the environment for an extended period causing adverse effects in wildlife.

- The International Agency for Research on Cancer (IARC) found evidence of tumour promotion in rats and suggestive evidence of malignant melanomas in humans. It also pointed out that the evidence was clouded by contamination of PCBs by polychlorinated dibenzodioxins (PCDDs).

In addition, PCBs produce very dangerous products during incomplete combustion (PCDDs), and are a serious environmental threat due to bioaccumulation.

It is important to note that at room temperatures PCBs are not considered an inhalation hazard due to their low volatility.

Possible Location On-Site

For a number of years now, pressure associated with the environment has resulted in the removal of PCBs from most transformer systems. In rare cases PCBs may still be found at coal mines in old transformers, capacitors or fluorescent lighting ballasts. Cases of PCB spillages have been reported in the coal industry with subsequent difficulty in their removal (Section 4-04e).

It is possible that operators may be required to handle oils lightly contaminated with PCBs (less than 50 ppm). In these cases there is a need to protect the skin via the use of appropriate gloves. As previously stated, inhalation toxicity is not a real danger because of the low volatility of the product. It is important to note that these practices are not markedly different from handling normal mineral oils that can also cause skin irritation in sensitive individuals.

o) PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) covers a broad range of products used to provide personal protection when other control measures are not achievable. The products include respirators, hearing protection, gloves, special garments, boots, face shields, glasses, etc. In this Manual the focus will predominantly be on respirators, hearing protection, eye protection and gloves.

Respirators

Particulate respirators contain filters that trap dusts, mists or fumes and allow the wearer to breathe local air. There are two main forms - the traditional replaceable filter type and the maintenance-free (disposable) type.

Maintenance-free respirators are generally constructed of moulded non-woven fibres and are designed to be adaptable to face sizes and shapes. They allow workers to converse in normal tones without lifting or removing the respirator.

Australian Standard 1715 1994[1] classifies the Classes of particulate respirators as:

1. Class P1 for mechanically generated particulates (dusts and mists). Particles generated from operations such as grinding, blasting, spraying and powder mixing, eg asbestos, silica, caustic mist, lead.

2. Class P2 for thermally generated particulates (fumes). Particles generated by high temperature operations such as welding, soldering, brazing and smelting, eg metal fumes.

[1] AS/NZS 1715:1994 – Selection, use and maintenance of respiratory protective devices.

3. Class P3 for highly toxic particulates such as radioactive compounds and beryllium.

Maintenance-free and re-usable respirators must meet the same testing or performance requirements as set out in the AS/NZS 1716:2003[2].

Dusts, mists, etc include particles of varying sizes. Particles typically less than 100 µm cannot be seen with the naked eye under normal light conditions and are generally considered to be inhalable ie breather in. Particles smaller than this (approximately 50 – 10 µm can penetrate to the thoracic region of respiratory and particles less than 10 µm can penetrate to the depths of the lungs.

Therefore it is important to select the correct class of respiratory protection for the process and not treat all respirators as equal.

Particulate respirators are used until they become damaged or difficult to breathe through because of loading.

Gases and vapours cannot be trapped by a mechanical filter, and thus a gas/vapour respirator must contain a specialised absorbent to trap these contaminants, eg activated charcoal is used to trap organic vapours.

They are used against gases and vapours with good warning properties - properties that allow the user to smell, taste or notice irritation at low concentrations below Australian Exposure Standards.

[2] AS/NZS 1716:2003 – Respiratory protective devices

AS/NZS 1715 has a number of gas and vapour classifications. Each filter type is designated by a letter or chemical abbreviation indicative of the substance or group or substances against which protection is intended.

Type A - For use against certain organic gases and vapours as specified by the manufacturer.

Type B - For use against certain inorganic gases and vapours as specified by the manufacturer (excluding carbon monoxide).

Type E - For use against sulphur dioxide and other acid gas and vapours as specified by the manufacturer.

Type G - For use against certain organic compounds with vapour pressures less than 0.01 mm Hg at 25°C (1.3 Pa) as specified by the manufacturer. These filters shall have an integral particulate filter with an efficiency at least equivalent to that of a P1 filter.

Type K - For use against ammonia and organic ammonia derivatives as specified by the manufacturer (boiling point less than 65°C).

Type AX - For use against low boiling point organic compounds as specified by the manufacturer.

Type NO - For use against oxides of nitrogen.

Type Hg - For use against metallic mercury.

Type MB - For use against methyl bromide

Specific - Chemical Type	For use against one or more specific chemicals not falling into any of the above type descriptions. The filter is identified by the name of that chemical. Additional particulate filtration may be provided.

When an airborne particulate hazard together with a a gas and vapour hazard are present a **combination** particulate and gas and vapour filter must be used. Examples include the spray paint industry where liquid droplets are organic vapours are present.

The combinations can be either:

- Filter combination comprising of a gas and vapour filter with a separate particulate filter on the inlet side.

- Integral filter which incorporates both the gas and vapour filter and particulate filter into single unit.

If combinations of filters are used, incoming air must contact the particulate filter first.

Respirators must be selected used and maintained in accordance with Australian Standard AS/NZS 1715.

Manufacturers' guidelines are a primary source of information in selecting the most appropriate respirator for the job and for assessing the maximum use requirement. Reputable manufacturers have technical personnel to help provide information about respirators and to assist with use questions and concerns. It is of absolute importance that the correct respirator be used for the situation at hand, and that the respirator be worn in the correct manner.

Facial hair that impedes the seal of a respirator greatly reduces its effectiveness and should be discouraged if respirator usage is a part of normal daily work activities.

All instructions and warnings regarding use, fit and product limitations must be followed for the product to work properly and provide adequate protection.

Fit testing should be considered before a worker uses a re-usable respirator for the first time. Some people may be unable to achieve a satisfactory fit.

Most manufacturers provide valuable training and educational materials for little or no cost, but if any doubt exists as to the suitability of a respirator, seek the advice of an occupational hygienist.

Personal Hearing Protection

Hearing protection can be categorised into two types; ear plugs and ear muffs.

Both plugs and muffs reduce the penetration of sound through the outer ear to the inner ear. Some sound also reaches the inner ear by conduction through bone and tissue. Thus, they are limited in the degree of protection that can be achieved. In sound fields in excess of 120 decibels, no protective device will give adequate protection for continuous exposure.

When ear protectors are first used by workers, they often experience a sensation that their own voice is very loud since outside noises are reduced. As a result, they tend to speak more softly, making it more difficult to communicate with others, especially if they are also wearing protectors.

Selection of the most appropriate device for an individual in a situation depends on two factors. These are:

- The degree of noise reduction necessary.
- Personal comfort.

For hearing protection to be effective (ie prevent hearing loss), it is important to know the level of noise to which an individual is to be subjected.

From that, the degree of attenuation or reduction ie Class of device necessary to comply with the current exposure standard of 85 dBA for eight hours daily can be established from the Table from AS/NZS 1269[3] Standard Classification Method to enable the correct selection of device.

The AS/NZS Standard recognises that wearing time is a most critical parameter in obtaining protection and that variation in the noise environment will often render accurate calculation redundant.

Indeed a high attenuation protector will have its performance degraded significantly if not worn all the time or the user enters another area. Therefore the simplified Class system was introduced to replace the requirements of Octave band, or C weighted measurement and it was intended that the focus of the risk management strategy be moved to engineering controls rather than technical fine tuning of an exact match between noise environment and hearing protector, a goal which is increasing difficult in any complex noise environment.

Hearing protectors are chosen in a simple 5 Class system which graduates the noise hazard in 5 dB increments and assigns a Class of hearing protector device to cover each increased level. Refer to the Table below.

Once the attenuation needed is established, consultation with equipment suppliers will help determine which type of hearing protectors to use. As part of this selection process potential users of the devices should be consulted to establish their personal choice. Specific requirements as to the material,

[3] AS/NZS 1269.3:2005 Occupational Noise Management, Part 3: Hearing protector program.

design and performance of hearing protection devices can be obtained from AS/NZS 1270[4].

Class	**$L_{Aeq,8hr,}$dB(a)**
1	Less than 90
2	90 to less than 95
3	95 to less than 100
4	100 to less than 105
5	105 to less than 110
Requires specialist advise	greater than 110

While experimentation with hearing protection is common within industry, it is important to realise that hearing devices may look good and feel good but unless they achieve the required reduction in noise exposure, they are ineffective. For instance heavy rim eye glasses may interfere with the seal of an ear muff. The optimum system, with the required degree of attenuation, must be obtained and the workforce encouraged through education programs to wear the correct device in areas of high noise levels.

The focus of the risk management strategy needs to be on wearing time and the contributing factors of comfort, fit, care and maintenance, applicability to the area or work and clear policy and follow through.

If the noise environment is narrow band in character with significant tonality or has significant high or low frequency components or exhibits other complexities, then the octave band method should be used.

Eye Protection

The use of eye protection in the Coal Mining Industry always gives rise to strong opinions as to the relative merits or otherwise of their use. Some operations have made eye protection compulsory with varying success.

[4] AS/NZS 1270:2002 – Acoustics – Hearing Protectors.

Numerous reasons are put forward by miners as why they do not wear eye protection as a matter of course. These range from them being uncomfortable to the fact that they fog up (especially in underground mines).

This may well be true, however the fact remains that in NSW each year (Coal Mines Insurance Incident Reports) many individuals have foreign objects enter their eyes which has, in some incidents, resulted in serious eye damage which would not have occurred if they had worn eye protection.

One recurring case worth noting concerns chemicals entering the eye (or surrounding skin) from roofbolting.

Discussions with several roofbolting crews reflect the concerns previously mentioned (fog up, etc), however when asked if they had ever considered using a face shield when mixing they said that it had never been considered as an alternative. Some experimentation by individual coal mines may be useful in overcoming this problem.

Irrespective of what eye protection is used on-site, care should be taken to ensure it is comfortable (and hence has greater wearer acceptance) and meets the requirements of AS/NZS 1336:1997[5] and AS/NZS1337:-1992[6].

AS/NZS 1336 sets out factors that should be considered in the selection of eye protectors. These include:

- The nature of the risk to the eyes.
- The condition under which the operator is working.
- The visual requirements of the task.
- The personal preference of the wearer. Comfort plus appearance are usually the main factors in wearer

[5] AS/NZS:1336:1997 "Recommended practices for occupational eye Protection (amended 1 July 1997).
[6] AS/NZS:1337-1992 (amended 1994 & 1997) "Eye protectors for industrial applications".

preference. Lightness, ventilation (anti-fog) and unrestricted vision are important considerations.

- The condition of the operator's eyesight.

Remember, there are special requirements for the protection of the eyesight of welders and welders assistants[7].

Gloves

Various types of gloves are commercially available, eg

- For protection against heat
  (leather, synthetic fibre, treated wool, Kevlar)

- For protection against abrasion
  (leather, canvas, pigskin, PVC impregnated fabric)

- For protection against chemicals
  (PVC, Butyl, Nitrile, etc)

It is important that gloves chosen for protection against chemicals are resistant to

- degradation upon contact with the chemical
- permeation by the chemical through the glove.

All gloves will deteriorate with time and wear, so must be regularly inspected for deterioration (general condition, seams, cracks, pinholes) which may allow penetration by the chemical.

Special care needs to be taken with the choice of gloves when handling mixtures where the ingredients may exhibit differing effects with respect to the glove. If an 'ideal' glove that has excellent/good resistance properties for all the ingredients in

[7] AS/NZS:1338.1- Amdt 1:1994 "Filters for Protection Against Radiation Generated in Welding and Allied Operations".

the mixture cannot be found, a compromise may need to be sought.

Compromises may also be needed in the choice of glove when finger dexterity is required for the task - thus thinner gloves may be chosen although degradation/permeation of the chemical will occur sooner than with a thicker glove.

Consult AS/NZS 2161[8] for more detailed information on gloves. (Note: There are currently seven (9) parts to AS/NZS 2161 and the part specific to requirements should be consulted. Part six was never issued.)

The major glove manufacturers have web sites that provide advice on glove material selection to provide protection against a range of the most commonly used industrial chemicals and often provide additional information in relation to permeation and breakthrough via on line data bases:

- CHEMREST is used by Best Gloves at www.chemrest.com (accessed October 2008)

- SpecWare is used by Ansell-Edmont at www.ansell-edmont.com/specware (accessed October 2008)

- North Safety Glove Products at www.pspglobal.com/nfvitongrades.html (accessed October 2008)

[8] AS/NZS 2161-Part 1-9: "Occupational Protective Gloves"

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**SPECIFIC ISSUES IN THE COAL INDUSTRY**

p) RADIATION

In daily life the entire population is exposed to a wide variety of radiation, ranging from natural rays produced by the sun through to radiation from power transmission cables. The only forms that the human can readily detect are visible radiation and infra-red radiation (by heat).

Radiation can be either non-ionising or ionising, both of which display a wide range of health effects depending on the type of radiation, duration of exposure, etc. Some forms of radiation (eg X-rays, gamma rays, and cosmic rays) are so energetic they may generate radioactive particles when they come in contact with the atoms of another material. This is called ionising radiation. Other forms of radiation are too weak to create new ions when they strike the atoms of another material and thus are called non-ionising radiation. Included in this category are visible light, infra-red radiation, microwaves, lasers, etc.

Radiation often gives rise to concern because it cannot be seen, and from the damage caused by nuclear weapons and the Chernobyl nuclear power station meltdown.

Ionising radiation can be emitted by electrically powered tubes (eg X-rays) or by radioactive materials. Radioactive material is unstable and gives off excess energy as it becomes more stable. Thus, these types of materials are always giving off their excess energy and cannot be turned off. It is necessary to have appropriate shielding of the radioactive source to protect persons in the immediate vicinity.

Over-exposure to radioactive materials (ionising radiation) can produce severe health disorders and in extreme cases, death.

Some coal mines may have radioactive sources on-site, usually for process flow measurement in preparation plants. Provided they are adequately shielded and are maintained by trained and experienced personnel, they present no real risk of exposure. Some X-ray type devices may also be present on-site and again, provided that the shielding is maintained in an appropriate manner when the X-ray tube is turned on, no problems should arise. The use of radioactive sources is usually covered by specific State legislation, which requires the appointment of a trained Radiation Safety Officer by the mine wishing to use such devices.

Non-ionising radiation is somewhat different in that most workers will come into contact with it during their normal activities. This is especially true for open cut workers where excessive exposure to ultra violet radiation can be a problem.

The two other sources of non-ionising radiation that are often found at coal mines are lasers and microwaves.

Lasers emit radiation that is unique in that it is said to be coherent, ie it vibrates in a single plane in phase, travels in one direction and at a single wavelength. The hazards of lasers are related mainly to the eye but also can affect the skin, depending on the type and power of the laser.

Various Australian Standards[1,2] apply to the use of lasers and in some States, Mines Department Regulations limit the power of lasers that can be used on-site.

Microwaves have the ability to penetrate organic matter, eg food, skin and heat the underlying tissue. The problems of the use of microwaves are tempered by the property that microwaves will not pass through metals, thus providing adequate shielding is present no adverse health effects should occur.

[1] AS/NZS 2211.1:2004 – Safety of laser products – Equipment classification, requirements and users guide.
[2] AS 2397:1993 “Safe Use of Lasers in the Building and Construction Industries”.

AUSTRALIAN RADIATION PROTECTION AND NUCLEAR SAFETY AGENCY

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Federal Government agency charged with the responsibility for protecting the health and safety of people, and the environment, from the harmful effects of ionising and non ionising radiation.

Part of the role of ARPANSA is to provide accessible information about radiation related issues. This information is available from their web site located at:
www.arpansa.gov.au/RadiationProtection/index/cfm
(accessed October 2008).

Here you will find useful links to topics such as:

- Radiation Basics – including radiation protection standards and codes of practice
- Magnetic and Electric Fields From Power Lines
- Mobile Phones and Health
- Solar Ultraviolet Radiation
- Radioactive Waste Management
- Links to other radiation protection websites

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	SPECIFIC ISSUES IN THE COAL INDUSTRY

q) SPONTANEOUS COMBUSTION

The issue of spontaneous combustion in relation to coal seams has challenged the minds of scientists for centuries. Dr Plott, Professor of Chemistry at Oxford, published, in 1686, the first known paper on spontaneous combustion of coal. Many theories have been put forward since that time, but a basic set of criteria must exist before spontaneous combustion can occur. These criteria, first outlined in 1914, are:

a) The coal must react (chemically or physically) with another substance.

b) The reaction must be accompanied by the production of heat, ie be exothermic.

c) The rate of heat production must be greater than the rate at which heat can be dissipated from the coal.

d) The above conditions must be satisfied at the prevailing ambient temperature and pressure.

There are many publications on spontaneous combustion that should be sourced if such an issue is likely to occur on-site. However, as this Manual is focused on occupational hygiene issues associated with coal mining, discussion is restricted to those long term health issues likely to arise from spontaneous combustion incidents.

In terms of health effects, spontaneous combustion results in oxidation of coal causing the release of large volumes of noxious and flammable gases that can cause asphyxiation, poisoning, or explosions if a source of ignition is present. The main toxic gases likely to be present as the result of spontaneous combustion are carbon monoxide, carbon dioxide, hydrogen sulphide, oxides of nitrogen and sulphur dioxide. Specific information on these gases can be found in Section 4-02g. The range of flammable gases evolved includes hydrogen, methane, ethane, ethylene, acetylene and a complex mixture of other hydrocarbons.

In recent years some focus has been placed on this hydrocarbon mixture. As with all combustion, some potentially dangerous aromatic hydrocarbons (Polycyclic Aromatic Hydrocarbons - PAHs) have been shown to be present in the gas streams of combusting coal. Exposure to high concentrations of these compounds for a significant period (years), may result in lung cancer. Most of this concern is based on the experience of coke oven workers where lung cancer in the past has been a serious problem and significantly higher concentrations of PAHs may occur. More recent research has demonstrated the possibility of spontaneous combustion releasing compounds that may play a role in skin cancer. Given this, it is important that caution is exercised when breathing the atmosphere in the vicinity of a spontaneous combustion heating, because of the presence of not only acutely toxic compounds such as carbon monoxide, but also the possibility of the presence of PAHs in significant concentrations. Moreover, care should be exercised when cleaning up after a heating to ensure no tars, etc come in contact with the skin, producing skin disorders such as Erythema (reddening of skin).

r) SYNTHETIC MINERAL FIBRES

Synthetic mineral fibres (SMFs) are a group of fibrous materials that are made from molten glass (fibreglass), molten slag (slag wool), molten rock (rockwool), or clay (ceramic fibres). These products are finding increasing use as substitute materials for asbestos products. They are used to replace asbestos in low to moderate temperature applications (ie some gaskets, tapes, packings) and for thermal or noise insulation.

There are three main groups of SMF:

- Glass Fibre, such as
  - Reinforcing filament
  - Glasswool
  - Superfine glassfibre
  - Fibre optics
- Mineral Wool, such as
  - Rockwool
  - Slagwool
- Ceramic Fibre, such as
  - Refractory ceramic fibres

Primarily, most SMFs have rather large fibre diameters compared with asbestos fibres. Continuous filament glass fibres are used in textiles and to reinforce plastics and concretes (eg used in fibreglass swimming pools, boats and surfboards etc). The diameters of the fibres typically range from 5 to 30 µm depending on the product with few or no respirable SMFs present.[1]

Glass fibre or glass wool is mainly in the form of insulation mats or blankets, with a small percentage of respirable size fibres (less than 3 µm diameter), even though most fibres are

[1] AIOH (2006): Principles of Occupational Health & Hygiene – an Introduction, Ed C. Tillman, AIOH 2006

in the range 5 to 15 µm. Rockwools (or slag wools) contain fibres in a similar size range as glass wool, except for a larger percentage of respirable sized fibres.

Ceramic fibres are alumino-silicates, and found mainly in the form of insulation blankets. Common trade names are Kaowool® and Fibrefax®. The diameter range is from sub-micron to around 6 µm, with a large proportion of respirable fibres. Ceramic fibres are required for high temperature applications.

The use of these products is rapidly increasing as asbestos is totally phased out. Concern has been expressed that given the experience of asbestos, perhaps one problem is merely being substituted by another. To assess this situation the National Occupational Health and Safety Commission (NOHSC) established an Expert Working Party on SMF. The results of their findings[2] in respect to chronic lung diseases were:

- SMFs are significantly less potent health hazards than chrysotile (white asbestos).
- SMF fibres are possibly carcinogenic to humans; the workplace risk has not been determined.
- There is no risk of lung fibrosis.
- There is no risk of mesothelioma (though some animal injection experiments have produced the disease).
- There was a slight increase in lung cancer incidence during early years of the rockwool and slagwool industries; glasswool and glass filament industries appear not to be implicated.

[2] NOHSC (1989) Technical Report on Synthetic Mineral Fibres and Guidance Note on the Membrane Filter Method for Estimation of Airborne Synthetic Mineral Fibres, NOHSC, AGPS, Canberra.

In 2002, the International Agency for Research on Cancer (IARC)[3] reviewed the available epidemiological data on SMFs and concluded that:

- special purpose glass fibres such as E-glass and '475' glass fibres are possibly carcinogenic to humans (Group 2B)
- refractory ceramic fibres are possibly carcinogenic to humans (Group 2B)
- insulation glass wool, continuous filament, rock (stone) wool and slag wool are not classifiable as to their carcinogenicity to humans (Group 3).

By far the greatest health effects from working with SMF are skin, eye and upper respiratory tract irritation, however the latter usually occurs only at very high concentrations.

In terms of prevention, NOHSC suggests that workers handling SMFs wear garments with close fitting collars and cuffs to protect against skin irritation while the use of respiratory protection is recommended to protect against SMF dust exposures.

The ASCC generic exposure standard for SMFs is
0.5 fibres/mL. If a workplace is involved in a significant amount of SMF handling the NOHSC Technical Report and Guidance Note[2] should be consulted.

[3] IARC (2002) Man-made Vitreous Fibres, Monograph on the Evaluation of Carcinogenic Risks to Humans', Vol.81.

s) THERMAL STRESS

Thermal stress is a condition in which the body is unable to maintain its deep core body temperature within its normal narrow range, thus leading to discomfort, stress and possible collapse.

The stress can be described as Heat Stress which is the major consideration here in Australia, BUT, increasing attention is now being paid to Cold Stress

Heat Stress

This occurs when the body can't lose heat at a fast enough rate in order to maintain the deep core body temperature at approximately 37°C. The excess heat can come from the external environment or from the body itself in the form of increased work activity. Thus the temperature of the body is the result of a balance of heat reaching or leaving the body. Body heating arises from radiation (sunlight), convection or conduction, as well as from the body processes such as work or metabolic processes such as digesting food. On the other hand, heat is lost by convection and by the evaporation of moisture (sweat). To rid itself of excess heat the body makes use of:

- Increased blood flow to the skin.
- The evaporation of sweat from the skin.
- The evaporation of moisture from the lungs by increased respiration.

If a stable core temperature cannot be maintained a number of outcomes may occur, depending on factors such as the degree of acclimatisation of those involved, fitness of individuals, ambient conditions, etc. Such conditions include:

Heat Discomfort

This is not an illness. If conditions are slightly hotter than we are used to we become aware of our bodies responding to the heat. We notice the flushing of our skin and an increase in sweating. Our health is not at risk but we feel uncomfortable. This discomfort is probably useful because it usually makes us try to cool down. At work we may not be able to move to a cooler place. In these circumstances it is important to realise that discomfort alone need not precede illness.

Heat Cramps

These are painful muscle cramps of the limbs or abdomen. They are usually associated with tingling or pins and needles in the hands and feet. These cramps are often described as a separate phenomenon, but in fact they are most probably an early part of Heat Exhaustion.

They have been said to be due to loss of salt but it seems more likely that they are the result of over-breathing. Electrolyte depletion can also be the cause of heat exhaustion without such cramps, especially in unacclimatised workers whose sweat is of high salt concentration. The taking of salt tablets to relieve cramps is not recommended, but it is highly desirable to maintain fluid intake, preferably plain water.

Heat Exhaustion (Heat Syncope and Heat Pre-Syncope)

At times, in hot conditions, people collapse and lose consciousness. Soldiers fainting on the parade ground are well known. In this case standing in the sun causes blood to pool in the legs and this leads to a drop in blood pressure and then to loss of consciousness.

On rare occasions a person, on suddenly being exposed to very hot conditions, may lose consciousness due to a rapid change in the cardiovascular system.

The common situation is that in a hot environment we start to sweat. In doing so we lose water from our bodies. In hot conditions a person may lose up to 1 litre of sweat an hour. If we do not drink enough to replace this water we become dehydrated. It is vitally important to recognise that the thirst stimulus may be inadequate to eliminate this and that the resulting heat exhaustion can progress to fatal heat stroke. Adequate supplies of fluids and supervision of their intake are essential ingredients of a successful heat stress management programme.

Excessive heat build-up puts an extra load on the body, particularly the cardiovascular system. Eventually it may lead to a drop in blood pressure and loss of consciousness (syncope). Before that, symptoms of pre-syncope often occur. These include feeling hot and tired, decreased work performance, headache, dizziness, loss of appetite, nausea and vomiting.

Heat Stroke

This is a serious medical emergency. If the central body temperature rises more than 2 or 3 degrees the heat regulating mechanism fails. The person stops sweating and their temperature continues to rise uncontrollably. This condition is not common but can be fatal. Most cases occur not at work but in other activities, notably in babies left in closed cars on hot days or athletes attempting to cover long distances in hot weather or unacclimatised or unfit workers doing unaccustomed heavy work in very hot conditions.

In heat stroke, as well as the symptoms of heat exhaustion, a person is often irritable, confused or aggressive; they may have an altered mental state, which may progress to seizures and unconsciousness. Usually the body temperature is above 40°C and the skin is dry.

Factors resulting in a net heat gain by the body, and thus a precursor for the above conditions, include:

- Muscular activity from work. As the muscles of the body undertake work and oxygen is consumed, heat is released which increases core temperature if not dissipated.

- Conductive and convective heat from working in hot air. In some cases, heat is picked up from handling hot objects. Cool air can cool the body directly. Air velocity is also very important in workplace cooling because if it exceeds 3 ms^{-1} it increases evaporation rate and convective cooling. Normal skin temperature is around 35°C. However if the ambient air is very humid, the evaporation rate of sweat is lowered significantly. In this situation the body cannot dissipate heat to the surroundings and thus the body heat accumulates quite rapidly.

- Radiant heat picked up from hot bodies, either nearby (ovens, etc) or at distance (sun). Hot bodies radiate heat in the infrared region which passes through air (or a vacuum), heating it very little. The energy is then absorbed by the body of the worker, equipment in the workplace, etc. This is a major factor contributing to heat stress.

There are a number of steps which can be taken to prevent heat stress, including ventilation and being heat acclimatised.

The human body is capable of working at different levels of efficiency. If we live and work in cool conditions and do a fairly light job, our bodies do not need to lose a lot of heat and so the sweating mechanism does not need to be very efficient. If we then start living and working in a hot environment or start doing physically harder work, after a period we start to sweat more.

We sweat more freely (release more sweat) and the amount of salt in the sweat is reduced. Our pulse rate and body temperature remain low, not increasing as much as if we had suddenly changed location and activity. This process of change in the body's response to heat is called acclimatisation.

Acclimatisation occurs over a period of about two weeks (most in the first four or five days) when a person starts becoming exposed to heat. It can make a large difference to the ability of a person to work in a hot environment.

People who have become acclimatised cope with their hot working conditions better than those who are not acclimatised.

People who do the same or similar job each day become acclimatised to those conditions. As the weather gradually becomes warmer as spring goes into summer, people whose workplace conditions are influenced by the weather (ie those who undertake physical work outside or in non-airconditioned buildings) acclimatise with it. They become acclimatised to "average" weather conditions for that time of year and although not fully acclimatised to the hottest days they are better able to cope. Most people have this degree of acclimatisation to their usual work conditions. Few people are ever fully acclimatised to conditions on the very hottest days in summer. Acclimatisation is not permanent and workers need to re-acclimatise after time spent in cooler climates than the work climate.

In addition, attention should be paid to the following to avoid any incidences of heat stress.

- Maintain appropriate levels of physical fitness.
- Ensure adequate liquid replacement.
- Maintain electrolyte balance of body fluids, especially for unacclimatised workers.

- Train supervisors and workers in recognition of heat overload symptoms.
- Alert workers to the synergistic effects of drugs, alcohol and obesity on heat illnesses.
- Screen workers for heat intolerance (particularly previous episodes).
- Provide shade where practicable, including broad brim hats.
- Ensure awareness of seasonal factors relating to climate.
- Restrict overtime in periods of excessive heat.
- Limit time exposure to hot work - use extra manpower to reduce exposure time for each worker and carry out strenuous tasks in the cool of the morning or evening.

When assessing the potential for heat stress to occur, supervisors should also take account of the following environmental factors:

- Air temperature
- Air velocity
- Relative humidity
- Radiant heat load
- Availability of shade, or protection from direct sunlight

Having stated the above, it is recognised that hot climates are normal for many coal mines in Australia (especially Queensland). Provided that commonsense is applied and workers are suitably acclimatised, the likelihood of severe heat stress conditions occurring is small. Over-zealous enforcement of work schedules, particularly for unacclimatised workers, can have severe consequences.

Evaluation of the Workplace

The evaluation of workplaces in terms of heat stress is complex and open to degrees of interpretation.

A number of heat stress indices are currently used in the mining industry, however each has been developed for a particular purpose, and experience has shown that without proper interpretation by suitably qualified persons, misleading results and recommendations can occur.

- Effective Temperature

Developed in the 1920's and was the first heat index and is still used around the world as an index of comfort as opposed to the more serious situation of heat stress.

While replaced by a number of other indices it is still used in underground mines and other places where the humidity is high and the radiant heat low.

It makes limited allowance for the effect of clothing worn and NO allowance for the level of physical activity.

- WBGT

Is probably the most widely accepted index and combines the effects of the four main components affecting heat stress: air temperature, humidity, air velocity and radiant heat as measured by dry bulb, natural wet bulb and globe temperatures. These parameters are incorporated into two formulas for either indoor or outdoor environments and are calculated as WBGT °C values. They are an empirical index of the environment and the screening criteria are adjusted according to the contributions of work demands and clothing worn, ie temperature values of added to the calculated WBGT values in °C.

These adjusted results are then compared to the ACGIG[1] Screening Criteria for TLV and Action Limit for Heat Stress. An allocation of work in a cycle of work and recovery may be recommended or there may be an additional requirement for physiological monitoring to be carried out.

Portable electronic instruments for measuring WBGT are commercially available.

- Predicted Heat Strain

The Predicted Heat Strain (PHS) is a rational index based on the human heat balance equation. It estimates the required evaporation rate and the maximum evaporation rate, utilising the ratio of the two as an initial measure of “required wettedness”. This required wettedness is the fraction of the skin surface that would have to be covered with sweat in order for the required evaporation rate to occur. The evaporation rate required to maintain heat balance is then calculated[2].

- Thermal Work Limit

The Thermal Work Limit (TWL) was developed by in Australia in the underground mining industry by Brake and Bates[3]. TWL is defined as the limiting or maximum sustainable metabolic rate that hydrated, acclimatised individuals can maintain in a specific thermal environment, within a safe deep body core temperature (<38.2 °C) and sweat rate (<1.2 kg/hr).

Recommended guidelines for TWL limits with corresponding interventions are provided by Brake and Bates. They are based on the hierarchy of safety controls and include a range of engineering, procedural and PPE interventions.

[1] ACGIH (2008): Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH, 2008.
[2] AIOH (2003): DiCorletto, R., Coles, G., & Firth, I: Heat Stress Standard & Documentation Developed for use in the Australian Environment, AIOH, March, 2003.
[3] Brake, D. & Bates, G., (2002): Limiting Metabolic Work Rate (Thermal Work Limit) as an Index of Thermal Stress, Applied Occupational and Environmental Hygiene 17:176-86.

A Heat Stress Monitor is commercially available to measure this index.

Small portable instrumentation is also available for personal or physiological heat stress monitoring.

These instruments do not measure the environmental conditions leading to heat stress but monitor the physiological indicators of heat strain based on a combination of body temperature and heart rate. These have some value but care must be exercised in their use and interpretation.

The best method to determine if heat stress presents a health hazard is to monitor the deep core body temperature using rectal thermometers or more recently, radio transmitting temperature devices that can be swallowed. As this does not present an acceptable method for most workers (this technique has successfully been used with sheep shearers in SA), measuring environmental factors and the metabolic work rate is normal practice. Again, interpretation of this data is complex and should only be undertaken by trained, experienced persons.

Guidance in the area of workplace evaluation and assessment can be obtained from the Australian Institute of Occupational Hygienists' publication on heat stress[2]. Many regulatory authorities are using this publication as a defacto standard as it best suits Australian conditions.

Cold Stress

Cold stress is defined as a thermal load on the body under which greater than normal heat losses are anticipated, and compensatory thermoregulatory actions are required to maintain the body thermally neutral.

The objective of cold stress indices are to avoid the core body temperature falling below 36°C and to prevent cold injury to the extremities of the body.

Much of the investigation into cold stress indices has been associated with military and expedition type activities and in respect to working outdoors. There is however increasing interest in working indoors, particularly in freezer rooms and cold storage plants. Efforts in the prevention of cold related health problems centre around the maintenance of body heat.

The body responds to cold by constricting blood vessels of the skin and shivering creating metabolic heat. Localised effects include frostbite and chilblains whee insufficient blood supply reaches the extremities and the cells literally freeze.

Generalised effects of over exposure to cold include uncontrollable shivering accompanied by slowing heart rate and decrease in blood pressure.

The main factors[4] contributing to cold injuries are humidity, wind contact with cold bodies, improper clothing and general state of health.

Wind chill, in which the wind blows away insulating layers of air near the body, can turn conditions which are cold into bitterly cold. This aspect is so significant for working in the cold that the ACGIH TLVs[1] are calculated on workload and the wind speed and presented as a work/warm-up schedule for a four work shift. Australia does not have standards for exposure to cold and the ACGIH values are used.

Control of cold environments can be achieved by consideration of a number of factors that are outlined in an International Occupational Hygiene Training Module[5] and includes:

- Personal Factors

4 AIOH (2006): Principles of Occupational Health & Hygiene – an Introduction, Ed C. Tillman, AIOH 2006

5 AIOH (2008): International Occupational Hygiene Training Module – Thermal Environment – Student Manual.

- Engineering Controls
- Management Controls
- Clothing
- A checklist for working in Cold Environments.

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	SPECIFIC ISSUES IN THE COAL INDUSTRY

t) VIBRATION

Vibration can be defined as oscillatory motions of solid bodies and can be visualised as waves on a lake. Vibration can be either:

- whole-body, or
- segmental (such as hand/arm or foot/leg)

Vibration energy can be passed onto operators from vibrating tools, vibrating machinery or vibrating work areas and may give rise to adverse health effects. The magnitude of these will depend on the severity and length of exposures.

Health effects

Vibration can induce a number of adverse health effects. For whole-body vibration (WBV) these may include:

- degenerative changes in the spine
- problems in the digestive system
- reproductive damage in females
- impairment of vision and/or balance

For segmental vibration these may include:

- the development of circulation problems in the fingers (Raynaud's Syndrome or Vibration White Finger) especially when combined with cold conditions
- nerve degeneration
- pressure on nerves passing through the carpal tunnel at the wrist giving rise to numbness and tingling in the fingers especially at night

- tenosynovitis (inflammation and pain in the tendons around the wrist or foot)
- muscle degeneration in the arms or legs

In addition to these long-term effects, short-term exposure can lead to fatigue and loss of dexterity when performing tasks. In Britain Vibration White Finger is emerging as a major compensable health issue in retired coal miners.

In Australia, whole-body vibration (WBV) is assessed according to AS 2670-2001[1].

Using this Standard, most rides measured in open-cut and underground coal mines exceed the recommended exposures for an eight-hour shift. In some very rough rides (usually in vehicles without suspension) recommended exposure times were well below any reasonable work or travelling time periods (4 or 5 minutes or less).

Control of vibration

The control of vibration in mining relies on both engineering design and administrative procedures. For example, to reduce whole-body vibration while driving or operating in coal mines the following aspects should be considered:

Engineering design

- Effective vehicle suspension or isolation of the cab from the frame of the machine
- Seat design including effective seat suspension (seat must not bottom out)
- Vehicle maintenance including appropriate seat maintenance and timely seat replacement

[1] AS 2670.1-2001: Evaluation of human exposure to whole-body vibration – General requirements.

- Sufficient cab space especially leg and headroom
- Careful layout of controls and displays
- Fully adjustable controls and seating
- Passengers to face forward in appropriately designed seats
- Good visibility from the cab especially at night
- Appropriate and effective road maintenance systems
- Appropriate tyres and tyre pressures

Administrative measures

- Defining and giving feedback on what ‘operating to conditions’ means in practice (appropriate speeds and skills)
- Specific vehicle operator training
- Job rotation – operation of different vehicles each shift
- Regular, frequent breaks out of the seat (a minimum of 5 minutes within each hour; preferably 10 minutes within each hour especially where 12-hour shifts are worked

Control of segmental vibration should include:

- Education on the effects of exposure to vibration and how to minimise these
- Engineering design to damp vibration eg handles of tools
- Isolation of the hands or feet from the vibration source
- Maintaining warm hands while using vibrating equipment

Vibration inside structures eg coal preparation plants, needs to be assessed and may require structural modification. Alternatively, isolation of operators may be appropriate along with a range of other techniques i.e. use of damping materials, sandwich structures etc.

Checklist for vibration exposure reduction

An extensive checklist has been provided in "A Handbook on Whole-Body Vibration in Mining [2]" a project originally funded by the Joint Coal Board Health and Safety Trust. Copies of the publication are still available from Coal Services Pty Limited.

This Handbook is currently being revised and will become available on the Coal Services Health & Safety web site: http://coalservices.hstrust.com.au/ (accessed October 2008).

The check list is to help identify and manage vibration problems at the mine. Photocopy the check list, date it and use it provide an overview of the current situation. Progressive checklists can be completed as problems are identified and solutions implemented.

The checklist includes headings for:

- Identification of vibration sources
- Measurement, assessment and recording of vibration levels
- Reducing vibration exposures
    - Operator training
    - Road maintenance programs
    - Restricting speeds
    - Design of vehicles and suspension
    - Cab design and layout
    - Seat design, suspension and layout
    - Maintenance of vehicle suspension systems
    - Lighting and visibility

[2] McPhee, B., Foster, G., & Long, A., (2001): Bad Vibrations – A Handbook on Whole Body Vibration in Mining, Joint Coal Board Health & Safety Trust.

    - Task design and work organisation
    - Shot firing standards
- Monitoring and evaluation
- General comments

u) WELDING

Welding, cutting, spraying, brazing or soldering processes take place every day on any coal mine site.

Welding and cutting operators are exposed to the following potential injuries and diseases more frequently than other workers.

- *Electric shock* - Contact with electrically live components.
- *Radiation burns* - Burns to the eyes or body due to the welding arc, which generates UV radiation.
- *Body burns* - Burns due to weld spatter or hot or molten materials; or due to burning of clothing, etc in oxygen enriched atmosphere.
- *Fire and explosion* - May be due to arc, flame, sparks or spatter or electrical faults in combination with flammable materials, gases or liquids.
- *Eye injury* - Radiation and foreign matter can cause injury.
- *Illness* - Illness may result from inhalation of fume from welding, brazing, metallising or cutting, from surface coating on the material being dealt with, from breakdown of contaminants such as residual chemicals in drums, paint or plastic bonded to metals or galvanising.
- *Asphyxiation* - Displacement of oxygen by non-toxic gases can be dangerous in confined spaces or poorly ventilated areas.

- *Hearing impairment* - Excessive noise.

While the focus of this Manual will be on the fumes and gases produced in welding and cutting processes, it is interesting to note that Workers Compensation records for miners indicate that a significant number of incidents of welder’s flash occur, all of which are preventable.

Many welding processes are used at mines including:

- Metal arc welding.
- Metal inert gas (MIG) welding.
- Tungsten inert gas (TIG) welding.
- Plasma arc welding.
- Submerged arc welding.
- Resistance welding.
- Thermal spraying.
- Oxygen cutting and gouging.
- Arc cutting and gouging.

All these processes produce fumes in varying quantities. Fumes are the result of vapourisation of metal or fluxes which, when it comes in contact with air, produces metal oxides. These oxides join together in small chains (when viewed under the microscope) to produce the distinctive fume associated with welding. Small amounts of gases such as ozone and oxides of nitrogen may also be produced in the arc.

Additional fumes and gases may be generated when welding or cutting metal that has a surface coating or surface contaminant. Examples include painted metal, metal cleaned with a solvent or a galvanised coated steel (see Section 4-04g).

Fumes generated during welding or burning have particle sizes small enough to be inhaled into the lungs. The health effects associated with fumes not only depend on the concentration, but also on the toxicity of the fume type.

Some common fumes encountered during welding or burning include:

- **Iron Oxide** - Usually the most abundant fume produced during welding or burning. Excessive inhalation may produce siderosis, a lung condition without disability.

- **Zinc Oxide** - Produced during welding or burning galvanised metals. Excessive inhalation may cause metal fume fever. This is characterised by chills and flu-like symptoms several hours after exposure. The symptoms will disappear in a short time, usually less than 24 hours (see Section 4-04g).

- **Chrome and Nickel Oxides -** Produced during stainless welding. Excessive exposures to chrome and nickel oxides are suspected of increasing the risk of developing nasal or lung cancer.

- **Other Metallic Oxides** - These include copper, beryllium, cadmium and lead. Potential health effects depend upon the extent that these materials are present in the filler metals, welding rods, wire or in the metal surface coatings. Beryllium is very dangerous and exposures should be controlled at all times.

- **Fluorides -** Dust, fume and vapour containing fluorides may be produced in welding operations from fluxes containing fluorspar. Fluoride fumes may produce irritation of the eyes, throat, respiratory tract and skin. Chronic exposure may lead to fluorosis as a result of fluoride deposition in the bones.

Gases generated during welding or burning usually are decomposition or oxidation products.

Some gases encountered during welding or burning include:

- **Ozone** - A strong irritant. Excessive exposure can cause headache symptoms. The material is unstable and disappears within a few minutes.

- **Oxides of Nitrogen** - High levels of nitrogen dioxide can lead to edema (liquid in the lungs). Nitrogen dioxide is very irritating at relatively low concentrations.

- **Phosgene** - Produced during decomposition of chlorinated solvents used to remove grease or oil from the metal. Excessive exposure can cause severe irritation.

Welding rods and fluxes represent a classic example of a hazardous substance that does not cause trouble until it is consumed in the welding process and produces potentially toxic fumes. Again, it is not the product itself that is the issue, but how it is used. Consequently, special care needs to be taken when welding in confined spaces or areas of poor ventilation.

The control of welding fumes and gases should be well known to skilled operators, however a thorough examination of work practices is useful to minimise exposure. Other control strategies include:

- Substitution of a welding rod with one containing less hazardous ingredients or substitution of process elements, ie change welding practices to reduce fume generation.

- Ventilation - Use of local exhaust ventilation to remove fumes as they are generated. Elephant trunks, or other flexible hoses, may be aligned very close to emission points, at least in welding shops.

- Improved Work Practices - Remove coatings from base metal before welding.

- Personal protective equipment.

Further Reading

1. *Welding Fumes and Gases*
   National Occupational Health & Safety Commission (NOHSC), November 1990
   Australian Government Publishing Service, Canberra

2. *Health & Safety in Welding*
   Technical Note 7
   Welding Technology Institute of Australia

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**HOW TO CONDUCT A WALKTHROUGH SURVEY**

INTRODUCTION

The walkthrough survey is a fundamental tool in the recognition of many workplace hazards. Its purpose is to identify those processes or procedures that need evaluation and possible control. It is important that the survey be conducted by people fully conversant with the process and with OH skills, for in many cases what actually happens may be different to that initially planned. This occurs from the degeneration of control technology, the adaptation of procedures by workers to suit their own work patterns or physical build, or as a result of process changes since the initial design.

A walkthrough survey is a data gathering exercise during which all possible sources of information should be explored. Ask questions and follow up until a full understanding of the activity is achieved.

Step 1

Before commencing a walkthrough, obtain an explanation of the basic process to be reviewed. Information such as the number of workers involved (including contractors) and the number and types of materials used or handled is very useful. If Material Safety Data Sheets (MSDS) exist for any of the products, obtain a copy for each material involved in each process in use in the area to be studied.

Step 2

In the company of an experienced worker from the area under review, ask them to take you through the process.

Look for deviations from standard procedures, etc and if materials are evident (eg drums of chemicals), ask how that particular material is involved in the process. At this stage you should look for:

- Evidence of reactions and any material transformation.
- Engineering controls in place and working correctly (check with local operator that they are routinely used - if not why not?).
- Satisfactory housekeeping.
- Signs that dusts, mists or vapours are (not) escaping from the process (eg build-up of material around workplace or pungent smells etc).

It is also useful to note:

- Type of clothing including footwear operators are wearing (is skin exposure a problem?).
- The presence of any foodstuffs in the area (is it acceptable to eat in the area?).
- Personal protective equipment being worn (gloves, eye protection, hearing protection, respiratory protection).

Experience has shown that the use of a camera (if possible) can have positive benefits when discussing identified issues with people concerned.

A list is a helpful tool at this stage but as every process is different it will need modification to suit your needs. A basic check list is provided at the end of this section.

Step 3

If possible examine records of machine or equipment failures and the resulting corrective action. Similarly, records of incidents or accidents may be of assistance in filling out the survey.

Once you have all the available data, list out all the possible issues in preparation for evaluation (Section 5).

TYPICAL WALKTHROUGH SURVEY - CHECKLIST

It is impossible to produce a checklist that covers all possible situations, but the use of the checklist below, and appropriate reference to the sections of the Manual indicated, should be sufficient for most situations.

- What processes are performed in the area? (Section 4-03, Step 1 & 2).

- How many people are involved in the activity under evaluation? (Include all employees and contractors.)

- Specific issues (read Section 4-02 before attempting to conduct the walkthrough audit).

  a) **Asbestos**

    - Is there any asbestos on site? Is there an asbestos register?
    - Does a site management policy exist?
    - Have safe work procedures been developed for its removal and/or use?

    (Asbestos may be present in building materials, gaskets, floor tiles, etc, depending on when they were first installed.)

b) **Confined Spaces**

- Are there any?
- Is AS/NZS 2865 being applied?

c) **Dangerous Goods**

- Are the relevant Dangerous Goods Regulations or Codes being applied (including the appropriate referenced Australian Standards, eg AS 1940).

d) **Dermatitis**

- Have any cases been reported in the last 1-2 years? If so, establish the circumstances or agents involved.

e) **Diesel Exhaust Fumes**

- Has this been an issue underground? If so, is the NSW Dept of Primary Industries Guidelines[1] for the diesel pollutant being followed?

- Is this an issue in workshops? If so, establish the circumstances (eg winter, closed doors) as this generally provides the cause.

- Are the requirements of the Coal Mines Regulation Act being applied in respect to ventilation?

[1] MDG 29: Guidelines for the Management of Diesel Engine Pollutants in Underground Environments, NSW Department of Primary Industries, April 2009.

f) **Dust**

- Does workplace monitoring indicate a problem?

- Are there particular circumstances which give rise to excessive dust?

g) **General Airbody Gases**

- Are these being managed appropriately?
- Ask what gases are being monitored for.
- Look at records, etc. Are all instrument calibrations valid?

h) **Hazardous Substances**

- Are there hazardous substances on site?

- Does a site management plan exist?

- Is there a register of all hazardous substances on site?

- Has each substance been evaluated for potential risk to employees?

- Are products correctly labelled, stored and used?

- Has the workforce received appropriate training?

i) **Lighting**

- Have any lighting surveys been performed?
- Are work areas adequately illuminated?

j) **MSDS**

- Do MSDSs exist on site for all hazardous substances? Are they up-to-date and readily available and of an acceptable quality?

- Are they used?

k) **Microbiological Agents**

- Are all water-based cooling systems being managed according to the Australian Standard (or local requirements)?

l) **Noise**

- Are there noisy locations?

- Have noise surveys been undertaken? (Examine them!)

- Is the level of signage adequate?

- Is hearing protection used in designated areas?

- Is there a site hearing conservation programme?

- Does the site have a "buy quiet" policy as part of new equipment purchases?

m) **Organic Vapours (Solvents)**

- Are solvents used for degreasing, cleaning, etc?

- Are procedures for their use appropriate?

- Are potentially volatile products used in confined spaces?

n) **PCBs**

- Are any PCBs known to exist on site? If so, how are they managed?

o) **Personal Protective Equipment**

- Does an adequate procedure for the selection and use of PPE exist?

- Does it cover suitability, usage, maintenance and storage?

- Is this information transmitted to and observed by the workforce?

p) **Radioactive Sources**

- Do any sources exist on site? If so, are they managed appropriately?

- Are emergency procedures available for radioactive sources and has appropriate training been provided to the designated Radiation Safety Officer?

- Ask for radiation calibration, testing and inspection records.

q) **Spontaneous Combustion**

- Is spontaneous combustion likely to occur on site? If so, are appropriate procedures in place to minimise workforce exposure?

r) **Synthetic Mineral Fibres**

- Are any used on site?

- Are the correct procedures for the use of these products being observed?

s) **Thermal Stress**

- Have any cases of thermal stress presented to the first aid station?

- Does a site policy exist?

t) **Vibration**

- Has any monitoring been undertaken on site?

- Have any measures to minimise vibration been undertaken on site?

u) **Welding & Welding Fumes**

- Are all concerned aware of the risks (eg fumes, gases) associated with welding?

- At what locations does welding occur?

- Is adequate fume extraction available?

- Are any special tasks, eg silver soldering, conducted on site? If so, what precautions are taken?

• **Contractors**

- How are contractors managed in respect to occupational hygiene?

- Are the procedures adequate and enforced?

- **Ventilation Systems**

    - Are all ventilation systems working?
    - Is their performance regularly monitored?
    - Are there any checks to ensure gas levels remain at safe levels?
    - Does the workforce choose not to use an extraction system even though it is provided? If so, why?

- **General Safety of the Area**

    - Is the safety of the area under inspection generally satisfactory?
    - Is housekeeping at an acceptable standard?

Notes

Remember this table is just an indication of what can be used, but it may not be relevant to your situation. Spend some time before the walkthrough audit and draw up your own checklist.

The above checklist does not imply that written procedures are required for every issue, as it may not be relevant to that site. The list is presented as a memory aid, not a list of mandatory items.

Experience has shown that photographs taken during an audit can add value to a report, especially on controversial issues.

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	CASE STUDIES

a) DUST

Since the mechanisation of the Australian coal mining industry, and the resultant introduction of high production continuous miner units and longwall faces, problems with worker exposure to high concentrations of respirable dust have increased. Whilst this is not a widespread problem, a review of a number of specific cases have identified the following situations where exceedances of the statutory limit have occurred.

- Operator exposure during breakaways.
- Intake contamination from outbye activities.
- Intake contamination from crushers and beam stage loaders on longwall faces.
- Operator exposure due to poor work procedures, eg working in advance of brattice or vent tubes in continuous miner panels.
- High dust concentrations adjacent to shearer drums.
- Intake contamination from panel and outbye belt roads.
- Excessive dust generation on longwalls related to drum speed.
- Excessive dust generation due to inadequate or incorrect water spray systems or water pressure.
- Inadequate ventilation.

- Quartz exposure due to mining floor or roof, inherent seam quartz or chock movement.

Guidance on how issues such as those above can be evaluated and controlled is provided in Sections 5 & 6 respectively.

b) HAZARDOUS SUBSTANCES

Hazardous substances exist within the work environment of every coal mine and therefore must be correctly managed (ie stored, used, disposed, etc) if incidents are not to occur. Many operations have formal procedures to manage these substances, but if they are not correctly applied in every case incidents will arise, some of which may affect workers.

The following photographs illustrate the reasons why effective hazardous substances procedures are a must for all coal mines. These specific cases are only a sample of a wider problem, which must be adequately managed.

FIGURE 4-04b(I)
UNMARKED & UNKNOWN CONTAINERS

FIGURE 4-04b(II)
SPILT CLEANING CHEMICALS IN A WORK AREA

FIGURE 4-04b(III)
LEAKING DRUMS OF KEROSENE/SOLVENTS

FIGURE 4-04b(IV)
STORING PRODUCTS WITH FOODSTUFFS

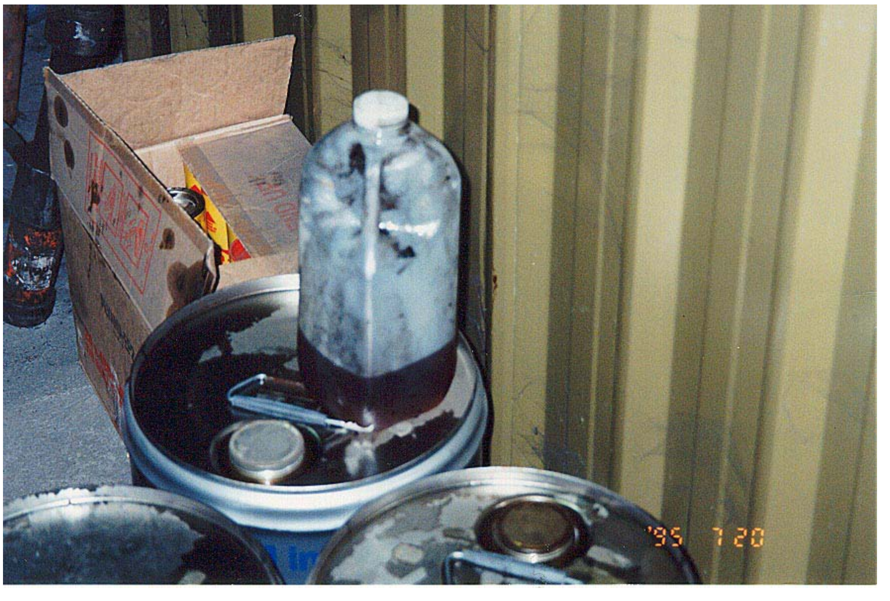


FIGURE 4-04b(V)
UNMARKED CONTAINERS

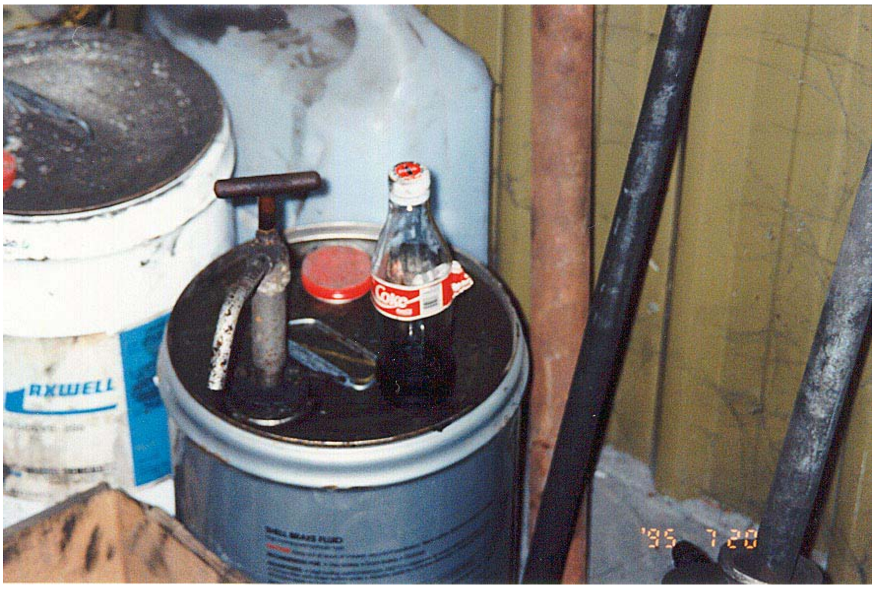


FIGURE 4-04b(VI)
INCORRECT USE OF FOODSTUFF CONTAINERS

FIGURE 4-04b(VII)
USE OF OPEN CONTAINERS OF CLEANERS IN BATHROOMS

The preceding selection of photographs merely serve to highlight some of the issues with hazardous substances. Many hazardous substances lead to substantial benefits in use, provided they are used correctly.

Sections 4-02h, 4-02j and 6-03c should also be consulted in order to see how these substances can be managed.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**CASE STUDIES**

c) NOISE

Workforce exposure to high levels of noise within the Coal Mining Industry present a major source of adverse health effects. "As indicated in Section 4-02l in 1990 56% of NSW coal miners had compensatable NIHL, twice the incidence in the general population." This is an intolerable situation that needs to be addressed, including the use of a comprehensive hearing conservation programme at all sites.

An examination of some typical situations may provide some insight into the reasons for this appalling situation.

In a recent survey conducted at a Hunter Valley open cut mine, noise levels were measured in the cabin of a Komatsu 730E truck. Under normal operating conditions the following sound levels were recorded:

No Radios	82 dBA
Commercial Radio	85 dBA
Commercial Radio & 2-Way Radio	88 dBA

While it is obvious that radio communication is an essential part of normal activities, care needs to be exercised to ensure that over-exposure does not result from the addition of several sources. Under normal circumstances noise levels should be maintained below 85 dBA for 8 hour shifts, or 83 dBA for 12 hour shifts.

In another case the need to wear appropriate personal protective equipment when operating diesel equipment was demonstrated. Noise level measurements at a southern NSW underground mine indicated that the driver of an Eimco LHD had the following noise exposures without personal hearing protection:

Start	109 dBA
Idle	78 dBA
Operating	104 dBA

In a third case, longwall pumps were positioned adjacent to the crib room on a longwall face. This caused severe discomfort to the workforce and resultant noise level measurements indicated a noise level of 103 dBA. The crib room was relocated and a significant reduction in the noise exposure of the workforce resulted.

Perhaps the best example of the need to conserve hearing can be obtained from the attached noise dosimeter printout, Figure 4-04c(I). In this case a general hand was cleaning up near the beam stage loader for the majority of the shift. During this period, noise exposure levels exceeded 95 dBA with respite only occurring when the bins were full or an electrical fault stopped the shearer. The importance of wearing hearing protection in diesel man cars (or other diesel transport) is emphasised with the high noise levels recorded.

Failure of the industry to address the issue of noise will result in further injury to the workforce and increased compensation payments. Both of these adverse situations can be minimised by the implementation and aggressive maintenance of a hearing conservation programme.

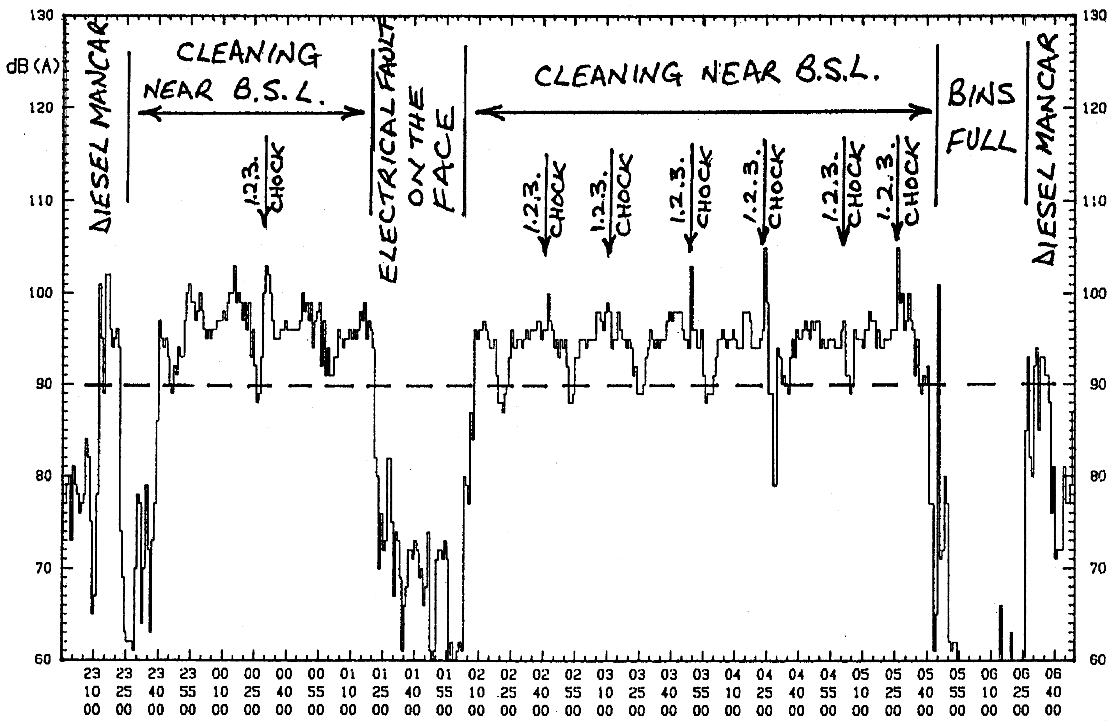


FIGURE 4-04c(I)
FULL SHIFT PERSONAL EXPOSURE DOSIMETRY

SECTION	:	IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES
SUBJECT	:	CASE STUDIES

d) ORGANIC VAPOURS

The inhalation of the vapours of organic solvents has been responsible for numerous incidents in the mining industry. In all cases these incidents could have been prevented if a review of the potential hazards had been undertaken prior to commencing the task.

The following case studies are provided to illustrate this point.

In one situation a worker was required to replace the rubber lining inside a pipe at a preparation plant. The pipe was located at approximately 2 m above the ground with access being gained through the removal of a cover on a blank end. The procedure required the removal of a worn section of rubber and the replacement by gluing down a new section. To perform this task the employee scaled a ladder and proceeded to place his head and shoulders within the pipe opening while gluing down the section of rubber. In a short space of time the worker was overcome with fumes, lost consciousness and fell backwards onto an unguarded arc lamp, receiving severe burns to his thigh.

As a result of an investigation of this incident it was discovered that the glue contained 80% trichoroethylene (Section 4-02m) and that no instruction had been provided to the employee on the potential hazards, eg confined space, working at height, fumes, etc associated with this task. An examination of the MSDS and the label on the container of glue clearly indicated the presence of trichloroethylene and the need for the task to be conducted in a well ventilated area.

A simple risk assessment of the work area by the worker and his supervisor should have highlighted the issues that led to this serious incident.

Another case involved the use of a hydrocarbon based cleaning solvent to remove a build-up of "blackjack" in the tub of a dragline. Again the compounding factor here was the confined area in which the vapours were present and the need for workers to be in the area to chisel off the "blackjack". The procedure was compounded by the lack of adequate ventilation, but thankfully, the signs of over-exposure were recognised and the workers removed before anyone was seriously affected.

The third case involved the use of a spray of degreaser to clean down traction motors on heavy haul vehicles. Because of the way the degreaser was being applied (spray) and the heat of the surfaces upon which it was being sprayed, the maintenance employee was being excessively exposed to organic vapours and in this case, without any basic protective equipment.

For the above situations it is obvious that solvents can impact on workers in the normal performance of their duties. While this may be the norm, there is no reason for anyone to be over-exposed if correct procedures are in place for every situation and due care is exercised. Information from MSDS and a risk assessment approach to each task should avoid any incidents of over-exposure to organic vapours
(see Sections 3-03, 4-02h, 4-02j).

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**CASE STUDIES**

e) POLYCHLORINATED BIPHENYLS

Many transformers used in coal mines have historically contained Polychlorinated biphenyls (PCBs), and although these units have in the most part been phased out, some may still be operating.

Care should be exercised when such equipment is being handled or transported. A case in NSW illustrates this point. A transformer containing PCBs was fractured while being transported out of an underground mine. The resultant leak from the fracture went undetected for the length of the journey, resulting in approximately four (4) km of roadway being contaminated with PCBs.

The mine was evacuated and the resultant solution was to brush the entire roadway with a continuous miner to a depth of 0.3 m in order to remove the contaminated material. This exercise presented major problems for the management of the mine and caused severe interruption to production.

No knowledge exists as to how the contaminated material generated from this exercise was disposed of, however given the nature of PCBs, the volume of PCB containing oil, the concentration of PCBs in the oil and the area of contamination, there was probably little risk to the health of workers, but it exposed a lack of foresight and planning and emergency treatment which led to an industrial relations problem.

In retrospect, those involved probably wished that they had the opportunity to conduct the original transportation exercise over again. No doubt, they would apply more appropriate practices for materials of this type.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**CASE STUDIES**

f) SPONTANEOUS COMBUSTION

A number of recent cases within the Australian coal mining industry highlights the range of occupational hygiene issues likely to arise from spontaneous combustion.

In the first case, workers at an open cut coal mine expressed concern as to the possible health effects arising from fumes generated by spontaneous combustion in waste dumps and the raw coal stockpile. Ensuing industrial and legal action resulted in a major medical assessment of the workforce in respect to exposure to airborne contaminants. As a result of that assessment, short term exposure to significant concentrations of carbon monoxide for a limited duration was determined to be the main risk to health. This occurred when operators were required to doze out fires in a waste dump or in the coal stockpile. The dozer required to perform this task was fitted with self contained breathing apparatus for use by the driver when performing this task. The introduction of a fire identification and management system has greatly reduced the number of fires that require dozing.

Fears of other adverse health effects, eg cancer, were found to be unfounded, with exposures in general to polycyclic aromatic hydrocarbons being low.

In another case a fire occurred in the goaf of a longwall at an underground mine. The area was isolated until the fire was adequately controlled, whereupon recovery of the longwall was commenced. As a result of the fire, tar-like deposits had formed on the metal structure of the wall machinery.

Some employees came in contact with this material and upon leaving the site for the day developed a reddening of the skin like sunburn. This was established as being a chemically induced skin condition resulting from aromatic compounds in the tar material. This, and a strong chemical odour, gave rise to significant concerns, both within management and the workforce. The issues were collectively resolved with the assistance of external occupational hygiene and medical expertise.

To overcome the odour, respirators shown to be effective against coke ovens emissions were introduced, thus reducing the odour and dust/fume levels. To combat the issue of this skin reaction, disposable clothing that covered the skin was introduced along with a personal hygiene programme (washing hands to remove any tar deposits).

Both these measures were effective and the longwall was ultimately recovered without any further adverse health effects occurring.

SECTION	**:**	**IDENTIFICATION OF OCCUPATIONAL HYGIENE ISSUES**
SUBJECT	**:**	**CASE STUDIES**

g) WELDING FUMES

Welding fumes can lead to adverse health effects as detailed in Section 4-02u. In one case a welder was given the task of removing old grid mesh in a washery and replacing it with new. This was a major job performed in all areas of the washery and involved cutting out sections of worn or damaged grid mesh with an oxy-acetylene torch and welding in new sections. Because of production requirements large sections were replaced at one time when the plant was down for scheduled maintenance, with approximately a week between each time the task was performed. The welder performing this task noticed that when he went home from work on a day when this job was performed, he experienced fever-like symptoms, chest soreness, headache, nausea, etc. These symptoms subsided quickly and did not recur until after the next time this task was performed.

After several occurrences of these symptoms the welder complained to the supervisor who sought specialist advice. Upon examination of the activity it was found that both the old and new grid mesh were galvanised and that the ventilation pattern of the building was naturally upwards, thus exposing the welder to high concentrations of zinc oxide fumes from the galvanised coating of the grid mesh when it was cut or welded. The symptoms reported by the welder were those of metal fume fever, an influenza-like disorder produced by the oxides of many metals, eg zinc, copper, aluminium, magnesium.

Although no permanent damage usually results from this health effect, it is totally preventable by the use of commonsense and basic ventilation techniques.

Exposure of welders to excessive concentrations of fumes is not unusual, especially inside chutes, tanks, crushers, etc of preparation plants where restricted space reduces the ability for fumes to disperse. In such situations a risk assessment should be made of the task and location to ensure that all appropriate measures to control worker exposure to fumes are in place.

SECTION	**:**	**HOW TO EVALUATE IDENTIFIED ISSUES**
SUBJECT	**:**	**A RISK MANAGEMENT APPROACH**

INTRODUCTION

As stated in Section 3-03, the structured approach to the process of occupational hygiene issue management revolves around the process of risk assessment. Specific details on the risk assessment process can be obtained by reading AS/NZS 3931:1998[1] and AS/NZS 4360:2004[2] and the supporting Guidelines Handbook[3]. In this section a matrix used by a number of operators in NSW for the evaluation of occupational health and safety issues has been used to highlight how the process works.

Step 1

The fundamental basis for the risk management approach is a belief that all workplaces should be free, as is reasonably practicable, of potential hazards that could give rise to adverse health effects. To ensure this, in respect to occupational hygiene, there is a need for total team commitment that should include:

- All plant and processes on-site that may give rise to potential adverse health effects be identified and evaluated.
- Any situations that are identified as involving occupational hygiene issues be assigned a relative risk ranking.
- Where appropriate, exposure assessment programmes are applied and interpreted by professionally qualified personnel.

1 AS 3931:1998 Risk Analysis of Technological Systems - Application Guide.
2 AS 4360:2004 Risk Management.
3 HB 436:2004 Risk Management Guidelines Companion to AS/NZS 4360:2004.

- Control strategies be initiated to
  - Reduce exposures where possible
  - Eliminate hazards where possible
  - Maintain control over workplace hazards

- Training be provided to all employees to ensure that occupational hygiene issues are identified.

- Effective personal protective equipment be provided to the workforce, where necessary, to ensure that those atmospheric contaminants that cannot be controlled by other means do not give rise to adverse health effects.

- All incidents that can be attributed to occupational hygiene issues are investigated and appropriate steps taken to prevent a recurrence.

Once the required commitment is achieved then the process of evaluating all occupational hygiene issues on-site can be undertaken.

Step 2

Following the identification of potential occupational hygiene issues (Section 3-03) or the advent of a new process on-site, a Risk Assessment Team should be formed to evaluate the issue or process for possible adverse health effects.

Each Risk Assessment Team would normally include the following:

- Supervisor familiar with the process or procedure (Team Leader).

- Workforce representative(s) from area involving the process or procedure.

- Safety Co-ordinator for area under review.

This is a suggested configuration, but there is no limit to the size of the team. Remember though that the larger the team the smaller the chances of consensus.

The Risk Assessment Team has responsibility for:

- Obtaining all information and advice necessary to plan an accurate assessment for any occupational hygiene issues.

- The assessment of any plant, process or procedure in terms of adverse health effects attributable to an occupational hygiene issue.

- The assignment of a category rating for all potential occupational hygiene issues.

- The indication of new or changed safe work practices or control strategies that must be developed for the activity under review.

- Notifying the Manager, the Safety Advisor and the Occupational Health & Safety Committee of any significant or moderate risk attributable to the activity under review.

Step 3

Once the Risk Assessment Team has been formed the team leader should arrange a short planning meeting where the following topics are addressed.

- All team members are familiarised with the specific issue, process or procedure to be evaluated.

- All available information should be tabled to enable a comprehensive risk assessment. If it is judged that more information is required then it is the team leader's responsibility to obtain that material before the process proceeds.

The Risk Assessment Team may agree that external expertise, (eg occupational hygienist, occupational physician) may be accessed at this stage to assist in the process, however it is more usual to undertake the risk ranking process prior to deciding on the need for external resources as this generally helps to define the aspects warranting expert advice.

Step 4

The Risk Assessment then assigns a risk rank level to the situation under review. This is done by the use of a Risk Rank Model, similar to that in Figure 5-01(I), where;

RISK = PROBABILITY X CONSEQUENCE

and;

RISK RANK 1-3	(SIGNIFICANT)	=	RED
RISK RANK 4-13	(MODERATE)	=	AMBER
RISK RANK 14	(LOW)	=	GREEN

The risk model used is very simplistic and organisations tend to have more complex models which suit the needs of their organisation. Irrespective of the model used the process remains the same.

RISK RANKING MODEL

	PROBABILITY					
CONSEQUENCE		A	B	C	D	E
	1	1	2	4	7	11
	2	3	5	8	12	15
	3	6	9	13	16	18
	4	10	14	17	19	20

PROBABILITY CATEGORY	DEFINITION
A	possibility of repeated incidents
B	isolated incidents known to have occurred
C	possibility of occurring some time
D	unlikely to occur
E	practically impossible

CONSEQUENCE CATEGORY	DEFINITION
1	serious long or short term health effects that may be fatal
2	serious adverse health effects that would require off-site medical treatment
3	non life threatening health effects that may require on-site first aid treatment
4	little if any adverse health effects

FIGURE 5-01(I)

If the Risk Assessment Team is uncertain of the risks, or has any concerns as to their ability to make a recommendation in respect to a particular issue, etc, they must seek more information or expert advice before repeating the process. This may involve the need to conduct workplace exposure monitoring, which should only be performed by qualified personnel. Advice on the selection of appropriate consultants is provided in Section 5-06.

For any issues, processes or procedures ranked to be in the Red or Amber categories (high or moderate risk), the team leader must notify the Site Manager, Safety Advisor and Occupational Health & Safety Committee. If possible, the Risk Assessment Team should provide recommendation(s) for possible control strategies that would minimise the risk to workers.

A schematic flowsheet of the above process is provided in Figure 5-01(II).

Step 5

Clear, concise records of the risk assessment process must be maintained in the Mine files, indicating who conducted the review, on the basis of the assessment, the result of the assessment and any recommendations for control strategies, (and whether adopted, with date of implementation).

It is good practice that risk assessments be reviewed every five (5) years or at any stage when the process, procedure or control mechanism changes. If workplace exposure monitoring is conducted as part of the assessment, the results should be recorded on the files of individuals concerned and retained for a minimum of 30 years.

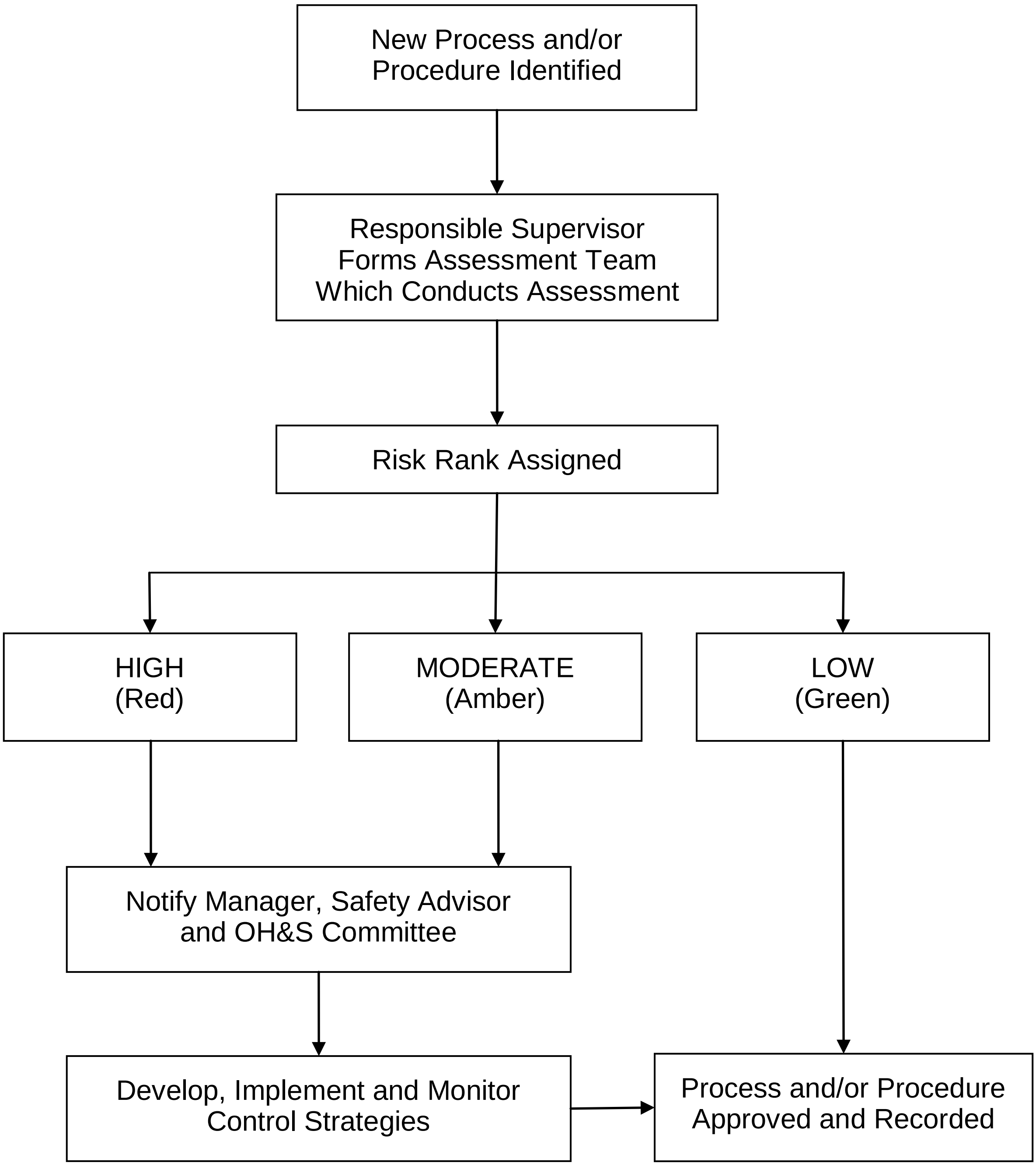


FIGURE 5-01(II)

SECTION	:	HOW TO EVALUATE IDENTIFIED ISSUES
SUBJECT	:	MONITORING PROGRAMMES

Monitoring workplace atmospheres is undertaken for a number of reasons relating to a particular set of circumstances that exist in respect to issues including:

- Compliance with legislation.
- Assessment of potential health risk.
- Evaluation of control measures and auditing their ongoing performance.
- Collection of data for epidemiological purposes.
- Resolution of complaints or industrial disputes.

Monitoring of the workplace does not in itself protect anyone but it does provide sound information on which corrective action can be based if necessary. Similarly, it should also be understood that measurement results are not the sole indicators of whether a risk to health exists in the workplace as neither the results of atmospheric monitoring nor the exposure limits to which they are generally compared are absolute (see Section 5-03). Both suffer from shortcomings and hence interpretation should only be undertaken by individuals experienced in this task.

Notwithstanding these shortcomings, it is true to say that workplace monitoring for atmospheric contaminants is very useful and has resulted in the quantification of risk of adverse health effects. This is an important tool that deserves to be understood and used appropriately.

Two types of workplace monitoring are generally employed to assess workplaces, ie personal and static (or area) monitoring.

Personal monitoring is considered to provide the best assessment of an individual's exposure to a workplace contaminant. In this procedure a sampling device is located within a person's breathing zone (a hypothetical hemisphere 300 mm in diameter centred on an imaginary line drawn down a person's face), to sample air the individual inhaled during the monitoring period. Exposure standards are usually based on personal sampling and therefore only comparisons to results collected in this manner can be reasonably made (see Section 5-03).

Non-personal samples are generally referred to as static (or area) samples and in most instances do not correlate well with personal exposures.

They still have a role in the overall assessment of workplaces provided they are located in appropriate positions. They are

- often used to check the performance of control devices,
- of use in identifying and quantifying contaminant sources in the workplace,
- of use in delineating areas of unacceptable/acceptable contamination.

When undertaking a sampling exercise for a particular employee's workplace, several considerations are involved in formulating a sampling strategy. These include:

- What contaminants are likely to be present?
- Which type of sample(s) (static vs personal)?
- Where should the sampling device be located?
- How many samples should be taken?
- How long should the sampling interval be?

- What periods during the shift should the employee's exposure be determined? What was the person actually doing during the time a personal monitor was operating? Is the person performing regular duties? Did they use PPE (breathing protection equipment)?

- What sampling method should be used?

- What is (are) the expected concentration(s)?

- What were the ambient conditions, air temperature, relative humidity, air velocity and direction?

- What (if any) compounds are present which may interfere with the sampling (or analytical) procedure?

- What analytical methods are to be used and what (if any) constraints will these place on sampling techniques?

All these questions should be given consideration by the person conducting the monitoring exercise prior to the commencement of sampling. As it is envisaged that most operations would use external resources for such exercises, detailed descriptions of each item are not provided, however it is prudent to check that the person doing the sampling on your behalf has considered these factors.

If the above represents what is required to look at one person's workplace, what is necessary to evaluate a whole operation? Two possibilities exist in such cases, eg monitoring everyone on-site or adopt a statistical approach to sample collection.

A good statistical basis for a sampling programme is essential if reliable exposure data is to be obtained and if management, employees and statutory authorities are to have confidence in the results.

The difficulty of obtaining reliable samples is apparent from observation of the way cigarette smoke hangs in the air as a slowly dispersing plume, or of the way smoke from the burning toast moves along the ceiling to the window or door: large differences in contaminant concentration can exist over very small distances. The rate of contaminant emission is also likely to vary with time and the worker will almost certainly be moving from one place to another with consequent variation in exposure levels.

Notwithstanding these problems, useful data can be obtained and assessments of workplaces in respect to adverse health effects undertaken. For this to occur, a number of basic steps are necessary. These are:

Step 1

Before any workplace monitoring programme is undertaken, the operation needs to determine the objective of the exercise. If it is to comply with legislation, the number and location of samples will probably be already established. If it is to evaluate a new control technology, area sampling will be suitable.

Step 2

If not already known, some information about possible contaminants present is essential, otherwise the exercise becomes one of identification not evaluation. In some cases this will be obvious, eg coal dust, noise, while in others a clearer indication may be obtained from documentation such as MSDS or the resources of suppliers. If there is any doubt, preliminary sampling to identify contaminants present should be conducted first.

Step 3

Only trained personnel should be employed to conduct workplace monitoring and expertise should be available to interpret results. Experience has shown that those persons who have actually seen the situation under evaluation offer more constructive opinions. Be cautious of “office bound” experts!

Ensure only validated analytical methods (eg Australian Standards, UK Health & Safety Executive methods, US NIOSH methods) are used and that the laboratory performing the analysis has either NATA registration (see Section 7-03) or is committed to equally strict quality assurance procedures.

Step 4

The monitoring exercise should be planned with the person engaged to perform the monitoring. While the aim is to always have a statistical approach (some operations in Australia have based their routine dust monitoring on statistics, see Section 5-05), the operation may be so intermittent that this is not possible or the level of exposure is such that remedial action is urgently required.

Either way you, as the client, should have a thorough knowledge of what the consultant sampling organisation proposes to do and you should evaluate the adequacy of their proposal for your needs. Remember, if they cannot justify their sampling protocol to you, how can you justify it to anyone else!

Step 5

Prior to any workplace monitoring commencing on-site, ensure all involved, especially workforce and supervisors are aware of the exercise and the reasons for it being conducted. This will improve co-operation, a paramount factor when personal monitoring is involved.

Step 6

Once the monitoring has been completed and all analytical results received, the initiator of the exercise (eg OH&S Committee, Mine Manager) should evaluate the results in terms of the initial aims, to ensure that a satisfactory outcome (albeit positive or negative in terms of exposure) has been achieved. Either way, all results should be made available to those who participated in the exercise, along with an explanation of their meaning and an indication of any actions to be taken to correct the situation if applicable. The placement of results on noticeboards without any explanation is poor employee relations and may jeopardise the prospects of subsequent surveys.

The above steps have been summarised in Figure 5-02(I).

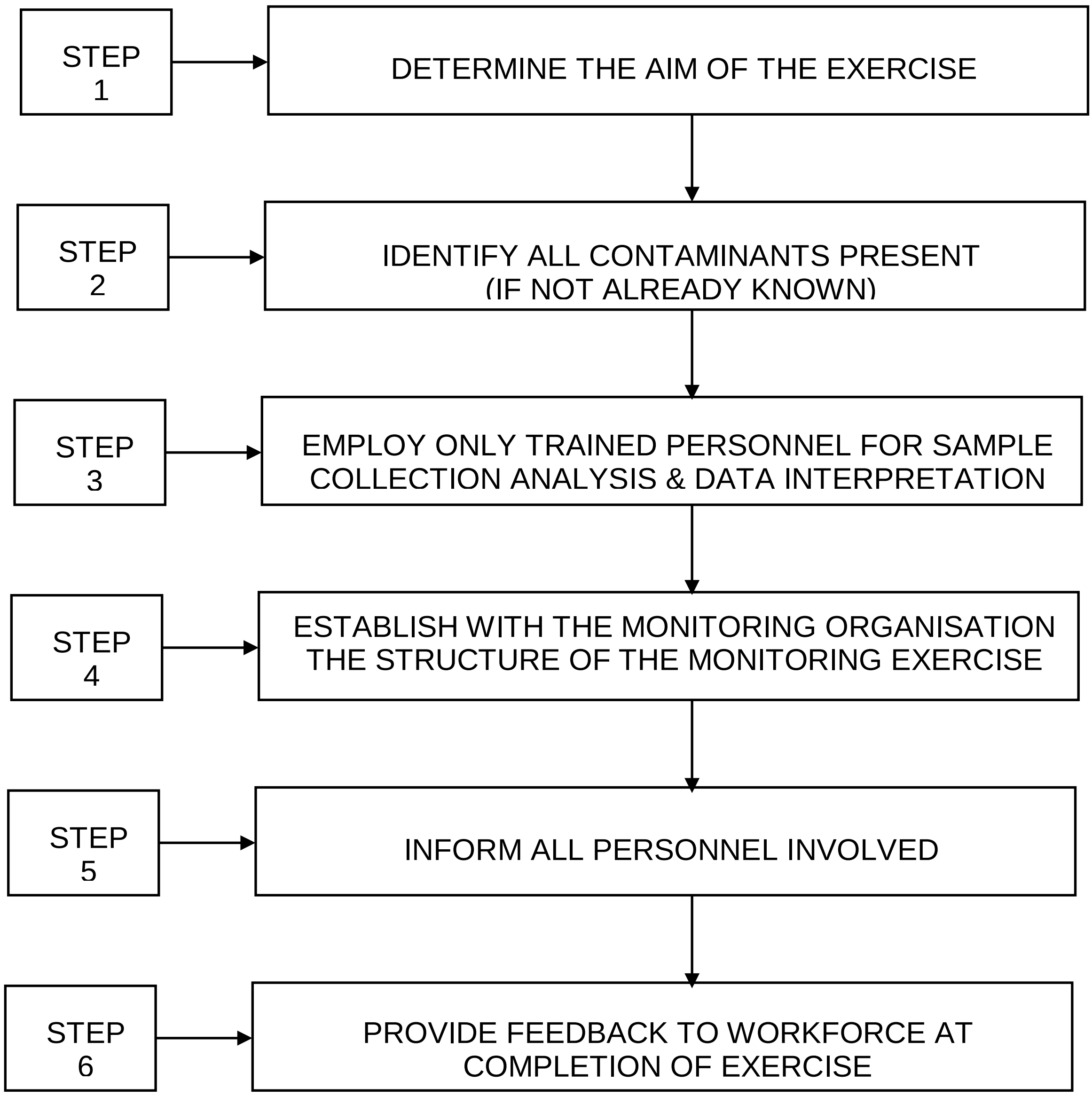


FIGURE 5-02(I)

In most coal mines the monitoring programme with the highest profile is that for exposure to coal dust. In most States, statutory monitoring programmes exist with the biggest being that conducted by Coal Services Pty Ltd in NSW. In 1946 an agreement was reached between the Federal and NSW Governments for the establishment of a statutory body to (among other things) monitor respirable coal dust in NSW coal mines.

This requirement has been ongoing since that date and continued with the introduction of personal gravimetric dust sampling in 1984. The frequency of sampling, places and persons to be sampled in each part of a mine is specified in regulations and the results are compared to mandatory exposure standards.

While this represents a major commitment in resources and effort, it has, along with other measures, contributed to a significant decrease in the level of observed disease (pneumoconiosis) associated with coal dust.

Other areas that may require either ongoing or targeted monitoring include:

- Noise
- Diesel exhaust emissions (gaseous and particulate)
- Welding fumes
- Organic Vapours (solvent fumes)
- Oil mist
- Asbestos fibres (asbestos removal operations)
- Vibration (ergonomics)
- Lighting
- Airbody gases

Other issues may require monitoring from time to time.

In summary, workplace environmental monitoring is a means to an end, that of ensuring members of the workforce are not exposed to excessive levels of contaminants which may result in adverse health effects. It should not be considered as absolute and should only be executed to achieve a defined outcome. Often an experienced hygienist will not recommend monitoring because there is either no applicable exposure standard, the exposures are either visibly so low (or high) that monitoring is a waste of resources, or the expected outcome of the exercise is not achievable.

Conversely, an experienced hygienist may suggest monitoring in situations where none has occurred before, with a view to confirming suspected areas of excessive exposure.

No matter how the issue of workplace monitoring is examined there are no simple answers as to when or where monitoring should be conducted. Each operation will need to review its own situation and make judgements on available expert advice and individual requirements.

Excellent advice on monitoring strategies can be obtained from the Australian Institute of Occupational Hygienists' publication[1] on monitoring strategies.

[1] Grantham, D., (2001): Simplified Monitoring Stategies, AIOH, November, 2001.

SECTION	**:**	**HOW TO EVALUATE IDENTIFIED ISSUES**
SUBJECT	**:**	**EXPOSURE STANDARDS**

DEFINITION:

An Exposure Standard[1] represents an airborne concentration of a particular substance in the worker's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers. The exposure standard can be of three forms:

Time Weighted Average (TWA)
Peak Exposure Limit (Peak)
Short Term Exposure Limit (STEL)

INTRODUCTION:

Exposure standards, in one form or another, have for many years been specified in Australian coal mining legislation. Those for coal dust were first introduced in NSW coal mines in 1946, and general airbody limits for diesel exhaust emissions followed. These standards differ from those established for gases such as methane (CH_4) in that they are based on long term health effects, while that for methane is based on its explosive characteristics, and to a lesser degree, its asphyxiant properties.

This chapter explains the basis of exposure standards, their strengths and shortcomings and guidance on their use.

HISTORY:

Professor Karl Bernard Lehmann of Wurzburg University, Germany is generally regarded as the originator of logically derived workplace exposure standards. He published the results of his exposure experiments (performed using his laboratory assistant instead of mice or rats!) in 1886.

[1] Exposure Standards for Atmospheric Contaminants in the Occupational Environment, NOHSC, May 1995

In 1893 he published a larger work "Methods of Practical Hygiene Vol 1" and a copy of this book is available at the NSW State Public Library. In the section on dust, he reported a typical concentration in a coal mine to be about 14.3 mg m^{-3}.

His values were quoted into the 1930s when MACs (maximum allowable concentrations) appeared in Germany and USA.

Further lists were to follow (1921 US Bureau of Mines, 1927 Sayers, - USA, 1928 Zangger - Germany) plus developments in the UK in respect to dust levels until in 1940 the American Conference of Governmental Industrial Hygienists (ACGIH) at their annual conference in Boston debated the need for a list of "safe limits or threshold limits and concentrations" for various substances. Due to the Second World War, progress was slow but in 1946 a first list of 150 compounds was adopted and so began the best known list of exposure standards in the world - the ACGIH Threshold Limit Values (TLVs) which now forms the basis of most exposure standard lists throughout the world.

In Australia prior to 1990, occupational hygienists from the State and Federal Governments under the auspices of the National Health & Medical Research Council (NH&MRC) would review the ACGIH list of TLVs and issue a list of ACGIH TLVs, together with a foreword containing Australian variations recommended for use in Australian industry. Many of these values were incorporated by the States into legislation (as is still the case).

The current approach is to reference those values produced by the Expert Working Party on Exposure Standards from NOHSC.

In May 1990 NOHSC published *"Exposure Standards for Atmospheric Contaminants in the Occupational Environment - Guidance Note and National Exposure Standard".*

A second edition was published in October 1991, and a third edition in May 1995. Amendments to this list were published by NOHSC on an ad hoc basis.

Updates are now published on the Australian Safety & Compensation Commission (ASCC) website located at: http://hsis.ascc.gov.au/SearchES.aspx/ (accessed October 2008) where a database exists of the 696 current national exposure standards.

While these standards do not automatically have the force of law behind them the various States and Commonwealth are actively moving towards these standards becoming uniform in law across Australia.

EXPOSURE STANDARDS

Exposure standards are guides to be used in the control of occupational health hazards. They should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity and should not be applied in the control of community air pollution.

An appropriately qualified and experienced person should undertake interpretation of exposure standards.

It is important to realise that exposure standards are based on the concept of the **threshold of intoxication** - for each substance, no matter how toxic, there exists a dose level, called the threshold of intoxication, which the human body is capable of receiving and detoxifying without injury to itself.

It should also be appreciated that the exposure limits, which have been established for chemical and physical agents, are not all based on toxicity. Many exposure standards are based on physiological (biological) action, eg:

Irritants - Ability to cause inflammation of mucous membrane with which they come in contact, eg hydrochloric acid fumes, SO_2, ammonia, ozone, acrolein.

Asphyxiants - Ability to deprive the body of oxygen.
- Simple asphyxiants, eg nitrogen, carbon dioxide, methane, helium.
- Chemical asphyxiants, eg carbon monoxide, cyanides, hydrogen sulphide.

Anaesthetics - Depressant action upon the central nervous system, particularly the brain, eg ether, chloroform, petrol and many other solvents.

Carcinogens - Asbestos, vinyl chloride monomer.

Types of Exposure Standards

There are 3 types of Exposure Standards:

- Time Weighted Average (TWA)
- Peak Limitation
- Short Term Exposure Limits (STEL)

Time Weighted Average

The majority of exposure standards for airborne contaminants are expressed as a time-weighted average (TWA) concentration over an entire eight hour working shift. During this eight hour averaging period, excursions above the TWA exposure standard are permitted, providing the excursions are balanced by equivalent excursions below the standard during the shift. Because some substances can give rise to acute health effects even after brief exposures to high concentrations, it is prudent that excursions above the TWA concentration should be restricted.

Peak Limitation

For some rapidly acting substances and irritants the averaging of the airborne concentration over an eight hour period is inappropriate. These substances may induce acute effects after relatively brief exposure to concentrations and so the exposure standard for these substances represents a maximum or peak concentration to which workers may be exposed. Although it is recognised that there are analytical limitations to the measurement of some substances, compliance with these ‘peak limitation’ exposure standards should be determined over the shortest analytically practicable period of time, but a single determination should not exceed 15 minutes.

Some substances can cause intolerable irritation or other acute effects upon brief over exposure, even though the major toxic effects may be due to long term exposure through accumulation of substances in the body or through gradual health impairment with repeated exposures. Exposure should be controlled to avoid both acute and chronic health effects.

STEL

Short Term Exposure Limits (STELs) provide guidelines for the control of short term exposure. These are important supplements to the eight hour TWA exposure standards, which are more concerned with the total intake over long periods of time. Generally, STELs are established to minimise the risk of the occurrence in nearly all workers of:

- intolerable irritation
- chronic or irreversible tissue change and

- narcosis to an extent that could cause or initiate industrial accidents

and can be used in these circumstances provided the TWA exposure standard is not exceeded.

STELs are recommended for those substances only when there is evidence either from human or animal study that adverse health effects can be caused by high short term exposure.

STELs are expressed as airborne concentrations of substances, averaged over a period of 15 minutes. This short term concentration should not be exceeded at any time during a normal eight hour working day.

Workers should not be exposed at the STEL concentration continuously for longer than 15 minutes, or for more than four such periods per working day. A minimum of 60 minutes should elapse between successive exposures at the STEL concentration.

Many people in industry fail to understand that exposure standards are not fine lines between safe and unsafe and as such represent target concentrations, but are really guides for use in the control of potential health problems. The true target concentration is always zero. The ultimate aim is to eliminate or control exposure to all contaminants likely to adversely affect health. Their application to situations outside the norm (eg 12 hour shifts) for which they were not designed can be disastrous. In such cases specific advice should be obtained from an occupational hygienist.

With many new products coming onto the market, it is impossible for any group to develop appropriate exposure standards for each before they are in commercial use. With this in mind, analogy to other compounds of similar type, common-sense and good occupational hygiene practice will help reduce unnecessary exposure.

A simple guide to follow is: If you are not familiar with the application of exposure standards in workplace situations, seek out the services of someone with good professional experience in this area, **before** making any decisions.

Application

From time to time mine personnel will be required to use some form of exposure standards in assessing workplace situations. In some cases a statutory value will exist, eg respirable coal dust, while in others reference to the ASCC/NOHSC Exposure Standards may be necessary.

In all situations it should be remembered that:

- All exposure standards contain a safety margin so minor excursions above the limit are unlikely to cause harm. Conversely if a value approaches the exposure standard don't fall into the trap of thinking all is satisfactory - investigate the cause and respond accordingly.

- Don't mix up exposure standards based on health effects and other limits based on a dangerous property, eg methane explosions.

- If you are unsure of how to use exposure standards seek expert advice. If you get it wrong it may result in harm to your colleagues.

EXTENDED WORK SHIFTS

Almost all occupational exposure limits are derived on the assumption that exposures would follow a traditional work week of a conventional 8-hour day workday followed by a 16-hour break from exposure over a 40-hour week. Many models have been used to adjust TWA for unusual and extended work schedules. It is not necessary to adjust

TWA-STEL and TWA-Ceiling values as these are associated with acute rather than chronic exposures[2].

It should be noted that before any adjustment of an exposure standard is attempted, the basis of that occupational exposure limit must be understood so as to determine whether it is appropriate to adjust for non-traditional work shifts, and if so, which model to apply.

Models that are used include:

- WA Department of Minerals & Energy Model.

  A practical approach (albeit based on the Brief and Scala Model. Based on the type of exposure standard and shift roster the exposure is multiplied by a exposure reduction factor. The Table to allow this calculation is available at:

  www.docep.wa.gov.au/resourcessafety/Sections/MiningSafety/Guidance_material_and_publications/guidelines.html (accessed October 2008)

- Brief and Scala Model

  This model was originally derived within the petroleum industry, reduces the 8-hour OEL proportionally for both increased exposure and reduced recovery time.

  While it is used widely it has not been validated for particulates.

[2] AIOH (2008): International Occupational Hygiene Training Module – Measurement of Hazardous Substances – Student Manual.

- OSHA (Direct Proportional) Model

This approach was formerly used by OSHA in the USA to adjust the occupational exposure limit in direct proportion to the hour worked.

- Pharmacokinetic Model

Other more complex models such as the Pharmacokinetic Model of Hickey and Reist have been based on pharmacokinetic actions that consider metabolism, biotransformation and excretion. They are beyond the scope of this manual.

SECTION	**:**	**HOW TO EVALUATE IDENTIFIED ISSUES**
SUBJECT	**:**	**QUALITY ASSURANCE (QA) SYSTEMS**

The QA system approach can be applied to occupational hygiene, just as it is to production. This is especially the case with the measurement of contaminants in the workplace where failure to perform appropriate calibrations for example, could result in the recording of erroneous values.

In Australia the best way of ensuring a quality approach to the analysis of occupational hygiene samples is via the endorsement of the National Association of Testing Authorities (NATA) (Section 7-03). Use of organisations accredited by NATA guarantees a minimum level of independent review and endorsement. Remember NATA accredits laboratories for analysis of samples, not individuals for the quality of their advice.

It may not always be possible to find a NATA registered organisation for the contaminant that you wish to measure. In such cases as long as the laboratory or sampling organisation in question follows sound quality principles it should be satisfactory to proceed.

When evaluating companies for this component, check that they practice the following:

- A quality Manual, setting out all procedures and kept up-to-date, including qualifications of report signatories.

- Only use known validated methods (eg Australian Standards).

- A quality assurance Manual, including methods of recording primary data, analytical results, calculation sheets, equipment calibration procedures and records.

- Participation in inter-laboratory replication exercises.

As mentioned earlier, NATA only accredits laboratories for the analysis of materials, including occupational hygiene samples so don't expect to find a NATA registered consultant. When you seek a consultant, follow the guideline set out in Section 5-06 of this Manual for a reasonable chance of success of getting accurate analyses and sound advice.

Details in relation to NATA accreditations for laboratories can be found on the NATA web site located at: www.nata.asn.au/ (accessed October 2008).

SECTION	:	HOW TO EVALUATE IDENTIFIED ISSUES
SUBJECT	:	CASE STUDIES

a) DIESEL EXHAUST EMISSIONS

As stated in Section 4-02e, diesel exhaust emissions are a complex mixture of gases and particulates. For many years vehicles operating in underground coal mines have been required to be monitored for carbon monoxide and oxides of nitrogen emissions. Depending on State legislation, two approaches have been adopted, namely to measure general airbody levels only; or to measure both general airbody and raw exhaust gases.

For general airbody gases, the usual method of measurement has been detector tubes, but they have inherent accuracy problems. Also, the procedures used by those conducting the test have been the subject of often justified criticism. In respect to raw exhaust gases, mine maintenance personnel use detector tubes but on a regular basis a NATA registered laboratory is required to conduct an analysis using a mobile laboratory (Figure 5-05a(I)).

FIGURE 5-05a(I)

Because of the limitations of detector tubes, and the difficulty in bringing vehicles to the surface, some mines in NSW have constructed underground test stations to measure carbon monoxide, nitric oxide and nitrogen dioxide. This is performed in a designated section of roadway where the ventilation can be controlled to the minimum level as required by the regulations. Peak concentrations are measured both under load and idle conditions thus giving a worst and best case evaluation. The monitoring system provides the vehicle operator with a printout stating the values and whether the vehicle passed or failed the test.

Results of these tests can be simultaneously recorded on the surface, allowing maintenance personnel to monitor performance of specific engines. This process is a major step forward over detector tubes. Photographs of the test bay and sensors at one BHP Billiton Illawarra Coal operation are provided in Figure 5-05a(II&III).

In March 2000 portable gas monitors for the measurement of ambient concentrations of gaseous diesel emissions were approved for underground use. These instruments typically measure CO, NO and NO_2 and have been demonstrated to be a cost-effective replacement for detector tubes.

These instruments offer the advantage of a data download facility to a computer, thus allowing the analysis of collected data at a later time.

These instruments, together with an underground diesel test station, provide the most effective means of monitoring diesel vehicle gaseous exhaust emissions.

FIGURE 5-05a(II)

FIGURE 5-05a(III)

The second component of diesel exhaust emissions is particulate, an emission of significant importance. As no authoritative information existed within Australia about measurement of worker exposure to diesel exhaust particulate (DP), BHP Billiton Illawarra Coal, in association with the US Bureau of Mines, developed techniques to evaluate exposures. This process was extended under ACARP Project C3080[1] to include eight NSW mines.

This project has been further developed by Alan Rogers and co-workers under a Health & Safety Trust project. The results of this work can be obtained from the Trust http://coalservices.hstrust.com.au/ (accessed October 2008). The results of these studies indicate that exposure data within NSW and Queensland coal mines is consistent across sites and that heavy diesel powered machinery produces the majority of DP. Research has also highlighted significant DP contributions to worker exposures arising from transportation vehicles. The monitoring also highlighted one mine as having lower exposure levels than the others evaluated. This, upon investigation, was attributed to:

- Use of low sulphur fuel.
- Good road conditions.
- A thorough scheduled maintenance program.
- Limited number of vehicles in ventilation splits.
- Computerised weekly exhaust emission testing.
- A replacement policy for older engines.

Monitoring for DP in workplaces is now available and can be accessed through Coal Services Pty Ltd.

BHP Billiton Illawarra Coal developed[2] a raw exhaust monitoring technique which has been found to be very useful to assist in the identification of "dirty" engines. More recently

[1] ACARP Report C3080 – Evaluation and Control of Employee Exposure to Diesel Exhaust Emissions in Underground Mines, May, 1995.
[2] ACARP Project C7014 – Application of an Elemental Carbon Analyser to the Measurement of Particulate Levels From Diesel Vehicles (May 2000).

portable instrumentation (Figure 5-05a (IV) has become available.

FIGURE 5-05a(IV)

Smaller monitoring instruments (Figure 5-05a(V) are currently being developed which will enable sites to monitor engines in a more cost effective manner.

FIGURE 5-05a(V)

Information on exposures measured in a range of coal mines in NSW and Queensland can be viewed on the Coal Services Pty Ltd website at www.coalservices.com.au/ (accessed October 2008).

b) DUST

In most States, coal mines are bound by regulations which require the Manager of an operation to conduct routine dust tests at a predetermined frequency. In addition, some States have a statutory authority (eg Coal Services Pty Ltd) that has the duty of monitoring mines on a set schedule, or in the event of special circumstances, at such frequency so as to ensure the health of workers is not put at risk from over-exposure to coal dust.

The importance of this can be demonstrated from the experience of one mine, where monitoring of respirable dust on the longwall face repeatedly indicated excessive dust exposures. This led to an intensive investigation program to identify the major source of high dust concentrations. The investigation revealed the problem to be largely due to high levels of dust in the intake air coming from the crusher and stage loader area. The solution to this problem is recorded in Section 6-03a.

While this is a situation where specific machinery was identified as causing the problem, workplace monitoring can establish other causes for high dust levels. One such case involved a number of mines where there were persistent problems of excessive exposure in continuous miner panels. As these problems were not expected, an extensive investigation involving personal monitoring and the use of a direct reading instrument was undertaken. This study showed that the sole cause was incorrect work practices of machine operators.

These case studies indicate how routine monitoring program can pinpoint potential problems, perhaps not otherwise discovered, which can be investigated and resolved. Once control measures have been implemented, monitoring can then be used to ensure their ongoing effectiveness.

More recently, research by BHP Billiton Illawarra Coal[1] has demonstrated that although respirable dust levels in their operations are generally low, inhalable dust levels were surprisingly high in some areas (longwall and continuous miner panels). An extensive investigation at Appin Mine longwall has demonstrated that water infusion practices were incorrect. Modification to the process has resulted in reductions in inhalable dust of over 50%.

Without an effective monitoring programme this situation may have continued as respirable dust levels (the normal statutory test) were acceptable. Taking a scientific approach to workplace monitoring can unearth problems but also lead to improved workplace exposures.

[1] Occupational Hygiene in the Coal Industry – A Case Study; by S McFadden and B Davies, 2004 – Health & Safety Trust project

c) NOISE

The incidence of noise induced hearing loss (NIHL) can be attributed to the relatively high sound levels experienced in the coal mining industry. One reported survey[1] indicated that most mine vehicles and equipment produce sound levels in excess of 90 dBA. Peak sound levels in the region of 115 dBA have been recorded with specific items of machinery used in underground and open cut mines. Table 5-05c(I) lists noise levels associated with various mining activities.

OPERATION	Sound Level dBA
Longwall Mining	
Beside operator, shearer and chain conveyor working	94
Beside operator, shearer working	90
Compressed air pick breaking up large rock fragments	98
Main gate operator, coal passing	88
Shaft Sinking	
Beside operator, compressed air grab workings	115
Three Panther Atlas air guns in operation at shaft bottom	115
On stage, beside operator, with grab working	106
On stage, only air hydraulic motor working	110
Underground Coal Transport	
At drivehead at the junction of conveyors, coal running	94
Shuttle car discharging coal onto belt at high rate	93
Beside Hannsford Feeder with hydraulic drive	95
Hydrocar unloading	90

TABLE 5-05c(I)

1 JCB Occupational Health & Rehabilitation, Technical Bulletin May 1991

OPERATION	Sound Level dBA
Roof Bolting	
Falcon, roof bolting in operation	112
Falcon, tightening roof bolts	110
Fletcher roof bolter installing bolt	88
Borer, Joy single boom drill	96
Continuous Miners	
Joy CM, miner filling, beside operator	94
Lee Norse 62H CM, cutting, beside operator	92
Lee Norse CM, filling, beside operator	98
Lee Norse, filling, beside operator	100-106
Screens, Crushers, Picking Belts	
Crusher	99
First floor drift gantry	104
Beside screen hand on picking belt	96
Background noise of drift belt without coal	88
Coal Preparation Plant	
Beside crusher mill	102
Ground floor of screen building	92
Beside operator of vibrating screens	98
Top floor beside cyclone	88
Earth Moving Equipment	
Front end loader	104-108
D9 bulldozer without muffler	100-106
Cabin of drilling machine	86-100
Beside Euclid truck	80-96
Dragline engine room	92-101

TABLE 5-05c(I)

All these measurements were taken with a recently calibrated Sound Pressure Level Meter.

As noise exposure in mining operations tends to be variable in intensity and intermittent in duration, the only way to assess daily noise exposure in these circumstances is by use of a personal noise dosimeter which integrates sound level exposure over the course of a full shift and calculates the Daily Noise Dose. Noise dosimetry instruments were approved for underground use in NSW coal mines in 1986. A study performed at a Newcastle underground mine showed that face workers were exposed to an average projected daily noise dose of 186%. This is the equivalent of a constant noise exposure of 93 dBA. Peak noise exposures during shifts varied from 60 decibels to 123 decibels for different workers.

The roof bolters received the highest average projected noise of 596%, the equivalent of 98 decibels constant exposure for eight hours.

These Daily Noise Doses highlight the importance for every operation to implement a comprehensive continuing hearing conservation programme. This will in itself not eliminate excessive noise merely minimise employee exposures. An industry-wide approach to original equipment manufacturers is necessary to reduce noise emissions at their source.

SECTION	:	HOW TO EVALUATE IDENTIFIED ISSUES
SUBJECT	:	CASE STUDIES

d) STATISTICALLY VALIDATED MONITORING

The benefits of statistically validated monitoring programmes incorporated in a quality systems approach have yet to be appreciated by the majority of the Australian Mining Industry. Some operations have embraced the concept with encouraging results, as the following demonstrates.

A major open cut coal mine that experienced severe industrial difficulties as a result of alleged exposure to excessive levels of contaminants resulting from spontaneous combustion of waste dumps, stockpiles, etc supplied the first of these case studies.

Although allegations of over-exposure were proven by independent investigations to be unfounded, it was apparent that the past monitoring programme had been ineffective and provided little information that would withstand scientific scrutiny, or could supply useful guidance for management.

As a result a new approach was taken whereby the procedures for monitoring respirable dust, inspirable dust, respirable quartz, sulphur dioxide, carbon monoxide and PAHs (benzene soluble fraction), were written in a form that would satisfy the requirements of the National Association of Testing Authorities (NATA) (see Section 7-03).

In addition a statistically planned monitoring schedule was developed whereby the workforce was sampled to ensure that at least one result in the top 10% of results would be recorded with 95% confidence. Once the number of samples needed to accomplish this was established, random number tables were used to allocate specific days for collection over a 64 week period.

The use of a 64 week period was to average out seasonal variations which influenced sampling conditions.

As an added step the operation decided to involve their workforce in the collection of these samples. Consequently, a number of safety representatives were given a four day on-site training course by an occupational hygienist, in all aspects of sampling, record keeping, report writing, etc. All samples requiring analysis were analysed off-site by a NATA registered laboratory.

Although this programme only commenced in early 1996, discussions with those involved indicated that the reasons for monitoring are better understood now by the workforce and that problems not apparent before are emerging (eg sealing of cabins, etc) while others (eg exposure to emissions from spontaneous combustion) are decreasing, because of improved work practices.

It is anticipated that the programme will run in its current form for several years, after which it will be reviewed and the validity of the database maintained by statistical means. While considerable effort and cost were involved in establishing the program, the operation can already see positive benefits in improved productivity, less industrial disputation and reassurance of workers about health challenges.

The second case study was undertaken in 2003 by BHP Billiton Illawarra Coal as part of a Health & Safety Trust project[1]. In this project a multi-disciplinary team from BHP Billiton Illawarra Coal identified 19 key issues using the principles outlined in this Manual. Based on a risk evaluation a statistically based monitoring programme for respirable dust, inhalable dust and noise was undertaken during the period January – May 2003.

[1] Occupational Hygiene in the Coal Industry – A Case Study; McFadden, S., Davies, B., Health & Safety Trust.

The principles of workplace exposure assessment[2] were adopted whereby the total workforce (excluding office staff) was divided up into homogeneous exposure groups (HEGs) or groups of similar exposure (SEGs in US publications). 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 5-05d(I) and 5-05d(II).

Operation	HEG	HEG Composition
Appin Mine	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
Elouera Mine	E1	Longwall
	E2	Panel
	E3	Belts
	E4	Transport Operators
	E5	General Underground
	E6	Yard Personnel
	E7	Workshop Personnel

[2] Simplified Monitoring Strategies – Grantham, D., AIOH 2001.

Operation	HEG	HEG Composition
West Cliff Mine	W1 W2 W3 W4 W5 W6	Longwall Panel Belts Outbye Workers Methane Drillers Surface Workers
West Cliff Coal Preparation Plant	WW1 WW2 WW3 WW4 WW5	Mobile Plant Operators Operators Materials Handling Control Room Haulage Drivers

FIGURE 5-05d(I)

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

FIGURE 5-05d(II)

All exposure data was corrected for extended shifts and statistically evaluated against workplace exposure standards (3.0 mg/m^3 for respirable dust, 85 dBA for noise). In the case of inhalable dust a best practice standard of 10 mg/m^3 was adopted as no statutory level currently exists for coal mines. The decision criteria for compliance was that the geometric mean of a parameter must be below the exposure standard of the HEG being evaluated.

The results of this very extensive sampling programme are listed in Figure 5-05d(III).

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
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 5-05d(III)

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.

The results for inhalable dust and noise were of concern. While no statutory exposure standard for inhalable dust currently existed at that time in the NSW Coal Mines Regulations, exposures in a number of homogenous exposure groups (HEGs) are well above those of acceptable working conditions.

From the above data it appeared 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.

A review[3] of health effects associated with exposure to inhalable coal dust did not find any conclusive evidence of adverse health effects from long term exposure to coal dust in addition to those already established for general dusts. The proposed introduction of a recommended standard of 10mg/m^3 was supported with recommendations of further sampling of inhalable dust, characterisation of particle size distribution and medical surveillance of respiratory symptoms for possible correlation with inhalable dust levels.

The Standing Dust Committee of Coal Services Pty Ltd has investigated this issue and airborne dust limits were subsequently gazetted under the NSW Coal Mine Health and Safety Regulations in December 2007[4].

The level of exposure of employees to noise within BHP Billiton Illawarra Coal is extreme and is consistent with published reports from Coal Services Pty Ltd in respect to

[3] Jennings, M. & Flahive, M.,(2005): Review of Health Effects Associated with Exposure to Inhalable Coal Dust, October 2005.

[4] New South Wales Government Gazette No 185. Coal Mine Health and Safety Act 2002, Coal Mine Health and Safety Regulation 2006, Notice – Airborne Dust Limits, Collection and Analysis, 21 December 2007.

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 an enhanced 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 above exercise clearly demonstrates that the long term focus (approximately 50 years) to reduce excessive exposures to respirable dust has been very effective. While control of this contaminant should still be paramount, it is clear a similar focus on reducing noise exposures is necessary if any significant improvement in working conditions is to be realised.

Both the above case studies required significant initial resources, however maintenance of the data going forward can be achieved statistically by the collection of as little as 3-6 samples per HEG per year. When applied to all contaminants in the workplace this represents the benchmark in workplace exposure evaluation.

SECTION	**:**	**HOW TO EVALUATE IDENTIFIED ISSUES**
SUBJECT	**:**	**CASE STUDIES**

e) WHAT! NO MONITORING?

This situation involved an occupational hygienist who was consulted regarding the likelihood of over exposure to hydrogen in a battery charging area of a workshop. In this workshop, battery locos were charged for extensive periods of time and because of the climate, the doors were closed in winter. Complaints from one individual who worked in the adjacent workshop area resulted in the safety officer seeking outside assistance and requesting personal monitoring for hydrogen exposure. Prior to an inspection of the workshop area at the mine, the occupational hygienist pointed out that the toxicology of hydrogen did not present a health issue but may be more of a fire or explosion risk if a build-up of gas occurred because of inadequate ventilation. The opinion was also expressed that monitoring would not be beneficial and that a more positive approach would be to inspect the area of concern. During the on-site inspection it became apparent that the situation was not one of exposure to hydrogen but one of industrial relations. It appeared that the employee in question had been moved from an area he had worked in for many years and deposited in the workshop next to the battery charging station; an area in which nobody normally worked. While it was acknowledged that this was a problem that needed to be addressed, the real cause of health irritation was the presence of sulphuric acid as an aerosol in minute quantities from the charging process. This was compounded by the fact that when the worker was transferred to the area, he started closing the doors to keep some warmth in the building.

The solution to the problem was to relocate the person to a more appropriate work area and reopen the doors to the building thus improving ventilation.

This exercise was an example of how the first reaction in a situation is often to perform workplace monitoring which then shows no excessive exposure.

In some cases this is valid and justified, however in others an objective review of the situation and unemotional discussions with those involved may indicate that monitoring is not necessary. This was one such case.

SECTION	:	HOW TO EVALUATE IDENTIFIED ISSUES
SUBJECT	:	CASE STUDIES

f) WHOLE BODY VIBRATION

In the NSW coal industry a significant number of Workers' Compensation claims are for back and neck injuries believed to arise directly or indirectly from exposure to what are commonly referred to as 'rough rides'. These rides include jolts and jars as well as 'steady state' vibration and are measured in terms of whole-body vibration (WBV).

In Australia, whole-body vibration exposure is assessed according to AS 2670 1-2001[1], on whole-body vibration. This standard is identical to the International Standard, ISO2631-1, 1997, Evaluation of human exposure to whole-body vibration.

A recent study[2] of WBV exposure in coal miners in NSW was carried out at four open-cut and four underground coal mines. Measurements were made on a range of vehicles undertaking a range of activities under normal operational conditions.

Whole-body exposures were evaluated using the International Standard (now the current Australian Standard). A summary of the results are given in tables 5-05f(I) and 5-05f(II).

[1] AS 2670.1:2001, Evaluation of human exposure to whole-body vibration.

[2] McPhee, B., Foster, G., Long, A., Exposure to Whole-body Vibration for Drivers and Passengers in Mining Vehicles, Joint Coal Board and WorkSafe Australia research project. 1995 – 2000. Reports and other guidance materials available through the Health & Safety Trust.

Vehicle Type	International Standard ISO2631-1997 (AS2670-2001)
	*Caution Zone**
Manhaul passengers	1.5 hr to 6 min
Rubber tyred dozers	1.5 hr to 12 min
Fitter's vehicles	1.5 hr to 12 min
Track dozers	1 hr to 24 min
Graders	3 hr to 1 hr
Loaders	1.5 hr
Water trucks	4.5 hr to 3.5 hr
Manhaul drivers	2.5 hr to 40 min
Dump trucks	7 hr to 4.5 hr

TABLE 5-05f(I) GUIDANCE ON EXPOSURE DURATION IN OPEN-CUT COAL MINES

Notes:

* Caution zone = time to reach the caution zone for health effects – highly dependant on the severity of jolts and jars in the vehicle ride as indicated by the range of times. The 'Caution Zone' could be considered as an 'Action Level'. The International Standard also has a 'Likely Health Risk' classification for higher exposure levels.

Vehicle Type	International Standard ISO2631-1997 (AS2670-2001)
	*Caution Zone**
Load haul dump, Type 1	2 hr to 8 min
Rail personnel carrier, Type 1 driver	2 hr to 20 min
Rail personnel carrier, Type 1 passenger	2.5 hr to 20 min
4WD with suspension, Type 1 driver	4.5 hr to 2 hr
4WD with suspension, Type 1 passenger	2 hr to 20 min
4WD with suspension, Type 2 driver	2 hr to 30 min
4WD with suspension, Type 2 passenger	1 hr to 7 min
Free steer vehicle without suspension, Type 3 - driver	1 hr to 6 min
Dollycar	24 hr to 15 hr
Loco - driver	4 hr to 1 hr
Loco - passenger	4 hr to 1 hr

Vehicle Type	International Standard ISO2631-1997 (AS2670-2001)
	*Caution Zone**
Multipurpose vehicle without suspension, Type 1 - driver	2 hr to 1 min
Multipurpose vehicle without suspension, Type 1 – passenger	1 hr to 1 min
Multipurpose vehicle without suspension, Type 2 - driver	30 min to 6 min
Load haul dump, Type 2	2 hr to 12 min
Skid steer vehicle	30 min to 3 min

TABLE 5-05f(II) GUIDANCE ON EXPOSURE DURATION IN UNDERGROUND COAL MINES

* Caution zone = time to reach the caution zone for health effects – highly dependant on the severity of jolts and jars in the vehicle ride as indicated by the range of times. The 'Caution Zone' could be considered as an 'Action Level'. The International Standard also has a 'Likely Health Risk' classification for higher exposure levels.

In open-cut mines, eighty-four percent of vehicle operators reported some musculoskeletal disorders (sprains and strains, aches and pains) in the previous 12 months which they believed were related to what they did at work. Thirty-four percent and eighteen percent reported low back pain and neck pain respectively in the last week. Low back pain (59 or 85.5%) and/or neck pain (39 or 56.5%) were the most commonly reported disorders in the previous 12 months.

REDUCING OPERATORS' AND PASSENGERS' EXPOSURES TO WBV

The following are approaches that are being used or could be used by coal mines in Australia:

1. Restricting speed

- Speed limits which are enforced
- Speed limited vehicles in specific situations
- Drivers and operators who are deemed competent and safe (appropriate training)

2. Road maintenance programs

- Dedicated vehicles and drivers for road maintenance
- Road maintenance programs that are planned and systematic and not regarded as secondary to production demands
- Effective communication of information on road conditions and potential problems
- Effective use of water pumps and drainage techniques
- Professional road construction especially for main roads
- Immediate removal of materials on the road likely to cause jolts and jars eg rocks

3. Design of vehicles

- Appropriate cab and vehicle suspension. Suspension systems must appropriate for loads typically carried by the vehicle. Vehicle suspension systems must never bottom out

4. Good seat design and improved vehicle suspension. Seat suspension must never bottom out.

- Improved visibility especially in bulldozers, graders etc
- Transport vehicles with forward facing seats and appropriately designed seating
- Appropriate tyres and tyre pressures
- Cab design and layout including sufficient head and leg space (a minimum of one metre clearance seat to roof, preferably more)
- Fully adjustable controls and seating

5. Maintenance of vehicles

6. Planned maintenance programs which include seating and vehicle suspension systems

7. Specialist maintenance for seating and suspension systems

8. Miscellaneous

- Ensuring adequate shot firing standards
- Communication and correction of problems that may lead to rough rides particularly at night
- Regular rotation of operators on vehicles
- Regular breaks out of the seat/cab

SECTION	:	HOW TO EVALUATE IDENTIFIED ISSUES
SUBJECT	:	HOW TO SELECT A CONSULTANT

INTRODUCTION

In certain circumstances the need will arise for the obtaining of external expert advice. This may be from a government department or an independent consultant. As most government departments operate on a “fee for service” basis these days for work outside their statutory role, it is fair that the same principles be applied to those organisations as to independent consultants when retaining such a body. If the term “Consultant” is then applied to all such organisations and individuals, the objective approach necessary for maximum benefit from the consultant is more likely to be obtained. The following procedure is recommended:

- Prepare a scope of work.
- Select a number of suitable consultants.
- Interview or assess consultants.
- Discuss the fine print.

SCOPE OF WORK

If external advice is necessary at any stage it is important that a scope of work be prepared. In most cases this will simply be a listing of those issues or aspects upon which advice is required, but in others, eg workplace monitoring, it may be advantageous to prepare details of who needs to be monitored and in which locations at this early stage.

Other points that may be useful when discussing the problem with a consultant may include timeframe (is it urgent or is tomorrow satisfactory?), production commitments that may hinder the consultant’s activities (remember you always pay if consultants have to wait around), budget constraints (don’t indicate this to the consultant but at least know your limits).

THE SHORT LIST

There are almost as many ways of finding consultants as there are consultants. The aim is to obtain a professional consultant who can effectively address the issue at hand at reasonable cost in a timely manner.

Four well tried methods of obtaining consultants in the field of occupational hygiene are:

- **Personal Recommendation**

  It is worth noting the names of consultants who have undertaken projects for other enterprises. If the project is clearly specified, then a general judgement on the appropriateness of the recommendation can be made. Remember, consultants can lose a good reputation from a project, which was mis-managed by the client!

- **Government Departments and Agencies**

  These organisations can provide assistance in locating consultants but may be wary about providing opinions on the quality of service provided. Some Departments and Commissions also issue directories of OH&S service providers from time to time. Remember, these are usually lists of providers without indication of performance skills.

- **Professional Associations**

  Most professional associations and societies, for example the Australian Institute of Occupational Hygienists (AIOH) (web site accessed October 2008) www.aioh.org.au can provide assistance in locating appropriate consultants who have current membership of the association. Whilst these lists also do not indicate performance skills, membership rules usually provide for minimum levels of qualifications and experience.

- **Industry Organisations**

These organisations, for example the Minerals Council can often provide assistance in locating appropriate consultants. They may even be able to advise other companies that have engaged consultants for similar projects.

SELECTING THE CONSULTANT

In most cases the selection of a consultant will be made by a site representative, with the first contact being by telephone. In such a process it is important to ask a number of questions to ensure that the consultant is suitable and able to serve the enterprise in a positive way. Typical questions include, but are not limited to, the following:

- What formal qualifications do you hold? When and where were they obtained?

- In what special conferences, seminars, symposia, or graduate courses in your profession have you been involved?

- What teaching or training have you done in this field?

- How many years have you been professionally active in this field? *

- How long have you been in private practice, or worked for the consultancy company?

- Can you supply a list of your recent clients, preferably in my geographical area, which have undertaken projects similar to mine? May I contact them directly about the projects you undertook for them? *

- Are you part-time or full-time? If part-time, are you employed by anyone? If so, is your employer aware of your consultancy activities? May I contact your employer concerning you?

- Are you associated with the manufacture or sale of a product or an organisation that could create a conflict of interest in this project?

- Of what professional associations or societies are you a member? What is your membership grade or classification? *

- In what areas of occupational hygiene do you specialise?

- Can you serve as an expert witness, either for your client or as a friend of the court? What experience have you had?

- Please indicate your fee structure. Do you handle this by hourly charge estimates for total job, retainer charges, or all of these? *

- If you use a contract form, please supply a sample.

- What statements do you have in your contract covering commercial security, liability, patent rights?

- In your charges, how do you treat such expenses as travel, subsistence, report reproduction, and computer time? *

- What insurance do you have? *

- Are you operating as an individual, partnership or company?

- What restriction is there on the use of your name in our reports, in litigation, in advertisements?

- What is the character and extent of reports that you prepare? Can you give examples?

- What is the size of your staff? What are their qualifications? Who will be working directly on this project? Who will supervise it?

- Will all work on this project be done in-house? If an external laboratory is to be used are they NATA registered or can they provide evidence of QA?

- When could you start work on the project? *

- How long will it take? *

This list covers many situations and not all questions will be applicable in all cases, however it is prudent to ask those questions marked * as a minimum.

If you are seeking to employ a professional occupational hygienist it is reasonable to expect that person to be a member of the Australian Institute of Occupational Hygienists Incorporated (AIOH). Section 7-02 of this Manual provides details of this organisation, together with information on the various levels of membership. Membership of this and similar organisations usually binds members (as is the case with the AIOH) to a code of ethics which should minimise problems with issues such as "conflict of interest".

THE FINE PRINT

Once the consultant has been selected, it is usual to formalise the agreement with either a contract or purchase order. Details such as commencement and completion dates should be included together with financial arrangements and the scope of work.

If the study is lengthy, frequent progress reports should be included in the terms of the Contract. The consultant's primary and secondary contacts with the company should be clearly defined.

SECTION	:	CONTROL STRATEGIES
SUBJECT	**:**	**INTRODUCTION**

Health hazard control is the final but by no means least important objective of occupational hygiene. In fact the control of hazardous workplaces and situations remains the area least understood and most poorly executed in most workplaces.

The following sections of this Manual set out the basic principles that should be followed when seeking measures to control worker exposures, and provides a number of case studies to illustrate some useful strategies. It is impossible to provide a solution to every problem. A good strategy to follow is to believe that most situations have arisen before and been resolved, the difficulty is establishing by whom and how.

To assist in this area a number of proven control strategies have been published by coal mining organisations, universities or others. Some useful examples can be obtained from the following organisations:

- Australian Coal Association Research Programme (ACARP)
- Australian Institute of Occupational Hygienists
  - A Guideline for the Evaluation and Control of Diesel Particulate in the Occupational Environment
- Coal Services Health & Safety Trust
- Mine Safety and Health Administration
- NIOSH
  - Pittsburgh Research Centre

- NSW Department of Primary Industries publication
  - Guidelines for the Management of Diesel Engine Pollutants in Underground Environments

- NSW Minerals Council publication
  - Diesel Emissions in Underground Coal Mines – Management and Control

- Technical Bulletins produced by Coal Services Pty Ltd
  - Conveyor Cleaner Spray Bar
  - Reverse Flush Strainers
  - Free Silica and Health in Coal Miners
  - Airstream Helmet
  - Noise and Hearing Loss in the NSW Coal Industry
  - Noise Reduction on the Eimco 913 LHD
  - Brattice Ventilation
  - Roadway Dust Suppression System at Cordeaux Mine
  - Homotropal Ventilation
  - Shearer Dust Deflector
  - Beam Stage Loader (BSL) Crusher Dust Extractor

- Victorian Institute of Occupational Safety & Health publication
  - Noise Control in Mining; seventy-five noise control solutions

Contact details of the above organisations are found in Section 7-04.

No doubt, other published information exists and operations (or OH&S committees) should consider commencing a file of such data, adding to it as new information becomes available. If it works, tell other people about it, as your solution may help improve the health of coal miners elsewhere.

SECTION	**:**	**CONTROL STRATEGIES**
SUBJECT	**:**	**A PROCESS FOR CONTROL**

The purpose of a control strategy is to reduce the exposure of coal miners to the various health hazards that exist in the workplace. In terms of occupational hygiene a series of measures can be applied to achieve this aim. Control measures include, but are not limited to, the following:

- Substitution or elimination
- Engineering controls
- Alteration of work practices
- Appropriate use of personal protective equipment (PPE)

The resolution may require one or more of these approaches and the temptation to introduce PPE as a long term solution must be avoided. In fact PPE should be used as an interim step until a more appropriate long term strategy can be developed, or for emergencies.

Substitution or Elimination

In some cases merely substituting one product by a less hazardous material may control the problem. Caution must be exercised to ensure that one problem is not merely being replaced by another further down the process.

Another approach is to review the whole process to see if the step causing the problem can be eliminated by some means. While this may initially be costly, returns in the non-use of consumables, or reduced waste handling costs, may make this cost effective in the longer term.

Engineering Controls

The types of engineering controls that may be used include:

- Introduction of a different process.
- Isolation or separation of the process or hazard.
- Isolation of workers, eg in air conditioned cabins.
- Enclosure of that part of the process.
- Use of mechanical or remote handling, or automation.
- The use of local exhaust ventilation at the emission source of the contaminant.
- Improved general ventilation.
- Improved maintenance techniques.
- Dust suppression with water.
- Changes to exhaust systems to reduce pollutant or noise emissions.

Isolation or Separation

In this instance a process or hazard may be relocated (or potentially exposed people adjacent to the hazard or process) so that their exposure is reduced. This may be accomplished by means such as relocating to a new area, sealing off the area, or only operating the process when few people are in the area.

Isolation of Workers

It may be more practicable to provide an enclosure for the workers, eg an air conditioned cabin for a dragline.

Enclosure

A process may be totally enclosed so the contaminants are unable to escape into the work area. This can be used to good effect with noise, where a noisy piece of equipment can be placed in a soundproof box and so the hazard is kept out of the work area.

Enclosures sometimes need to have doors or other openings and these can allow some of the contaminant to escape. To overcome this, an extraction system may be used to put the enclosure under slight negative pressure so that air be drawn into any gaps in the seals, thus preventing contaminant escape.

It may also include installation of better quality seals on glands, pumps, etc to prevent the emission of contaminants.

Mechanical Handling

The advent of remote control or automatic machines within the Mining Industry has certainly been a major factor in reducing exposure to dust.

This principle can also be applied to many other processes.

Local Exhaust Ventilation

Where measures to remove or enclose an emission hazard have not been possible, it may be controlled by collection and removal before it enters the work area. This can be done with a local exhaust system that has:

- a hood or cowl or other device designed to produce sufficient air velocity to capture the contaminant at the point where it is generated
- a duct system through which the contaminated air passes from the hood
- an air cleaning system to trap the contaminant and prevent it polluting the general atmosphere
- a discharge point remote from the workplace and any air intake ducts if disposal by dilution is in accordance with any environmental regulations, and
- a fan to draw sufficient air through the system to ensure its effectiveness.

The design of extraction systems is a highly skilled task and it is important that the installation, adjustment, and maintenance of the system are of the highest standard.

Unfortunately, ventilation systems deteriorate and become inefficient without good maintenance, thus it is not enough to consider the job complete after installation of a system; it has to be fully operational every time it is used to be effective.

Coal mine ventilation is a special case of both local exhaust and general ventilation in that intake (inbye) air is intentionally drawn to the area of greatest contaminant emission and then isolated from contact with workers thereafter as it is used to remove those contaminants.

General Ventilation

This is some times called dilution ventilation and involves diluting a contaminant rather than capturing it as is the case with local exhaust ventilation. Examples of general ventilation would be the use of ridge vents or air movers to aid circulation in a workshop or merely opening the doors of a workshop.

Dust Suppression With Water

The use of water sprays remains the most cost effective means of controlling dust in or about coal mines. Different types of surfactants, to aid better wetting of dust particles, have been tried over the years within the industry on roadways, on stockpiles and on airborne dust generated at the coal face.

In general terms the results have varied from little or no apparent improvement to demonstrated reduced levels of airborne dust levels. With such different and variable locations, coupled with the choices relating to the selection of the surfactant and its application method each situation needs to be assessed on an individual basis.

Care should be exercised with the use of any wetting agents or surfactants to ensure that they do not produce adverse health effects particularly to the skin or respiratory tract of workers.

Alteration of Work Practices

In some instances it may be possible to alter work practices in order to lower exposure. While some guidance on this possibility may be gained from monitoring data (eg two employees doing the same job, one with a high exposure, the other with a low exposure), on-site evaluation of the specific task is usually the best means of identifying possible improvements, or causes of excessive exposure. Rotation of jobs during a shift may help reduce noise exposure.

Personal Protective Equipment

There will be occasions where acceptable control of hazards at source will not be possible and thus a need to wear some type of personal protective equipment.

This may include goggles or face shield, gloves, aprons, safety footwear, whole body protection, respirators or hearing protectors. The important thing to realise about these devices is that they do not remove the source of the hazard and so if they are worn incorrectly, or allowed to deteriorate significantly they may provide little protection.

In all cases appropriate selection, correct fit, employee preference, instruction in correct use, maintenance and wear time are major factors and must be optimised if adequate protection is to be maintained.

Implementation

To correctly implement an appropriate control strategy a number of factors need to be established and clearly understood. In introducing control technologies the following factors need consideration:

- The contaminant and the assessment of hazard.
- How the contaminant affects the body (eg there is no point controlling for an inhalation hazard if skin exposure is the problem).
- The level of control necessary.
- Possible control strategies, ie elimination, substitution, ventilation, etc.
- Relative effectiveness of different control procedures.
- Maintenance requirements.
- User acceptability.
- Cost.

Many practical solutions exist for problems within the Mining Industry, however the transfer of information between operations on these topics is limited, resulting in many cases of “reinventing the wheel”. This need not be the case, but until some centralised system arises to disseminate information, each mine should commence its own library of solutions and actively seek contributions from other organisations.

SECTION	:	CONTROL STRATEGIES
SUBJECT	:	CASE STUDIES

a) DIESEL EXHAUST EMISSIONS

Diesel exhaust emissions have given rise to concern for many years in respect to adverse health effects in underground coal mines. While many statements in respect to diesel usage have been challenged over the years the fact remains that the scientific community is undecided about some aspects of diesel exhaust emissions (ie particulate) and cancer. Other constituents of diesel emission, eg carbon monoxide, oxides of nitrogen, do cause adverse health effects (Section 4-02e). Given this, one NSW coal producer undertook a major research project on diesel emissions with a view to developing appropriate control technologies. This work took place in the 1990's at Tower Colliery and was based on the principle that if emissions are lowered then the risk of adverse health effects is also lowered.

Specific details of this work is available in ACARP Publication C3080[1], however the basis of the control strategies employed can be summarised as follows:

- Introduction of low sulphur fuels.
- Introduction of a tagging system.
- Development of an underground diesel test station (Section 5-05a).
- Chemical decoking of engines.
- Replacement of old engines.

[1] ACARP Report C3080: Evaluation and Control of Employee Exposure to Diesel Exhaust Emissions in Underground Mines, May, 1995.

- Introduction of disposable exhaust filters.

- Workforce education.

All these strategies played a role in the overall reduction of diesel particulate emissions, and it is important to realise that no simple solution exists. By far the most effective strategy was the use of disposable exhaust filters, although factors such as backpressure on engines, filter size, etc limit the range of vehicles to which it could be practically applied. The system involves the placement of a polypropylene filter after the water conditioner to filter out diesel particulate prior to its entry into the general airbody, Figure 6-03a(I). Trials with this system have indicated reductions of up to 85% in diesel particulate levels being achieved with a minimum filter life of 3-4 shifts, depending on operational conditions. The use of filter backpressure indicating systems give more effective use of filters.

A number of operators have adopted this technology and claim benefits not only in terms of occupational health and safety but also productivity.

FIGURE 6-03a(I)

The system was originally thought best suited to larger equipment because of the size of the filter, however the system has been fitted to transport vehicles (Figure 6-03a(II) without any issues.

FIGURE 6-03a(II)

One area of control which doesn't receive the attention it deserves is that of maintenance.

A major study[2] analysed the raw exhaust of 66 individual engines at four NSW coal mines for both particulate and gaseous emissions.

The process involved bringing every unit to the surface and analysing the gaseous emissions with a mobile gas laboratory and the particulate emissions with an elemental carbon analyser (ACARP Project C6040)[3] mounted in a trailer (Figure 6-03a(III))

[2] The Control of Diesel Particulate in Underground Coal Mines – Doctorial Thesis, Brian Davies, University of Victoria 2004.

[3] ACARP Report C3080: Evaluation and Control of Employee Exposure to Diesel Exhaust Emissions in Underground Coal Mines, May 1995.

FIGURE 6-03a(III)
R&P SERIES 5100 ANALYSER AND MOBILE GAS LABORATORY ON-SITE DURING TESTING OF AN EIMCO LHD

The testing of engines was performed in accordance with section 4.1 of MDG 29 (NSW Department of Mineral Resources 1995) under torque stall conditions. Each engine was operated at full throttle with sufficient load being added to bring the engine speed down from its maximum by 200 – 300 rpm. A satisfactory load is achieved under these conditions when the raw exhaust CO_2 content is not less than 6% by volume.

Given the lack of clarity at that point in time in regard to raw exhaust particulate limits, it was considered appropriate to adopt a comparative approach to identify abnormal engines within the BHP Billiton Illawarra Coal diesel fleet.

Consequently the elemental carbon results of each engine were compared with the average for that engine type. Those engines exceeding the 95% upper confidence limit of the mean value were deemed to be abnormal.

Discussions were held with mine engineers and this approach was considered appropriate given the lack of any statutory guidance.

Using this approach, at the end of the testing the following acceptance criteria were confirmed (Figure 6-03a(IV).

Engine Type	No. Engines Tested	Mean ECmg/m³	95% UCL mg/m³
Caterpillar 3304	26	30	37
Caterpillar 3306	5	10	19
KIA 6-247	12	56	85
Perkins 1006.6	14	30	42
MWM D916.4	6	40	56
MWM D916.6	3	70	Variance too large

FIGURE 6-03a(IV)

In relation to gaseous emissions the NSW statutory requirements (NSW Department of Mineral Resources 1995) were adopted. These are:

Carbon Monoxide 1,500 ppm (load)
Oxides of Nitrogen 750 ppm (load)

for engines tested under field conditions.

Following the initial testing and after the application of engine acceptance criteria, the following units were deemed to be unacceptable (Figure 6-03a(V)) and the reasons for elevated particulate emissions investigated.

Mine	Vehicle	Engine	EC mg/m³	CO ppm	NOx ppm
A	Driftrunner	Perkins 1006.6	93	620	720
A	Driftrunner	Perkins 1006.6	60	950	740
A	MPV	Cat 3304	71	420	350
B	PJB	KIA 6-247	102	1,025	350
C	PJB	KIA 6-247	131	>2,500	280
C	PJB	KIA 6-247	139	1,250	250
C	Ram Car	MWM D916.6	159	760	250

FIGURE 6-03a(VIII)

Investigation on available engines as to the reason for high raw exhaust results identified blocked scrubber tanks and worn injectors as being the prime cause. Re-sampling after repairs on these engines gave the following results (Figure 6-03a(VI)).

Mine	Vehicle	Engine	EC mg/m³	CO ppm	NOx ppm
B	PJB	KIA 6-247	61	720	320
C	PJB	KIA 6-247	40	600	350
C	PJB	KIA 6-247	46	690	400
C	Ram Car	MWM D916.6	71	620	230

FIGURE 6-03a(VI)

In 2008 the NSW Department of Primary Industries revised MDG 29 which includes requirements on the in-service monitoring of engines for both gaseous and particulate emissions[4].

An emission's based maintenance programme has been shown to provide benefits not only in worker exposure to emissions but also in greater potential productivity

4 MDG 29 Guidelines for the Management of diesel engine pollutants in underground environments, NSW Department of Primary Industries, April 2008.

SECTION	**:**	**CONTROL STRATEGIES**
SUBJECT	**:**	**CASE STUDIES**

b) DUST

The three situations discussed in Section 5-05b in respect to excessive dust exposure, can be used to illustrate how effective control measures can be developed and illustrated.

In the first case discussed in 5-05b, intake air contamination was identified as the major issue for high dust levels on the longwall. As a result, engineering staff of the mine developed a crusher - beam stage loader (BSL) dust extraction system that has been successfully adapted to several other longwall faces. This procedure has been documented in the form of a Coal Services Pty Ltd Technical Bulletin titled "Beam Stage Loader (BSL) Crusher Dust Extractor", a copy of which can be found at the end of this section.

In the second case study discussed in Section 5-05b, the major factor in the high dust levels recorded was identified as poor work practices. To control this problem operator education programs were initiated by the mines concerned, with support from Coal Services Pty Ltd. The aim of the education programme was to create awareness of the dangers of working ahead of the ventilation ducting or brattice. This improved awareness resulted in a change to operating procedures, ie operator location, which was ultimately reflected in a significant lowering of employee dust exposures.

The third case involved the minimisation of inhalable dust on Appin longwall. Using the BHP Billiton Operational Excellence (OE) Programme a small team of longwall personnel and specialists investigated the issue of high airborne dust levels. Following intensive evaluation the OE group concluded that the best way of controlling dust was to prevent it getting into the atmosphere by an improved process to wet the coal in situ.

Consequently, the team trialled a new method of infusing water into the coal prior to mining. This new approach allowed four times as much water to be injected into the coal compared to the old system (Figure 6-03b(I)).

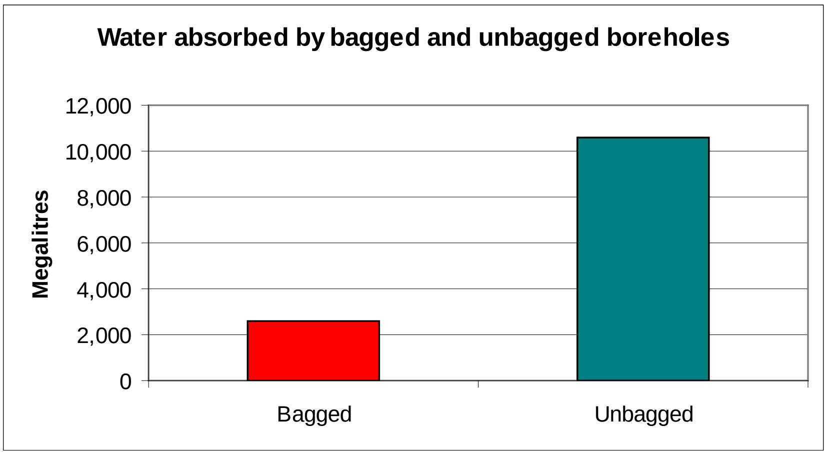


FIGURE 6-03b(I)

The amount of inhalable dust generated under this system was approximately 50% of that under the old system (Figure 6-03b(II)).

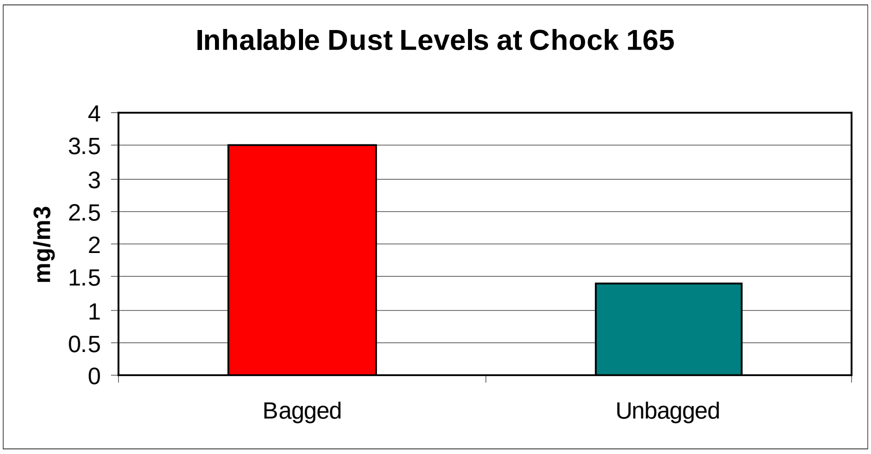


FIGURE 6-03b(II)

The benefits of the new system were numerous, for example the cost of the process was significantly reduced. The new process provided a means to use recycled mine water which was an issue at the mine, and worker exposures were significantly reduced.

• *WARNERS BAY:*
TEL: 049 42 9222
• *SINGLETON:*
TEL: 065 78 8523
• *CORRIMAL:*
TEL: 042 83 4011

Joint Coal Board

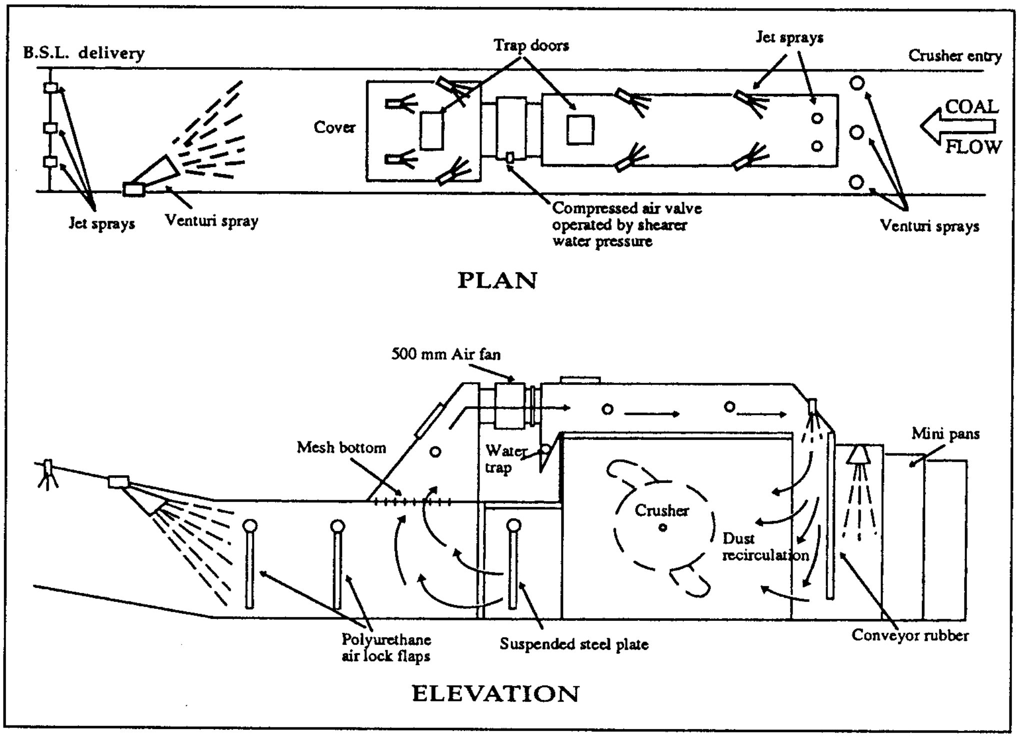
ISSUE No. 13

• TECHNICAL BULLETIN •

This technical bulletin contains information on certain equipment suitable for use in the NSW coal mining industry which has proved successful in reducing airborne dust, at West Wallsend Colliery.

BEAM STAGE LOADER (B.S.L.) CRUSHER DUST EXTRACTOR

The dust extractor is a simple way of collecting dust generated in the B.S.L. crusher which would otherwise contaminate the intake air for the longwall face.



• TECHNICAL BULLETIN •

The system developed at West Wallsend is that dust laden air on the discharge side of the crusher is extracted by the 500mm diameter compressed air fan and circulated past water sprays contained within a chamber above the crusher. Air is continually re-circulated from the crusher past the water sprays. Dust contaminated water is trapped and discharged into the B.S.L.

The dust extraction unit is mounted above the crusher with the compressed air fan and water sprays activated by the shearer water pressure. Sealing of the unit is important to minimise the dusty air leaking outside the system.

Respirable dust results in the vicinity of the crusher have been reduced and improved conditions on the longwall face have been highlighted from dust monitoring.

The trial installation of the crusher dust extractor has been successful at West Wallsend Colliery and a further installation has resulted at Appin Colliery in the southern coalfield.

To obtain further details on the system, please contact the Joint Coal Board office at Warners Bay, Singleton and Corrimal.

Information and sketch kindly supplied by the management and staff of West Wallsend Colliery – Oceanic Coal Australia.

SECTION	:	CONTROL STRATEGIES
SUBJECT	**:**	**CASE STUDIES**

c) HAZARDOUS SUBSTANCES

The control of hazardous substances on-site can be a major task, especially at sites with many contractors. In order to better manage the issue, a number of regulatory authorities have adopted a risk management approach based on the NOHSC model regulations[1], the basis of uniform legislation within Australia. Under this scheme, all hazardous substances (or chemicals) that come onto a site must be recorded in a site register, must have a compliant MSDS available, and must have undergone a risk evaluation and have the outcomes of that evaluation incorporated into safe work procedures.

While these actions appear to be a relatively simple task, the ongoing maintenance of such a system can consume significant resources. In order to minimise such consequences it is important that any management system has the following elements and/or ongoing actions:

1. Management and workforce commitment to the process
2. Involvement of key site personnel, eg storeman, safety officers, check inspectors, OH&S committee
3. Regular reviews of site inventories
4. Acceptance that there are no shortcuts to the approval process
5. Insistence with suppliers that only compliant MSDSs will be accepted
6. Access to specialist advice in the event of a difficult risk evaluation

to ensure the data is up-to-date and correct.

[1] NOHSC: Control of Workplace Hazardous Substances, March 1994.

Notwithstanding the above issues, effective systems can be made to work. One such system is detailed in Figure 6-03c(I). This process uses a commercial system (ChemAlert) for MSDS storage and on-site substance inventory. All hazardous substances are evaluated by an approval committee comprising:

- A OH&S committee representative
- A management representative
- Safety officer
- Local check inspector

While implementation of a system such as this has occurred within the coal industry, maintenance of such a system in the long-term will be the ultimate goal. To achieve good occupational hygiene practice such systems require the commitment of all site personnel.

Substance Evaluation

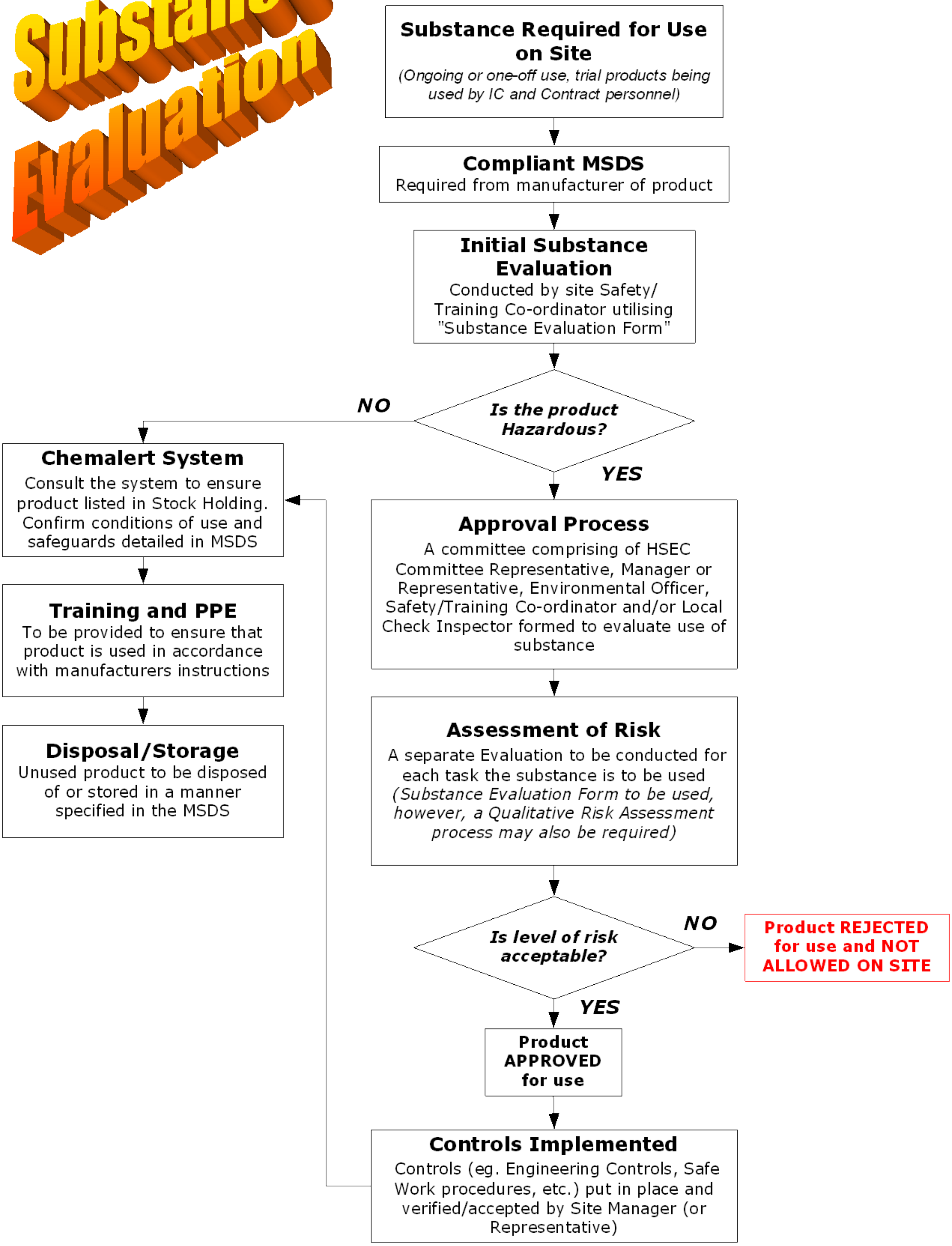


FIGURE 6-03c(I)

d) NOISE

Numerous measures currently exist within the Mining Industry to reduce the exposure of workers to noise. Unfortunately, few of them have been thoroughly implemented and thus workers continue to be unnecessarily exposed, and both workers and owners pay a high cost.

The following two case studies are reproduced with the permission of Dr Thomas Mitchell of the Victorian Institute of Occupational Safety and Health at Ballarat. More measures to control noise can be found in his publication on Noise Control in Mining[1].

Case Study No. 1

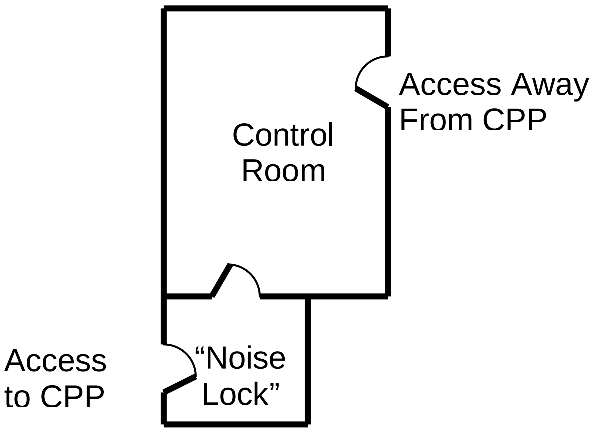
Coal preparation plant control room refitted to reduce noise exposure to employees.

Problem

Coal Preparation Plants (CPP) contain a range of processing equipment that produces considerable noise. The equipment and processes of the plant are operated from a central control room. The CPP control room operators spend a full shift at their workstation, monitoring, interpreting and controlling the production performance aspects of the plant. To perform effectively it is imperative that the operator's workstation is as comfortable as possible. Noise levels of 90-100 dBA are not uncommon in the processing areas of many CPP and this noise may be transmitted through both the air and the building structure to the control room operator.

[1] Mitchell, T. & Else, D.: Noise Control in Mining – Seventy-five Noise Control Solutions, VIOSH; August 1993.

Doors and windows often offer little resistance to the transmission of noise.



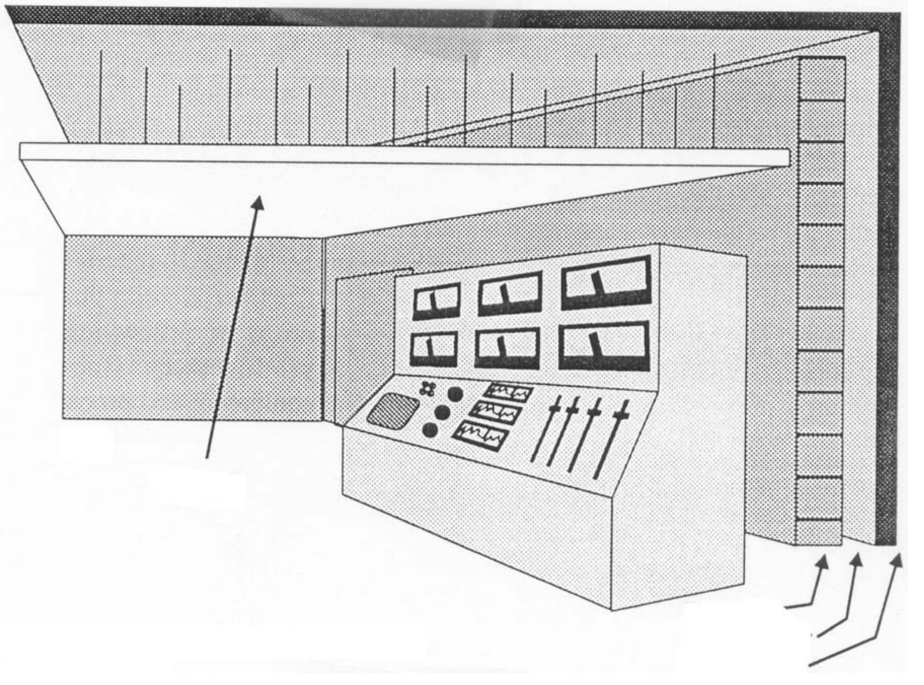
CONTROL ROOM
FLOOR PLAN

Solution

Recognising that a noise problem existed in their control room, the management of one coal preparation plant sought to reduce noise to an acceptable level. The control room was lined with cavity brick walls creating an air gap, a suspended ceiling installed, and a noise/air lock at the doorway to the processing area. To enter the control room from the process area, employees pass through an external self-closing door lined with lead sheet (5 kg/m^2). Once inside the noise/air lock, a second self-closing door is opened to gain access to the control room.

Benefits of the Noise Control Solution

Besides providing a significantly lower noise level inside the control room than that experienced in the processing areas, the noise/air lock entry section provides an area for removing wet gear and for cleaning boots to maintain good housekeeping within the control room.



Solution Summary

Type of Operation: Mineral Processing
Mineral: Coal
Equipment Type: Coal Preparation Plant
Equipment Make/Model: Control Room
No. of Employees Exposed: 1
Exposure Period: 6-8 hours
Method of Noise Control:
Room Redesign - Introduction of a noise/air lock
Insulation - Cavity brick lining
Noise Type: Steady
Noise Level: Outside 91 dB(A)
Inside 73 dB(A)
Solution Provider: Details available on request

Case Study No. 2

Substitution of starter motors on personnel transport vehicles.

Problem

Diesel powered personnel transport vehicles are used to convey personnel and equipment from the surface to the workings of underground mining operations. Personnel being transported spend around one to two hours per day on board the vehicle, however, the driver of the personnel vehicle will frequently spend six to eight hours operating the vehicle. While there are several noise problems associated with the diesel personnel vehicle, high noise levels have been recorded when the machine is started. These peak noise levels are attributed to the compressed air starter motor being activated.

Noise levels higher than 100 dB L_{Peak} have been recorded at the operator's ear position as the starter motor is engaged and compressed air from the starter is vented. The air turbulence created by the rotation of the starter motor combined with the compressed air exhaust have been identified as being the main contributors to the high peak noise levels.

Solution

The engineering department of an underground coal mining operation in NSW have successfully substituted the pneumatic starter units with similar starter motors operated by hydraulic power. The use of hydraulic fluid in the starter motor avoids air turbulence noise inherent in the operation of the compressed air starter motors. Being a closed circuit system, there is no noise produced by the medium being vented after it has delivered its energy.

Another alternative to the pneumatic starter motor is a spring starter motor.

The spring starter motor operates on the stored mechanical energy from a spring mechanism. While being generally quieter than the pneumatic system, the maintenance and replacement cost of the spring starter motors is inhibitive and as a result the use of these type of starter motors is gradually being phased out.

Benefits of the Noise Control Solution

Peak noise levels during start up of the diesel personnel vehicles have been reduced significantly. Dust previously created by the air flow from the starter motor has also been eliminated. With regular maintenance the hydraulic starter motor is capable of performing equally to, if not better than, the pneumatic units.

Factors Limiting the Success of Solution

None identified if a regular maintenance programme is introduced.

Solution Summary

Type of Operation: Underground Mining
Mineral: Coal
Equipment Type: Personnel Transport Vehicles
Equipment Make/Model: Baldwin
No. of Employees Exposed: 1-20
Exposure Period: Intermittent exposure over a period of 6-8 hours
Method of Noise Control:
Substitution - Pneumatic starter motor with hydraulic starter motor unit
Noise Type: Intermittent High Peak Levels
Noise Level: Before >100 dB L_{Peak}
After 80-85 dB L_{Peak}
Solution Provider: Details available on request

SECTION	**:**	**USEFUL RESOURCES**
SUBJECT	**:**	**INTRODUCTION**

When searching for information on occupational hygiene or occupational hygienists the prime source should be the relevant professional association.

In Australia this is the Australian Institute of Occupational Hygienists (see Section 7-02), however valuable information can be obtained from the following international bodies:

- American Conference of Governmental Industrial Hygienists (ACGIH) www.acgih.org
- American Industrial Hygiene Association (AIHA) www.aiha.org
- British Occupational Hygiene Association (BOHS) www.bohs.org
- International Occupational Hygiene Association (IOHA) www.ioha.com

Other sources of useful information are detailed in Sections 7-02 to 7-05, all of which are accessible via the internet.

SECTION	:	USEFUL RESOURCES
SUBJECT	:	AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS

INTRODUCTION

This section is supplied to assist assessment of the professional background of consultants. It is not intended that non-membership of this Institute should exclude potential consultants. It is anticipated that after reading this section you will understand the role of the AIOH in OH&S and the significance of its various levels of membership. This should assist your assessment of consultants' professional status and experience.

THE INSTITUTE

The Australian Institute of Occupational Hygienists Inc (AIOH) was formed in 1979 and incorporated in Victoria in 1988. An elected governing Council comprising the President, Secretary, Treasurer and four Councillors manages the affairs of the Institute.

The overall objective of the Institute is to help ensure that workplace health hazards are eliminated or controlled. It seeks to achieve this by:

- Promoting the profession of occupational hygiene in industry, government and the general community.
- Improving the practice of occupational hygiene and the knowledge, competence and standing of its practitioners.
- Providing a forum for the exchange of occupational hygiene information and ideas.
- Promoting the application of occupational hygiene principles to improve and maintain a safe and healthy working environment for all.

- Representing the profession nationally and internationally.

The AIOH is a member of the International Occupational Hygiene Association (IOHA).

ACTIVITIES

The Institute provides professional recognition of its members both nationally and internationally. Members are able to meet and have the opportunity of contact with other hygienists in various areas of practice.

Professional Representation

The Institute is active in the development of occupational health and safety legislation, regulations and codes of practice throughout Australia through representations to government and industry. Institute members participate on committees and working parties of NOHSC, State Occupational Health and Safety Authorities, Standards Australia, National Association of Testing Authorities and various other industry and employer organisations.

Education

The AIOH conducts public meetings, workshops, symposiums, exhibitions and courses of instruction to promote an awareness and understanding of occupational health issues. The Institute develops guidelines and standards for the teaching and training of occupational hygienists and the accreditation of occupational hygiene courses.

Professional Development Courses and One-Day Seminars are available through the AIOH as well as Continuing Education Seminars on the preceding days before the annual conference held in December of each year.

Annual Conference

The annual conference of the Institute provides a forum for the presentation of papers, and conduct of seminars and workshops on scientific and related issues in the occupational health field. The conference also offers an opportunity for the informal exchange of views and is a means of broadening the knowledge of participants. Attendees have the opportunity to see first hand the latest in equipment, instrumentation and other technologies used in the occupational hygiene field at the Trade Exhibition included in the conference.

MEMBERSHIP

Four levels of membership exist within the Institute's framework, reflecting both the qualifications and experience of members.

The following details of membership levels are provided as a guide.

Associate Level

A non-professional level of membership for those persons holding an appropriate TAFE Certificate and working in the field of occupational hygiene.

Provisional Level

The first level of professional membership, which requires an appropriate degree from a recognised university, at least one (1) year's professional experience and to be working in the field of occupational hygiene.

Full Membership

The major level of professional membership, which has the same educational requirements as a provisional member, but requires in excess of five (5) years professional experience in occupational hygiene.

Fellow

This is a special category for those full members who have worked for more than fifteen (15) years in a professional capacity and have been judged by their peers to have made a distinguished contribution to the advancement of the field of occupational hygiene.

CERTIFIED OCCUPATIONAL HYGIENIST

The Certified Occupational Hygienist (COH) is certified by the AIOH. The AIOH Certification Scheme is recognised by the International Occupational Hygiene Association.

Applicants for certification are assessed under three criteria to demonstrate competence – knowledge, experience and verification (written and oral examination).

A Certification Maintenance Program is in place to ensure COH's continue to develop and enhance their occupational knowledge and skills. The emphasis of the Certification Maintenance Program is on continuing education.

For more detailed information contact the Institute at:

Australian Institute of Occupational Hygienists Inc
PO Box 1205
TULLAMARINE VIC 3043

Telephone: (03) 9335 2577
Facsimile: (03) 9335 3454

www.aioh.org.au (accessed October 2008)

SECTION	:	USEFUL RESOURCES
SUBJECT	:	NATIONAL ASSOCIATION OF TESTING AUTHORITIES

The National Association of Testing Authorities

(NATA) was originally created by the Australian Government in 1947 to provide a national laboratory accreditation system for Australia. It was the first such system in the world and remains the largest and most diversified, serving as a model for many other countries.

Today, NATA operates as a non-profit association of its client members, with offices in most State capitals. It has evolved over the years to provide a range of conformity assessment services to industry and the community.

- Laboratory Accreditation

  NATA provides independent assessment and accreditation of testing, measurement and calibration laboratories in eleven separate fields of testing.

- Personnel Certification

  NATA can provide for the certification of personnel involved in certain activities such as field testing and sampling.

- Quality Systems Certification

  NATA is a recognised third party certifier of organisations complying with national and international quality management standards.

NATA also provides a series of complementary training and information support programs.

The Association is recognised by the Commonwealth Government, through a Memorandum of Understanding, as Australia's national provider of laboratory accreditation. It has mutual recognition agreements with several equivalent bodies in other countries, including Sweden (SWEDAC), the Netherlands (NKO/STERIN/STERLAB). Hong Kong (HOKLAS), USA (NVLAP and A2LA), New Zealand (Telarc) and the UK (NAMAS). These agreements help confer international recognition on NATA laboratories.

NATA also represents Australia on a variety of international bodies involved in testing or conformity assessment including:

- International Laboratory Accreditation Co-operation (APLAC).

- Organisation for Economic Co-operation and Development (OECD) Panel on Good Laboratory Practice.

From time to time the services of a NATA accredited laboratory will be required. Details of those laboratories registered for the specific item to be measured can be obtained free of charge by contacting any of the NATA offices listed below or from the NATA website at www.nata.asn.au (accessed October 2008).

Sydney (Head Office)
7 Leeds Street
RHODES NSW 2138
PO Box 7507
SILVERWATER NSW 2128
Telephone: (02) 9736 8222
Fax: (02) 9743 5311

Brisbane
628 Ipswich Road
ANNERLEY QLD 4103
Telephone: (07) 3870 3844
Fax: (07) 3848 3660

Melbourne
71-73 Flemington Road
NORTH MELBOURNE VIC 3051
Telephone: (03) 9329 1633
Fax: (03) 9326 5148

Adelaide
Unit 1
13 King William Road
UNLEY SA 5061
Telephone: (08) 8179 3400
Fax: (08) 8271 7601

Perth
Business Centre
2A Brodie-Hall Drive
BENTLEY WA 6102
Telephone: (08) 9496 2800
Fax: (08) 9486 2828

It is important to remember is that NATA registration covers a multitude of items and just because a laboratory is NATA registered is no guarantee that the laboratory is registered for the item of interest. Consequently, it is important when seeking assistance from NATA to ask, for example, "Which laboratories in my area are NATA registered for the identification of asbestos or the analysis of dust for quartz etc".

Similarly, don't be frightened to ask any laboratory that you wish to engage, for a copy of their "Terms of Registration" and check that the item you want exists on that list.

SECTION	**:**	**USEFUL RESOURCES**
SUBJECT	**:**	**SOURCES OF RELEVANT INFORMATION OR PUBLISHED RESEARCH**

This is not an exhaustive list, but it does include libraries and other places which may possess reports and similar information relevant to occupational health and safety in the mining industry.

- Australian Coal Association Research Programme (ACARP)
  www.acarp.com.au/ (accessed October 2008).

  Australian black coal producers contribute to a programme of collaborative research that is conducted for the benefit of the coal mining industry. Coal producers have committed to pay 5 cents per tonne to fund the Australian Coal Association Research Programme (ACARP). The funds are paid to Australian Coal Research Ltd (ACR), a company established by the industry to manage all aspects of the programme. Project administration and programme support is provided by Australian Research Administration Pty Ltd (ARA) as prime contractor.

  ACARP's mission is to research, develop and demonstrate technologies that lead to the safe, sustainable production and utilisation of coal.

  Each year approximately 60 projects are selected for funding, many of which are in the OH&S area. A complete list of projects can be viewed at the ACARP website.

- Australian Institute of Occupational Hygienists (AIOH) www.aioh.org.au (accessed October 2008)
  - Simplified Monitoring Strategies
  - Heat Stress Standard & Documentation Developed for Use in the Australian Environment
  - A Guideline for the Evaluation & Control of Principles of Occupational Health & Hygiene – an Introduction
  - Diesel Particulate in the Occupational Environment
  - Simplified Occupational Hygiene Risk Management Strategies
  - Principles of Occupational Health & Hygiene – an Introduction
  - International Occupational Hygiene Training Module – Measurement of Hazardous Substances – Student Manual
  - International Occupational Hygiene Training Module – Thermal Environment

- Australian Institute of Mining and Metallurgy (AUSIMM) www.ausimm.com.au/ (accessed October 2008).

  This institute runs annual conferences on the industry, publishes papers and bulletins and covers health and safety issues. The Proceedings may be purchased or the library facilities utilised with usual safeguards.

- Australian Mineral Industries Research Association Ltd (AMIRA) or AMIRA International www.amira.com.au/ (accessed October 2008).

  AMIRA is an industry organisation, which manages collaborative research for member groups in the global minerals industry.

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
  www.arpansa.gov.au/RadiationProtection/index/cfm
  (accessed October 2008)

  This The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Federal Government agency charged with the responsibility for protecting the health and safety of people, and the environment, from the harmful effects of ionising and non ionising radiation. Part of the role of ARPANSA is to provide accessible information about radiation related issues

  Australian Safety & Compensation Commission (ASCC)
  www.ascc.gov.au/ (accessed October 2008).

  This is the Federal Government's resource of OH&S. It publishes guidelines which are then adopted (sometimes with modifications) into law by the states.

  ASCC has an excellent library which is unfortunately now only available by interlibrary loan.

- Diesel Emission Evaluation Programme (DEEP)
  www.deep.org/ (accessed October 2008).

  NB The DEEP project is completed and eventually the website will cease to exist.

  This is a research group based in Canada with the sole function of researching issues related to diesel emissions. Many excellent projects have been completed and can be downloaded free of charge from their website.

- Dieselnet
  www.dieselnet.com/ (accessed October 2008).

Dieselnet is a commercial organisation based in Canada which, for a fee, provides useful information on world diesel issues. Some useful information can be obtained from their website free of charge.

- Mining Diesel Emissions Conference
  www.dieselnet.com/mdec (accessed October 2008).

  The Canadian mining industry holds a conference in Toronto at which speakers from around the world provide updates on research. Much useful information can be obtained from reviewing presentations of speakers.

- Mine Safety and Health Administration (MSHA)
  www.msha.gov/ (accessed October 2008).

  Even though this is the main regulatory body for the US mining industry, the site does contain useful information provided it is viewed in light of the US legislative system and appropriate application to Australian conditions.

- Minerals Industry Safety and Health Centre (MISHC)
  www.mishc.uq.edu.au/ (accessed October 2008).

  This centre was founded as a joint venture between the University of Queensland, seven mining companies and the State Mines Department.

  MISHC has both an education and research function with research outcomes to date available from their website.

- NSW Minerals Council
  www.nswmin.com.au/ (accessed October 2008).

  The NSW Minerals Council publishes various documents on health and safety from time to time. The NSW Minerals Council is currently developing a web page specifically targeted at health issues.

- National Institute of Occupational Safety and Health – Pittsburgh Research Centre
  www.cdc.gov/niosh/mining/ (accessed October 2008).

  This body is essentially the old US Bureau of Mines and conducts significant research within the mining industry.

- South Australian Mine and Quarry OH&S Committee (Quarry-Safe)
  www.maqohsc.sa.gov.au/ (accessed October 2008).

  Funds OH&S projects in the SA mining and quarrying industries.

- The Coal Services Health & Safety Trust
  www.coalservices.hstrust.com.au/ (accessed October 2008).

  Various occupational health and safety projects are funded by this body. Details of current projects are available via the website of the Trust while final reports are also available through the Trust.

  This body has funded numerous excellent projects in the OH&S area.

- Victorian Institute of Occupational Safety and Health (VIOSH).
  Located within Ballarat University
  www.ballarat.edu.au/ard/sci-eng/viosh/ (accessed October 2008).

  Thomas Mitchell and Dennis Else, who are the joint authors of “Noise Control in Mining: Seventy-Five Control Solutions”, published 1993, are both key persons within the VIOSH structure.

SECTION	:	USEFUL RESOURCES
SUBJECT	**:**	**STANDARDS AUSTRALIA**

Standards Australia was founded in 1922. Its original name was the Australian Commonwealth Engineering Standards Association. Recognising its wider role in the community, it became the Standards Association of Australia in 1929 and was incorporated under a Royal Charter in 1950, under whose articles it still operates. In 1988, its relationship with the Commonwealth Government was formalised under a *Memorandum of Understanding*. In the same year, its trading name was changed to Standards Australia.

In co-operation with other technical infrastructure bodies, its mission is to excel in meeting national needs for contemporary, internationally aligned standards and related services which enhance the nation's economic efficiency, international competitiveness, and fulfil community desire for a safe and sustainable environment.

Standards Australia is governed by a 100 member Council, whose composition is defined under the Charter, and which represents a broad cross-section of the Australian community. The Council meets annually to establish policy and to elect an Executive Board and a Finance and Audit committee, both of which meet quarterly to provide direction to management and to ensure financial probity and fiscal stability.

There are in excess of 7,000 Australian standards currently available.

Sales of Australian Standards and other products in the catalogue are provided by SAI Global Ltd on behalf of Standards Australia. Standards can be purchased from any one of the following offices during office hours.

Customer Service Centre

For Australian Sales, International Services, Update Services
Phone: 131 242
Fax: 1300 65 49 49
Email: sales@sai-global.com
Internet ordering: www.saiglobal.com.au/shop/ (accessed October 2008)

Personal Shopping

Sydney

Unit T,
10-16 South Street,
Rydalmere NSW, 2116

Melbourne

19-25 Raglan Street
South Melbourne VIC 3205

Brisbane – Preferred reseller

SDS Express
Mineral House
41 George Street
Brisbane Qld 4001

Head Office and Administration

SAI Global Limited
286 Sussex Street (cnr Bathurst Street)
Sydney, NSW 2000
GPO Box 5420
Sydney NSW 2001
Phone (02) 8206 6000
Fax (02) 8206 6001
Email mail@saiglobal.com

SECTION :	GLOSSARY
SUBJECT :	GLOSSARY

ALDEHYDES Chemical compounds of carbon, hydrogen and oxygen, with characteristic odours and a tendency to cause eye irritation with the more volatile members. (Formaldehyde has a rather pungent odour.) Aldehydes may be formed during combustion of diesel fuel in diesel engines.

ASPHYXIANT A gas, or atmospheric condition, which causes either the concentration of oxygen in the environment to drop below a level sufficient to maintain life, or a gross excess of carbon dioxide which may fatally disturb the respiratory system.

AUDIOMETRY The measurement of hearing capacity. The simplest form is Screening Audiometry, which measures the capacity of an individual to hear pure tone sounds. This provides an indication of NIHL and presbycusis.

CHLORACNE A disfiguring form of acne associated with gross exposure to chemicals containing high amounts of chlorine. Recovery usually follows the cessation of exposure.

DAILY NOISE DOSE AS/NZS 1269 states that the daily limit for exposure to noise is 85dBA for a period of 8 hours. Such an exposure for this period is considered to be 100% of the Daily Noise Dose or DND. It is legislated into most State regulations governing industrial noise.

EQUIVALENT AERODYNAMIC DIAMETER	The measurement of the total mass of particles likely to be inhaled by exposed workers can be measured gravimetrically with precision, but measuring the sizes of those particles is a difficult task, for particles come in all shapes and sizes. The system which has been widely adopted for size measurement is based roughly on the principle that particles can be classified as to where they might lodge in the respiratory system on the basis of their diameters, if they were spherical in shape. The Equivalent Aerodynamic Diameter (EAD) is specified in micro-metres, that is, millionths of a metre.
HAEMOGLOBIN	A protein found in blood, rich in iron, which carries oxygen collected in the lungs, through the arteries to all parts of the body. When it has collected its load of oxygen it is known as **oxy-haemoglobin,** and after it has delivered its oxygen and is returning to the lungs via the venous system it is known as **haemoglobin.** Haemoglobin also combines very readily with CO to form a complex known as **carboxy-haemoglobin,** which is incapable of carrying oxygen.
λ	Greek letter "lambda", used to indicate wavelength in wave motion. Commonly used in respect to light and sound.
MATERIAL SAFETY DATA SHEET(S) (MSDS)	A document prescribed by regulations, required to be supplied to users of all industrially used substances, setting out, among other things, precautions to be observed when using substances.
µ	Greek letter, "mu" - micro a prefix indicating 10^{-6}
µm	micrometre eg one µm =1 millionth of a metre

n "nano" a prefix indicating 10^{-9} , or 1 billionth , eg 1nm= 1billionth of a metre. Used mainly for describing electro-magnetic wave-lengths.

PHOSGENE $COCl_2$, a poisonous gas used in World War I and in some chemical syntheses. Can be unintentionally generated when some chlorinated solvents, such as perchlorethylene, are heated sufficiently to cause decomposition, including being drawn through a lighted cigarette.

PREVALENCE The incidence of illness or other symptoms of ill-health in a specific group of workers, or a community. For instance, the prevalence of pneumoconiosis among NSW coal miners was 16% in 1948. That is 16 of every 100 coal miners showed clinical symptoms of pneumoconiosis in 1948.

RADIATION Forms of energy, including sunlight, heat, and that from radio-active substances, which travel by either electro-magnetic wave forms, or as minute particles. Energy from the sun covers a wide range of wave lengths, ranging from the very short wave Ultra-Violet (UV) rays which are mostly absorbed in the ozone layer, high above the earth, through the visible range (or spectrum), on to the Infra-red (IR). Heat energy from fires, hot metal, or even hot humans, consists of IR radiation. Radiation from radio-active materials may include very short wave length energy such as X-rays.

All these types of energy belong to the one electro-magnetic spectrum. Below a certain wave there is enough energy to cause molecules or atoms to split off parts of their structure, either permanently or temporarily and this process is known as ionisation. X-rays, most radio-active waves and very short UV radiation can all cause ionisation, excessive exposure to that can cause very bad effects, including cancer.

For this reason X-rays are only ordered medically when there is a real need for diagnostic purposes. Cosmic rays, which arrive from unknown sources in outer space, are examples of particulate radiation. We are all exposed to a continuous background of radiation from many sources, UV being the commonest. These days, outdoor workers are encouraged to minimise UV exposure by the use of clothing, sun-screens, broad brim hats and other means.

SECTION	:	SUBJECT INDEX
SUBJECT	:	SUBJECT INDEX

Asbestos	4-02a
Australian Institute of Occupational Hygienists (AIOH)	7-02
Australian Standards	7-05
Cold Stress	4-02s
Confined Spaces	4-02b
Consultants	5-06
Control Strategies	6-01, 6-02, 6-03
Dangerous Goods	4-02c
Dermatitis	4-02d
Diesel Exhaust Emissions	4-02e, 5-05a, 6-03a
Dusts	4-02f, 4-04a, 5-05b, 6-03b
Exposure Standards	5-03
General Airbody Gases	4-02g
Hazardous Substances (Chemicals)	4-02h, 4-04b, 6-03c
Heat Stress	4-02s
History of Occupational Hygiene	2-02
Issue Management	3-01, 3-02, 3-03
Lighting	4-02i

Material Safety Data Sheets	4-02j
Microbiological Agents	4-02k
National Association of Testing Authorities (NATA)	7-03
Noise	4-02l, 5-05c, 6-03d
Occupational Hygiene	2-01
Organic Vapours (Solvents, etc)	4-02m, 4-04d
Personal Protective Equipment	4-02o
Polychlorinated Biphenyls (PCBs)	4-02n, 4-04e
Potential Occupational Hygiene Issues	3-04
Quality Assurance	5-04
Radiation (Non-ionising and Ionising)	4-02p
Risk Assessment	4-04b, 5-01
Sources of Information	7-04
Spontaneous Combustion	4-02q, 4-04f
Standards Australia	7-05
Statistically Based Monitoring	5-05d
Synthetic Mineral Fibres	4-02r
Thermal Stress	4-02s
Vibration	4-02t, 5-05f
Walk Through Surveys	4-03
Welding and Welding Fumes	4-02u, 4-04g
Whole Body Vibration	4-02t, 5-05f
Workplace Monitoring	5-02, 5-05e