FOCUS ON Atmospheric contaminants causing respiratory illness

Focus on learning key	
Exercise Analyse the information in your work group	**Discuss** Go through questions in your workgroup

Date:	
Shift:	
Discussion led by:	

Attendees names:	

Introduction

Respiratory disease caused by atmospheric contaminants as a result of mining activities, can significantly impact on an individual's capacity to function in day to day activities that most would take for granted. This resource will aid further analysis of exposure to atmospheric contaminants in your workplace and aims to reduce the occurrence of respiratory disease using the risk management approach:

- Identify
- Assess
- Control
- Evaluate

The purpose of this education resource is to increase awareness of the possible health consequences associated with exposure to atmospheric contaminants, relevant to the mining industry, and step workers through the risk management approach for management of atmospheric contaminants.

1 Entry to the Body

The size of the contaminant particle determines how the contaminant enters the body. Contaminants (such as dust) that are small enough, may be inhaled[1]. Most of the time the lungs natural defences are able to extract the contaminant but sometimes these contaminants can get trapped in the lungs. The smallest contaminant particles and gases may be drawn into the lower parts of the lung and can interfere with oxygen exchange and / or gain entry into the body where the contaminant has the potential to harm other organs[2].

2 Contaminant Forms

Contaminants can vary significantly but it is the size of the contaminant that is important. If the contaminant is small enough, when inhaled it can reach the narrowest airways of the lung[3].

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[1] *National Occupational Health and Safety Commission (2004) Approved criteria for classifying hazardous substance, 3rd edition, Australia.*
[2] *Australian Institute of Occupational Hygienists (2007) Principles of Occupational Health and Hygiene, C.Tillman, Allen & Unwin, Australia.*
[3] *National Occupational Health and Safety Commission (1999) Atmospheric contaminants, Australia.*

Atmospheric Contaminants

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A Atmospheric Contaminants

Think of some examples of the different forms of atmospheric contaminant that may exist in your workplace.

Form	Description	Example
Dusts	Airborne solid particles	
Fibres	Solid particles length is longer than width	
Fumes	Airborne solid particles condensed from a vaporous state	
Mists	Airborne droplets of substance	
Smoke	Particles generated from incomplete combustion of fuel	
Vapour	Molecular dispersion of material, normally liquid at ambient temperature	
Gas	Molecular dispersion of material, boils below ambient temperature	

National Occupational Health and Safety Commission (1999) Atmospheric contaminants, Canberra.

B Atmospheric Contaminants

The following table demonstrates different work tasks and the atmospheric contaminant associated with those tasks. Circle the tasks that your work group regularly engage in.

Example: Ben works in the mechanical workshop where he conducts maintenance on mining equipment and welding is one of the typical activities he conducts. Ben would circle the plant maintenance in the 'Source/Task' field, followed by welding. If Ben followed the contaminant field across the table inline with the task of welding he would identify 'Cadmium, Hexavalent and Trivalent Chromium' as the atmospheric contaminants. The intensity field would identify that Cadmium, Chromium IV and Chromium III form fumes and the 'Severity' field identifies Bronchitis/emphysema, fibroid lung disease and lung cancer as possible health consequences of exposure to welding fumes.

Source / Process	Contaminant	Intensity	Severity
Roof bolting	Silica	Dust (Inhalable)	Silicosis, lung cancer, Bronchitis / emphysema
	Coal	Dust (Inhalable)	Pneumoconiosis
	Diesel Particulate	Smoke (Inhalable)	Bronchitis / emphysema, lung cancer
Crushing and screening	Silica	Dust (Inhalable)	Respiratory disease, Silicosis
	Coal	Dust (Inhalable)	Pneumoconiosis
Mining / Extraction	Silica	Dust (Inhalable)	Silicosis, lung cancer, Bronchitis / emphysema
	Coal	Dust (Inhalable)	Pneumoconiosis
	Diesel Particulate	Smoke (Inhalable)	Bronchitis / emphysema, lung cancer

Source / Process		Contaminant	Intensity	Severity
Coal and Mineral Processing		Coal	Dust (Inhalable	Bronchitis / emphysema Pneumoconiosis
		Silica	Dust (Inhalable)	Silicosis, lung cancer
Blasting		Silica	Dust (Inhalable)	Silicosis, lung cancer, Bronchitis / emphysema
		Coal	Dust (Inhalable)	Pneumoconiosis
		Ammonium Nitrate	Dust (Inhalable, absorbed)	Bronchitis / emphysema
		H_2S, SO_2, NO_2 CO_2', CH_4, NO_2	Gas (Inhalable)	Asphyxiate
Grout Spraying		Cementitious	Mist (Inhalable)	Bronchitis / emphysema
		Polymeric agents	Dust (Inhalable)	Bronchitis / emphysema
		Ash	Fibres (Inhalable)	Fibrotic lung disease
		Aggregate	Dust (Inhalable)	Bronchitis / emphysema
		Sand	Dust (Inhalable)	Bronchitis / emphysema
Leaching		Xanthate	Vapour, fume or Mist	Irritation, pulmonary oedema
		Cyanide	Gas	Asthma / bronchitis
		Sulphuric Acid	Gas	Irritation, pulmonary oedema
Plant Maintenance	Welding	Cadmium	Fumes (Inhalable, absorbed)	Bronchitis / emphysema, fibrotic lung disease, lung cancer
		Hexavalent Chromium (Cr(VI)), Trivalent Chromium Cr(III))	Fumes (Inhalable, absorbed)	Bronchitis / emphysema, fibrotic lung disease, lung cancer
	Painting Adhesives	Isocyanate	Fumes (Inhalable)	Bronchitis / emphysema, fibroticlung disease, lung cancer
	Solvents	Hydrocarbons	Vapour (Inhalable, absorbed)	Bronchitis / emphysema, lung cancer
	Mechanical	Diesel Particulate	Smoke (Inhalable)	Bronchitis / emphysema, lung cancer
	Maintenance	Silica	Dust (Inhalable)	Bronchitis / emphysema

Source / Process		Contaminant	Intensity	Severity
Installing / Maintaining / Removing of Ventilation Tube		Fibre Glass	Solid (Inhalable)	Fibrotic lung disease
		Asbestos	Solid (Inhalable)	Asbestosis, lung cancer, mesothelioma Respiratory disease
		Silica	Dust (Inhalable)	Silicosis, lung cancer, Bronchitis / emphysema
		Coal	Dust (Inhalable)	Pneumoconiosis
Gases Present in Underground Mines and Reclaim Tunnels		CO	Gas (Inhalable, absorbed)	Irrespirable
		Rn	Inhalable, absorbed in water)	Cancer
		H_2S, SO_2, NO_2 CO_2', CH_4,	Gas (Inhalable) Gas	Asphixiant
Leaking Hydraulic Circuits		Oil	Mist (Inhalable)	Bronchitis / emphysema
Polymeric Chemical Injection		Phenol Formaldehyde Acid	Mist (Inhalable, Absorbed)	Bronchitis / emphysema, lung cancer
Infrastructure Maintenance	Roadway Maintenance Noxious Weed Eradication	Chemical	Vapour/Mist (Inhalable, absorbed)	Bronchitis / emphysema
Pneumatic Lubricators	Oil	Mist (Inhalable)	Bronchitis / emphysema	Bronchitis / emphysema

Driscoll, T (2007) Summary literature review of health and safety issues related to NSW mining, Australia.

3 Entry to the Body

The work task contaminant table identified illness associated with atmospheric contaminant relevant to mining. The following are descriptions of the illnesses identified in the table.

Read the description of the possible associated health effects identified with the task you and your crew regularly engage.

Example: Ben our maintenance worker from the previous example would read about the health effects associated with the welding. Ben would read about bronchitis/emphysema, fibroid lung disease and lung cancer as the health effects associated with welding.

Pneumoconiosis and Silicosis

Coal Workers' Pneumoconiosis is caused by very small particles of coal dust and Silicosis is caused by very small particles of silica found in quartz. These particles, when inhaled, reach the depths of the lung and become lodged there. The body reacts to these 'lodgements' by covering them with tissue, similar to scarring, forming nodules. This scarring can progressively damage the lung and limit its ability to expand. This means less oxygen is able to enter and be absorbed, reducing lung function.

Asphyxia

Asphyxiate is to be “starved” of the proper amount of oxygen. It is caused by a lack of oxygen in the respired air, resulting in a deficiency of oxygen in the blood and an increase in carbon dioxide in the blood and tissues.

Irrespirable

Irrespirable means unfit for breathing. In respect to mining, irrespirable is used in explaining an atmosphere containing poisonous gases or a lack of sufficient oxygen.

Lung Cancer

Lung Cancer is a disease of uncontrolled cell growth in the tissue of the lung, this tissue referred to as a tumour, takes over the healthy tissue of the lung and as the tumour increases in size the capacity of respiratory gas exchange decreases. Signs and symptoms which may indicate lung cancer include: shortness of breath; coughing up blood, chronic coughing; wheezing; and chest pain.

Fibrotic Lung Disease

Fibrotic Lung Disease or otherwise better known as Pulmonary Fibrosis develops when the alveoli become damaged and inflamed. The body tries to heal the damage and scars form. These scars then collapse and make the lungs less elastic. This cycle will continue and the lungs will increasingly be unable to deliver oxygen to the blood. There are certain environmental and occupational exposures which may lead to fibrosis, these exposures may include: cigarette smoking, prolonged exposure to occupational, environmental contaminants and dust, viral and bacterial infections, certain medicines and acid reflux disease.

Emphysema

Emphysema is an abnormal condition of the lung marked by an abnormal increase in the size of the air spaces and as such decreases the elasticity of the lung. These changes are irreversible and can cause destruction of the lung wall. Signs and symptoms of emphysema may include pursed lip breathing; central cyanosis or blue finger nails and ruddy complexion of the face to name a few.

Pulmonary Oedema

Is the build-up of fluid in the air spaces of the lung making oxygen exchange difficult.

Bronchitis

Bronchitis is inflammation of the membranes lining the bronchial tubes in the lung. More specifically it can be either acute or chronic, with acute bronchitis being caused by viruses or bacteria and lasting several days or weeks. Chronic Bronchitis being a persistent, productive cough lasting at least three months in two consecutive years.

Mesothelioma

Mesothelioma is a malignant tumour of the thin lining of the lung, abdomen or around the heart and it is commonly associated with exposure to asbestos. Mesothelioma is an aggressive cancer, and its signs and symptoms may include but not limited to dyspnoea, chest pains, cough, weakness, fever and difficulty swallowing.

4 Assessing Risk

When we assess the risk of exposure to atmospheric contaminant, like safety issues, we still consider the possible consequences of exposure and the likelihood.

Consequence

To determine the consequence we need to consider what can happen.

Likelihood

We need to determine the chances of a negative effect occurring.

C What is the potential consequence from the atmospheric contaminant exposure you identified in exercise B?

- ☐ A - Permanent Illness/ Death
- ☐ B - Severe permanent health effects
- ☐ C - Mild permanent health effects
- ☐ D - Temporary health effects
- ☐ E - Minor health effects

Example: Our friend Ben in maintenance has read that permanent illness and/or death are possible consequences as a result of exposure to welding fumes. He would assess the consequences as A.

What is the severity rating for your identified atmospheric contaminant?

Example: Maintenance worker Ben selected A being that it results in permanent illness and or death. A=Severity Rating Red.

The following table rates the severity of the consequence.

Consequences Key		Severity Rating Description	
A	**Death/ Terminal Illness**	Red	Increasing debilitation over time resulting in death
B	**Severe permanent health effects.**		Substantial loss of normal function (severely restricted or loss of mobility due respiratory disease)
C	**Mild permanent health effects**		Permanent restriction of normal function
D	**Temporary health effects**	Orange	Health effects that are likely to resolve and not result in permanent disability or illness
E	**Minor health effects.**		Short term impacts that are fully reversible
F	**No effect**	Green	Exposure level not likely to cause effect

International Council of Mining and Metals (2009) Good practice guidance on occupational health risk assessment, London UK.

5 Likelihood

To determine likelihood we consider the amount of atmospheric contaminant we are exposed to + the amount of time we are exposed + and how often we are exposed.

Intensity + Exposure Time + Frequency of Exposure = Likelihood

6 Intensity

To determine intensity of atmospheric contaminant you will need access to the most recent atmospheric exposure monitoring results. You will also need access to past atmospheric exposure monitoring results.

If there are no results available and you regularly engage in activities that have been identified in the work task contaminant table, you should inform your supervisor, WHS practitioner or WHS committee that you require information regarding atmospheric exposure levels and that this may be a good time to consider atmospheric contaminant exposure monitoring. To assess whether exposure is within the acceptable limits you will need to have access to *Adopted National Exposure standards for Atmospheric Contaminant in the Occupational Environment*[4].

Example: Ben our maintenance worker has obtained a copy of the most recent atmospheric exposure monitoring report.

The report has details of different atmospheric contaminants and Ben identifies sampling conducted on the contaminants he identified for welding and the results are as follows;

- Cadmium at 0.004 mg/m^3 sampling was conduct for 208 minutes
- Chromium (III) 0.5mg/m^3 sampling was conducted for 208 minutes
- Chromium (IV) 0.001mg/m^3 sampling was conducted for 208 minutes

D

1. Record your identified atmospheric contaminant in the atmospheric contaminant exposure monitoring history table below.
2. From the NOSHC:1003 (1995) *Adopted National Exposure standards for Atmospheric Contaminant in the Occupational Environment* determine what the exposure standard is for your identified atmospheric contaminant. Exposure limit may be expressed in a Time Weighted Average (TWA) and/or Short Term Exposure Level (STEL).
3. Use the Risk Assessment graph to assess intensity of the atmospheric contaminant.

Example: Bob is a miner and mines in hard rock 8 hours a day. Time Weighted Average is the appropriate standard for comparison. The atmospheric contaminant identified is crystalline silica.

Bob has obtained the last 4 exposure monitoring reports measuring crystalline silica. Bob has also obtained the NOHSC document 1003. If Bob worked longer than this, the exposure standard would be recalculated to reflect the extra hours. The recalculation would typically see a reduction in exposure limits with increased working hours.

[4] National Occupational Health and Safety Commission (1995) Adopted national exposure standards for atmospheric contaminant in the occupational environment, Australia.

Bob's Example Atmospheric Contaminant Exposure Monitoring History Table				
Atmospheric Contaminant	Crystalline Silica	Exposure Standard	0.05 mg/m^3	TWA
			0.15 mg/m^3	STEL

Date of Atmospheric Contaminant Exposure Monitoring	Atmospheric Contaminant Exposure Monitoring Results	Risk Rating Red, Orange or Green	
		TWA	STEL
27 / 8 / 06	0.014 mg/m^3	Green	
13 / 1 / 08	0.039 mg/m^3	Orange	
20 / 1 / 09	0.047 mg/m^3	Orange	
19 / 5 / 10	0.07 mg/m^3	Red	

Atmospheric Contaminant Exposure Monitoring History Table				
Atmospheric Contaminant		Exposure Standard	mg/m^3	TWA
			mg/m^3	STEL

Date of Atmospheric Contaminant Exposure Monitoring	Atmospheric Contaminant Exposure Monitoring Results	Risk Rating Red, Orange or Green	
		TWA	STEL
__ __ / __ __ / __ __	mg/m^3		
__ __ / __ __ / __ __	mg/m^3		
__ __ / __ __ / __ __	mg/m^3		
__ __ / __ __ / __ __	mg/m^3		
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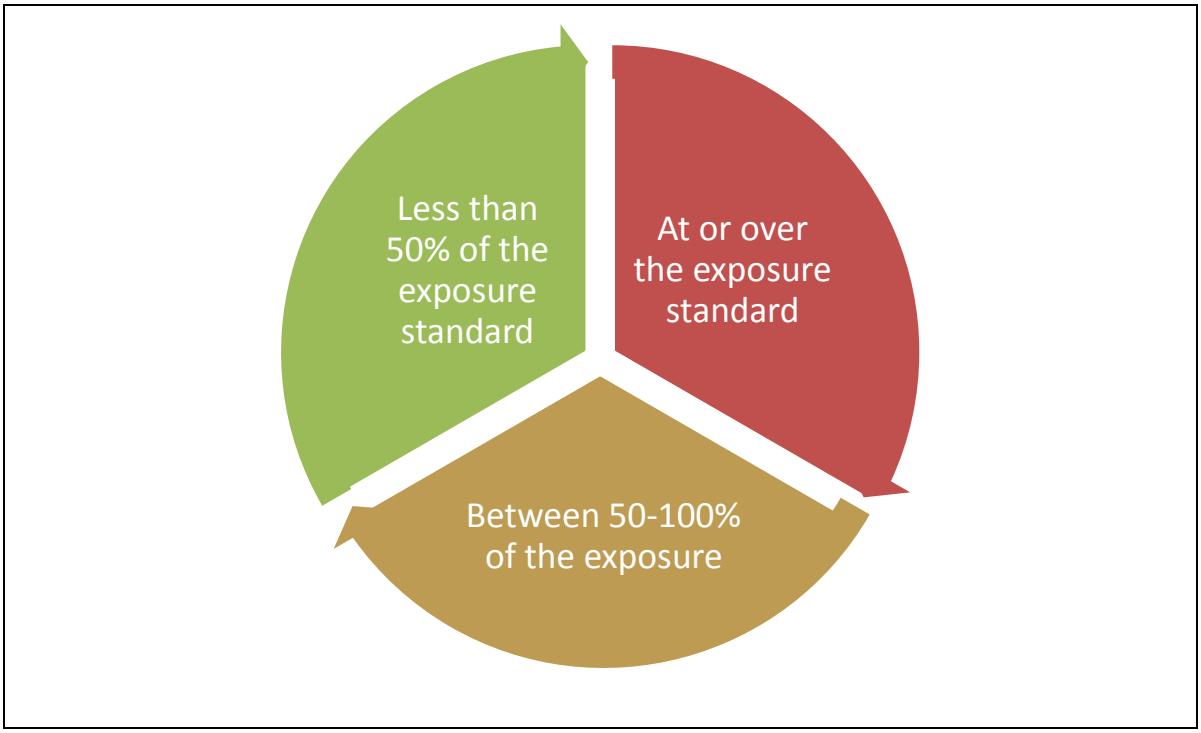

International Council of Mining and Metals (2009) Good practice guidance on occupational health risk assessment, UK.

E

Are the past results consistent?

- ☐ Yes
- ☐ No

If you answered yes, are the results consistently?

- ☐ Red
- ☐ Orange
- ☐ Green

Are the most recent atmospheric contaminant exposure monitoring results?

- ☐ Red
- ☐ Orange
- ☐ Green

F Time Weighted Average (TWA)

Time weighted average is an exposure limit that has been established based on the average tolerance of exposure of the atmospheric contaminant within an 8 hour period, 5 days a week[5].

Are you exposed to your atmospheric contaminant more than 8 hours per day?

No	Yes

Are you exposed to you atmospheric contaminant more than 5 days a week?

No	Yes

[5] *National Occupational Health and Safety Commission (1995) Exposure standards for atmospheric contaminants in the occupational environment, 3rd edition, Australia.*

6 Short Term Exposure Limits (STEL)

STEL are limits that have been established for atmospheric contaminants that have been identified where higher exposures can be tolerated in small periods[6]. The criteria for STEL is the exposure should not be more than 15 minutes, nor should the frequency of exposure exceed more than 4 times a day with a minimum of 60 minutes break between exposures.

This exercise should only be conducted if a STEL has been established for your identified atmospheric contaminant. It would not be appropriate to assess a STEL for an atmospheric contaminant that does not have an established STEL.

Example: Charlie is responsible for cleaning out the ball mill. During personal sampling, crystalline silica was measured at 0.25mg/m^3. It typically takes Charlie 2.5 hours to complete the task.

This example exceeds both Time Weighted Average and Short Term Exposure Limit. It exceeds the Short Term Exposure Limits because Charlie works more than 15 minutes per exposure.

G

Does your atmospheric contaminant have a STEL?

- ☐ Yes
- ☐ No

If you answered no, you can skip the next exercise.

Exposure Length

The following assessments look to identify if and where you may be exceeding your STEL. Short Term Exposure Limit Assessment 1 assumes that the time on a task is 15 minutes or less. The assessment analyses how often you conduct the task and the length of break between exposures.

Analyse your short term exposure and tick the relevant box.

Example: Charlie only cleans the ball mill once throughout the day and is only exposed once in a day so he would tick "less" in the "4 times a day" field. This would also mean that he would tick "More" in the "60 Mins Between Successive Exposure" field.

Short Term Exposure Limit Assessment 1						
Exposure Length Assessment	4 Times a Day			60 Mins Between Successive Exposure		
15 Mins	Less	Equal	More	Less	Equal	More

National Occupational Health and Safety Commission (1995) Exposure standards for atmospheric contaminants in the occupational environment, 3rd edition, Australia.

H

Frequency

Short Term Exposure Limit Assessment 2 assumes that frequency is 4 times a day or less and analyses the amount of time you spend on task and the length of break you get between exposures.

Example: Charlie works on cleaning the ball mill for 2.5 hours so he would tick "More" in the "15 Mins" field. As he assessed above he only does it once throughout the day so again he would tick "More" in the "60 Mins Between Successive Exposure" field.

Short Term Exposure Limit Assessment 2						
Frequency	15 Mins			60 Mins Between Successive Exposure		
4 Times a Day	Less	Equal	More	Less	Equal	More

National Occupational Health and Safety Commission (1995) Exposure standards for atmospheric contaminants in the occupational environment, 3rd edition, Australia.

[6] *National Occupational Health and Safety Commission (1995) Exposure standards for atmospheric contaminants in the occupational environment, 3rd edition, Australia.*

I

Break Length Between Exposure

Short Term Exposure Limit Assessment 3 assumes that the break between successive exposures is 60 minutes or more and analyses the frequency and length of time spent on task.

Example: Charlie only conducts the task once throughout the day so same as above he would tick “less” in the “4 Time a Day” field but he works more than 15 minutes on the task so Charlie would tick “More” on the “15 Mins” field.

Short Term Exposure Limit Assessment 3						
Break Length Between Exposure Assessment	4 Times a Day			15 Mins		
60 Mins Between Successive Exposure	Less	Equal	More	Less	Equal	More

National Occupational Health and Safety Commission (1995) Exposure standards for atmospheric contaminants in the occupational environment, 3rd edition, Australia.

J

Prioritising Risk Management

Determining what factor increases the likelihood of a negative health consequence.

Example: Charlie assessed the consequence as permanent illness/death, intensity was more than the STEL, the STEL assessment showed that the task was longer than 15 minutes, less than 4 times a day, with more than 60 minutes between successive exposures and the TWA was not more than 8 hours and not more than 5 days a week.

Consequence	Likelihood							No of red Risk Ratings
	Intensity		STEL			TWA		
	TWA	STEL	Length	Frequency	Break	Length	Frequency	
RED	Green	Red	Green	Red	Green	Green	Green	4
			Green	Green	Red			
Red Rating	Immediate Intervention		Immediate action is required to reduce exposure. Identify whether your exposure risk is from intensity, frequency or length and implement controls.					
Orange Ratings	Reinforce Control Measures		Evaluate current controls and determine what further controls are needed.					
Green Ratings	Monitor Existing Controls and Exposure		Continue to monitor the effectiveness of controls and take appropriate action when needed.					

Consequence	Likelihood							No of red Risk Ratings
	Intensity		STEL			TWA		
	Recent	Average	Length	Frequency	Break	Length	Frequency	
Red Ratings	Immediate Intervention		Immediate action is required to reduce exposure. Identify whether your exposure risk is from intensity, frequency or length and implement controls.					
Orange Ratings	Reinforce Control Measures		Evaluate current controls and determine what further controls are needed.					
Green Rating	Monitor Existing Controls and Exposure		Continue to monitor the effectiveness of controls and take appropriate action when needed.					

International Council of Mining & Metals (2009) Good practice guidance on occupational health risk assessment, London (UK).

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