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This presentation is specific to the respiratory protection needs of the coal mining industry. Many of the concepts outlined within are highly relevant to other industries, but have been placed into a coal mining context.

Respiratory Protection for Coal Mining

Session 1 – Airborne Hazards & Exposures

Session 2 – Respirator Selection

Session 3 – Fit and Wear time

Session 4 – Maintenance

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Session 1 – Covers the main hazards, health effects and typical exposures encountered in coal mining. We will cover both gas and particulate hazards, exposure levels and exposure standards.

Session 2 – In this session we will cover the principles of respirator selection, the 3 factors to be considered and an overview of some 3M respirators that fit the selection criteria for the coal mining industry.

Session 3 – Session 3 will cover the correct fitting procedures of the respirators selected in Session 2. The importance of fit testing, and fit checks that wearers should conduct each time a respirator is fitted to make sure it is being correctly worn. Session 3 will also cover the topic of wear time and its importance to respiratory protection.

Session 4 – Our last session will cover the care and maintenance of Airstream mining helmets

Session 1

When selecting respiratory protection,it is vital to know what airborne hazards are present in the environment, this session will briefly cover:

Common dusts, mists and fumes encountered in mining environments

Diesel Particulate matter (also known as DPM or DP) and the gaseous products in diesel emissions

The exposure levels for these contaminants

Dusts, Mists & Fumes

- Dust
  - Crushing, Cutting, Sanding etc
  - *Eg Coal Dust, Crystalline silica,*
- Mist
  - Airborne droplets from Spraying etc
  - *Eg Oil mist*
- Fume
  - Fire, Hot Work processes
  - *Eg Welding Fume*

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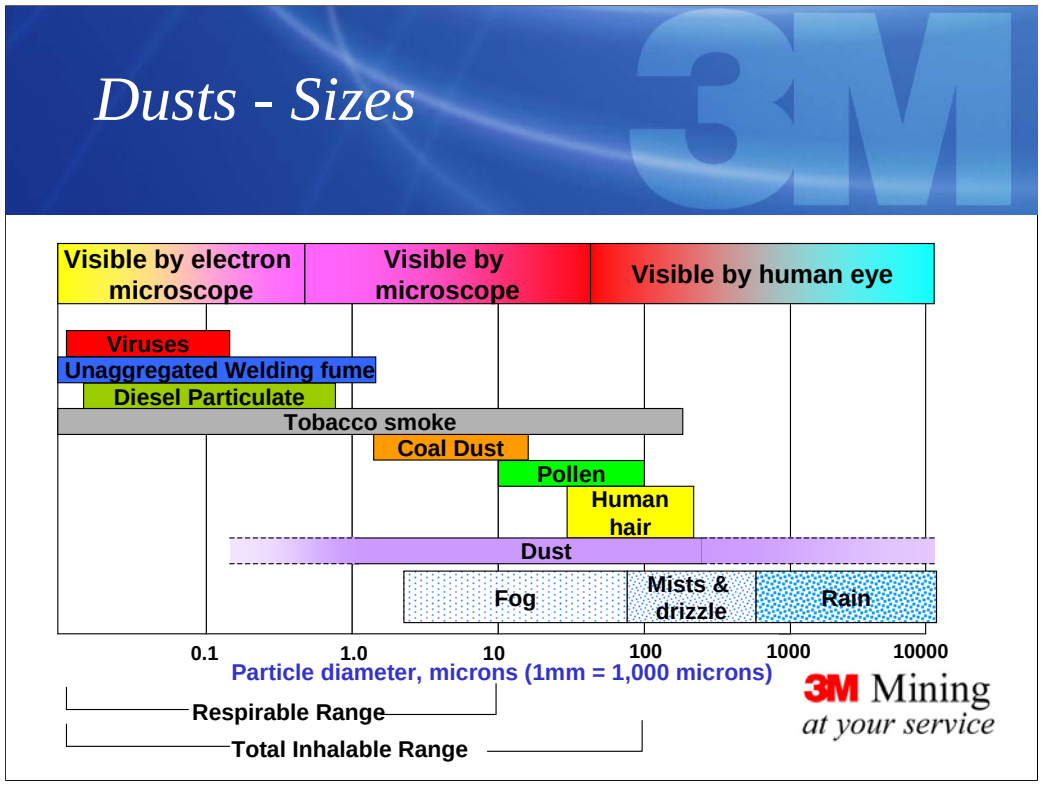
Particulates are classified in Australian Standard AS/NZS 1715 into 3 main types:

Dusts – solid particles generated by mechanical means such as crushing, cutting & sanding.

Mists – airborne droplets of liquid suspended in air. They are usually formed by condensation of vapour of by atomisation of a liquid.

Fumes – formed when material from volatilised solid condenses into small particles. Hot work processes such as welding, soldering and brazing generate fume.



The key aspects of dust mist and fumes lies with the particle sizes typical to each. Mechanically generated particles such as those from dusts and mists have a size range that is considerably greater and a larger proportion of non respirable sized particles.

Thermally generated particles such as fumes on the other hand have a considerably smaller particle size and a large proportion of respirable size particles.

Dusts, Mist & Fumes - Effects

- Coal Dust
  - –Coal workers pneumoconiosis
- Crystalline Silica
  - Silicosis
- Welding fume
  - Varies with type of metals in the fume. Eg galvanised steel – metal fume fever from Zinc Oxide

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Commonly encountered dusts, mists and fumes in coal mining are

Coal Dust – respirable sized particles of coal dust are responsible for the condition known as coal workers pneumoconiosis. Larger sized particles are removed from the respiratory tract with no adverse effects. Photo on the right is of a lung from a person with coal workers pneumoconiosis. Note the blackened areas of coal dust deposition and large empty spaces in the lung tissue.

Crystalline silica – Predominantly due to quartz. Respirable sized particles released from rock. Causes a pulmonary fibrosis where the elasticity and gas exchange regions of the lung are reduced over time. This increases the resistance to breathing causing increased strain on the circulatory system.

Welding fume – The effects of welding fume exposure vary depending on the type of metals being welded. For example welding galvanised steel will release Zinc Oxide which can cause a temporary illness known as metal fume fever where influenza like symptoms last for about 48 hours

Diesel Particulate Matter

- Formed from combustion
- Elemental carbon (EC) particles with adsorbed chemicals (OC)
- EC stick together to form chains or clumps

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In the past diesel emissions were not considered to be of great significance. However, with advances in knowledge and medical science much greater emphasis is now being placed on exposure to diesel emissions worldwide.

Diesel particulate matter is composed of very small particles of carbon which stick together to form chains or clumps (these are known as the Elemental carbon or EC component). Stuck to the surface of the EC are organic compounds formed from the incomplete combustion of diesel (these are known as the Organic carbon or OC component)

The sizes of the DP is mainly less than 1 micron.

Diesel Particulate - Effects

- High concentrations cause irritation
- Due to the size and composition of DP it is easily inhaled and retained in the lungs.
- On the basis of animal studies has been classified by the International Agency for Research on Cancer (IARC) as ‘probably carcinogenic to humans”

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Where levels of DP are >0.2mg/m3 eye irritation and discomfort from the odours are more apparent.

Because DP is so small it is readily inhaled and deposited in the gas exchange region of the lungs. This also allows the adsorbed OC to be delivered into the lungs.

The presence of OC which contains many chemicals shown to be carcinogenic and the results of tests on animals has led the IARC to classify DP as a group 2A carcinogen “probably carcinogenic to humans”

Gaseous Diesel Emissions - Effects

- Carbon Monoxide
  - Chemical asphyxiant
- Sulfur Dioxide
  - irritant, bronchoconstriction (airway narrowing)
- Oxides of Nitrogen (NO NO_2)
  - Respiratory irritants
- Aldehydes
  - Irritants particularly eyes

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Particulates are only one component of the emissions from diesel engines. The gases and vapours produced have their own effects. Some of the gaseous constituents are

Carbon Monoxide – (from incomplete combustion) binds with haemoglobin in the blood and reduces the oxygen carrying capacity.

Sulfur Dioxide – (from the sulfur in the fuel) dissolves in mucous membranes to form sulfurous acid which acts as an irritant on the membrane. The increased acid concentration causes the smooth airways to constrict. Long term exposure can result in chronic bronchitis. Can induce asthma.

Oxides of Nitrogen: Nitric Oxide and Nitrogen Dioxide (from the nitrogen in the combustion air) are potent respiratory irritants which are able to penetrate deep into the lung. The effects of exposure to these agents can take up to 18 hours to appear

Aldehydes – oxygen containing organic compounds from incomplete combustion, the two most prevalent being Acrolein and Formaldehyde. Acrolein and Formaldehyde are also strong irritants to mucous membranes, the eyes being particularly sensitive

Exposure Standards

Respirable coal dust	3mg/m^3
Respirable silica	0.10mg/m^3
DP	0.16mg/m^3 (MSHA Standard)
Carbon Monoxide	30ppm
Nitric Oxide	25ppm
Nitrogen Dioxide	3ppm
Sulfur Dioxide	2ppm
Acrolein	C 0.1ppm

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Exposure standards “represent airborne concentrations of individual chemical substances which, according to current knowledge, should neither impair the health of nor cause undue discomfort to nearly all workers. Additionally, the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents.

Except where modified by consideration of excursion limits, exposure standards apply to long term exposure to a substance over an eight-hour day, for a five-day working week, over an entire working life.

The exposure standards do not represent `no-effect' levels which guarantee protection to every worker. Given the nature of biological variation and the range of individual susceptibility, it is inevitable that a very small proportion of workers who are exposed to concentrations around or below the exposure standard may suffer mild and transitory discomfort. An even smaller number may exhibit symptoms of illness.

It follows from the foregoing that the exposure standards are not fine dividing lines between satisfactory and unsatisfactory working conditions, but rather that they are best used to assess the quality of the working environment and indicate where appropriate control measures are required.”

From Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:3008(1995)] 3rd Edition

Session 2 – Respirator Selection

In this session we will cover:

- Selection factors
- 3M Respirators for the Coal Mining Industry

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Session 2 will cover the key factors to be considered when selecting respiratory protection and an overview of some 3M respirators that fit the selection criteria for the coal mining industry

Respirator Selection

AS/NZS 1715 “Selection, use and maintenance of respiratory protective devices”

Influenced by 3 factors:

- Contaminant
- Task
- Operator

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Australian / New Zealand Standard 1715 covers the Selection, use and maintenance of respiratory protection. It is the foremost guide to respiratory protection in Australian and has been developed by experts from mining, fire fighting, defence, electricity, university government and employer groups.

AS/NZS 1715 outlines the respirator selection process as being influenced by 3 main factors:

•Contaminant related

•Task related

•Operator (or wearer) related

We will now go through each one in a bit more detail

Respirator Selection - Contaminant

Contaminant Related Factors

- Form – gas, particulate, both?
- Concentration, Exposure standard, Protection Factor
- Need for other PPE to protect
- Warning given by the contaminant

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First and foremost the respirator will need to have capabilities against the physical form of the contaminant. Particulates will require a filter web, whilst gases and vapours require sorbents to “soak” up the contaminant. Depending on their properties different gases and vapours need different sorbents. That is why in AS 1715 there are different classes of gas and vapour filters e.g:

A: Organic Vapours, B: Acid gases, E: Inorganic gases, K: Ammonia, G: Low vapour pressure agricultural chemicals

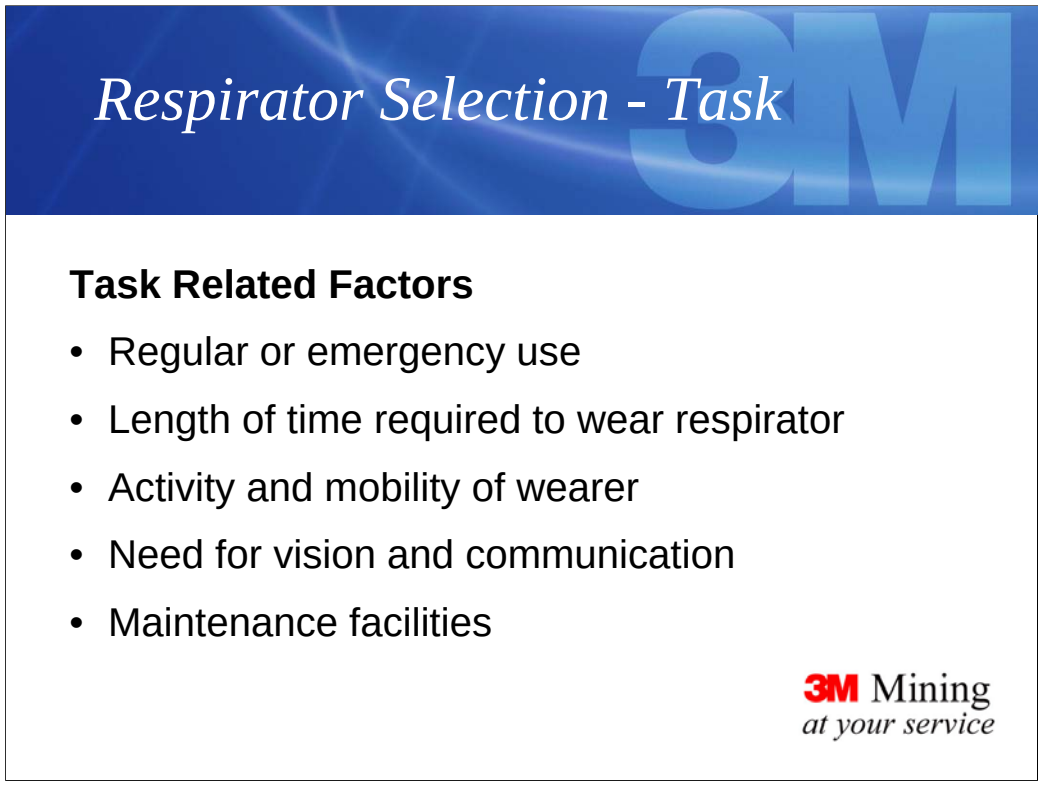
The reduction in exposure which a respirator can provide is dependent on the level of contaminant in the environment and the type of respirator. The required minimum protection factor is the factor necessary to reduce the exposure of the wearer to a level below the exposure standard or to minimise exposure to an accepted level.

It is expressed by the equation :

Required minimum protection factor= = Concentration of contaminant in environment / Exposure standard

The use of other forms of PPE such as eye protection to guard against non respiratory effects of the contaminant is another factor to be considered. Eg Ammonia affects the eyes so full face protection may need to be considered.

The degree of warning given by the contaminant if the respirator is overloaded. Where the odour threshold of a contaminant is at a level that is below health effects, any event or breakthrough can be detected by the wearer before health effects can occur. If the odour threshold is higher than



Respirator selection Factors that relate to the task are:

Whether the respirator will be used on a regular basis (i.e. day to day) or only for emergency purposes. Where regular use is expected, comfort and convenience will be a significant factor. The extended use of negative pressure respirators will impose some discomfort and where particulates are involved a gradual increase in breathing resistance will be detected .

Where strenuous activity is required the physiological load imposed by negative pressure may decrease the performance of wearers. The degree of mobility may restrict the use of air line or air hose.

Any restrictions on vision would need to be considered, particularly in tasks that require good peripheral vision. Where the task requires good clear communication with others, the characteristics of the respiratory protection can assume considerable importance.

The availability, organisational arrangements and resources to maintain respiratory protection devices need to be considered.

Respirator Selection - Operator

Operator Related Factors

- Physiological Effects
- Facial Fit
- User acceptance

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When selecting a respirator , the effect on the user and their characteristics should be investigated.

The wearing of respirators in hot environments or when undertaking strenuous exercise impose considerable physiological load on wearers. The ability of the wearer to cope with this load needs to be taken into account.

Facial fit, is a prime factor in obtaining good respiratory protection when using half or full face respirators. Facial hair around the cheeks, neck and jaw will impair the ability of respirators to seal and permit inward leakage of the atmosphere into the respirator. AS1715 contains detailed information in relation to facial fit.

Users must be confident in the ability of the respirator they are wearing to protect them and it must be comfortable, not obstructing to their field of vision and not impeding their ability to communicate when needed. If users are not accepting of the respirator, then it will not be worn the entire time they are at risk of exposure – this reduces wear time a concept we will cover later in session 3.

After considering the preceeding factors, the coal mining industry has selected the following respirators for use:

3M 8710 maintenance free cupped

3M 9913V maintenance free cupped

3M 9300 Series maintenance free fold flat

3M Airstream™ AH6TM Underground Mining Helmet

3M Airstream™ AH6HRM Underground Hardrock Mining Helmet

3M 8710 P1 Maintenance Free

- AS/NZS 1716 Rating: P1
- Galvanised steel nose clip
- Lightweight, Comfortable
- No maintenance

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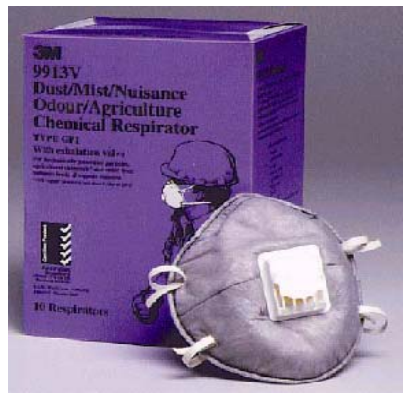
8710 are rated as P1 respirators capable of providing protection from mechanically generated particulates.

They are fitted with galvanised steel nose clips enabling them to be used in underground coal mines and lightweight only 9 grams.

3M 9913V GP1 Maintenance Free

- AS/NZS 1716 Rating: GP1
- Galvanised steel nose clip
- Cool Flow™ valve
- Lightweight ,Comfortable
- No maintenance



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9913V are rated as GP1 respirators capable of providing protection from mechanically generated particulates as well as agricultural chemicals and nuisance level organic vapours.

They are fitted with galvanised steel nose clips enabling them to be used in underground coal mines and are fitted with a cool flow valve to assist exhalation.

3M 9300 series flat fold Maintenance Free

- AS/NZS 1716 Rating: P1 or P2 versions
- Individually wrapped
- Cool Flow™ valve models
- Foldable – easy to store
- Lightweight ,Comfortable
- No maintenance

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9300 flat fold respirators are available in 4 styles, P1 filters with or without valves, and P2 filters with or without valves. They are individually wrapped in the packages enabling unused respirators to remain clean and dry in harsh environments. They are easy to store, fold up and put away.

The design of the respirators provides ease of fitting and are light weight & comfortable.

9300 series contain an aluminium nose clip which is covered by the filter material. Some mining jurisdictions do not permit the use of these in underground coal mines.

3M Airstream™ AH6TM Underground Mining Helmet

- Intrinsically safe
- ASNZS 1716 Rating: PAPR-P1 or P2
- Lightweight 1070g
- Powered by Oldham miners battery
- High impact Face protection, Type 1 Industrial helmet

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The AH6TM has a specially designed intrinsically safe motor and power system for use in environments where intrinsic safety is required. The units have been certified by SIMTARS and classified as: Ex ia I , Certificate Number AUS Ex.03 2510X.

Depending on the main filter they will provide PAPR-P1 (minimum protection factor 10) or PAPR-P2 (minimum protection factor 50) . They are powered from a standard miners battery (Oldham) which also provides power to a cap lamp attached to the helmet.

The visor provides high impact face protection and helmet conforms to AS1801 as a Type 1 industrial helmet

3M Airstream™ AH6HR Underground Hardrock Mining Helmet

- ASNZS 1716 Rating: PAPR-P1 or P2

- Lightweight 1070g
- Powered by Oldham miners battery
- High impact Face protection, Type 1 Industrial helmet

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Only difference between AH6TM and AH6HRM is the absence of intrinsic safety in the motor.

Depending on the main filter they will provide PAPR-P1 (minimum protection factor 10) or PAPR-P2 (minimum protection factor 50) . They are powered from a standard miners battery (Oldham) which also provides power to a cap lamp attached to the helmet.

The visor provides high impact face protection and helmet conforms to AS1801 as a Type 1 industrial helmet

Session 3- Fit and Wear Time

In this session we will cover:

- The correct fitting of 3M Respirators
- Fit testing
- Fit Checks
- The importance of wear time

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Regardless of the respirator selected, it is necessary to wear them right. This session will cover fitting procedures of 3M cupped (8710, 9913V) and flat fold (9300) disposable respirators. We will briefly cover the different types of fit testing procedures, fit checks and look at the effect wear time has on protection.

Fitting 3M Maintenance Free Cupped Respirators



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Fitting instructions for 3M Cupped Respirators

1. If using an 8710 – pre stretch each strap
2. Cup respirator in each hand, nosepiece at fingertips and straps hanging below hand.
3. Position respirator under chin, low on the nose. Holding respirator firmly in position take straps over head

Fitting 3M Maintenance Free Cupped Respirators



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- Position straps so the top strap is above and the bottom strap is below the ears
- Using both hands mould metal nosepiece to shape of nose. Never pinch the nosepiece with one hand as this may impair face seal
- To check fit, cup both hands over the respirator and inhale sharply. If air flows around the edges readjust nosepiece and straps and repeat fit check.

Fitting 3M Maintenance Free Flat Fold Respirators



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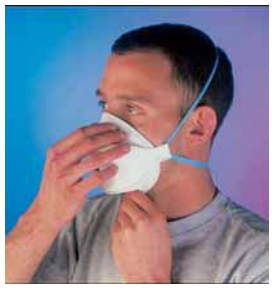
1. The noseclip is located in the top panel. Pre form the noseclip by gently bending at the centre of the panel. Hold the respirator in one hand and pull out the bottom panel to form a cup.
2. Turn respirator over to expose headbands
3. Cup respirator under chin and pull both straps over head.

Fitting 3M Maintenance Free Flat Fold Respirators



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1. Locate the lower strap below the ears and the upper strap across the crown of the head. Adjust top and bottom panels for a comfortable fit.
2. Using both hands, mould noseclip to the lower part of the nose. DO NOT pinch the noseclip using only one hand as this may result in less effective respirator performance
3. To check fit, cup both hands over the respirator and inhale sharply. If air flows around the nose, remould the nosepiece.

Fit Testing 3M Maintenance Free Respirators

- AS/NZS 1715 – fit testing requirements
- Qualitative
  - Saccharin (3M FT-10)
  - Bitrex (3M FT-30)
- Quantitative
  - Portacount
- Annual testing – ongoing monitoring of control measures

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The use of any form of risk controls (of which PPE is one) requires the employer to verify the controls are implemented and functioning as intended. In relation to respiratory protection, the best way to initially verify the respirator is correctly functioning is to perform fit testing

Additionally there are 2 considerations: Assuming there are several types available, which one fits the wearer best? AND How does the wearer know the respirator fits properly? Fit testing will answer both of these questions.

There are 2 types of facial fit tests: Qualitative and Quantitative

Qualitative – simple, inexpensive, quick, uses a challenge agent Saccharin (Sweet) or Bitrex (Bitter) aerosols. Detection of taste in mouth indicates leakage (Pass/ Fail)

Quantitative – more complex, expensive equipment, takes time. Uses a count of particles in the ambient air and inside the respirator to calculate a fit factor (number), which is compared to a predetermined factor in order to determine leakage. (Pass/ Fail)

Regardless of the type of fit testing employed, there needs to be ongoing monitoring of the control measures, there fore fit testing *"should be performed at least annually, or whenever there is a change in the wearers facial characteristics or other features which may affect the facial seal of the respirator" from AS/1715:1994*

Fit Checks

Gross determination of fit

- Each time a respirator is fitted
- Cover facepiece and inhale sharply
- No air channelling around the face seal

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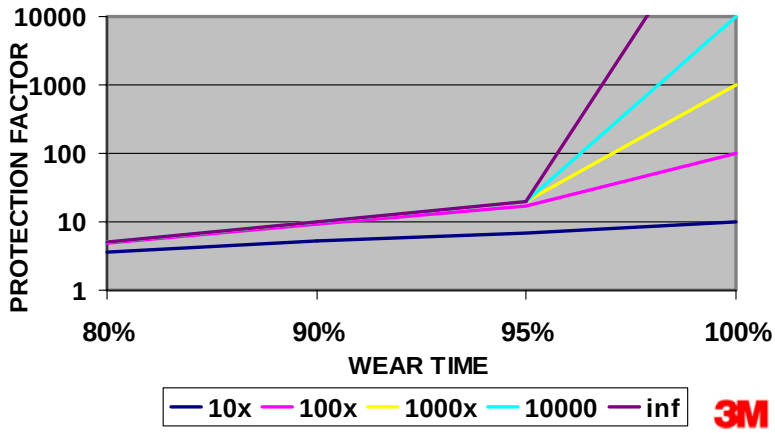
At each use wearers of tight fitting facepiece respirators should check the fit after donning by performing a negative pressure fit check. Cup both hands over the facepiece and inhale sharply. An unsatisfactory face seal is indicated by the feel of air channelling around the face seal. The respirator should be readjusted on the face until a satisfactory seal is indicated.

The Importance of Wear Time



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Regardless of the protection factors afforded by different types of respiratory protection, they will only perform at their designated level if they are worn 100% of the time the wearer is exposed. The above graph shows how even a 5 to 10% reduction in wear time dramatically reduces the actual protection factor achieved by the wearer.

Session 4 – 3M Airstream™ Mining Helmets

In this session we will cover:

- Checks prior to use
- Care & Maintenance of Airstream Mining Helmets

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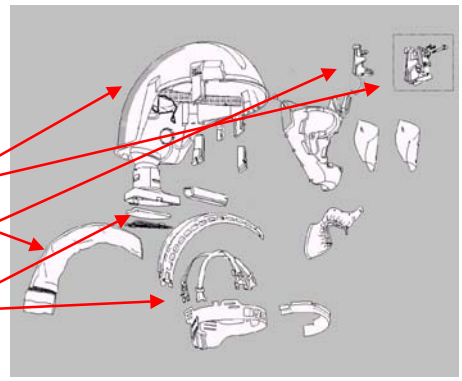
Our last session specifically covers the care and maintenance of Airstream mining helmets to ensure they keep providing you with protection day after day.

Before Use

What to Check:

- Filters
- Motor & Cap Lamp Circuits
- Adaptor & Cap Lamp Fitting
- Helmet Shell
- Adjustments
- AirFlow Testing



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Filters

- Main filter is fitted around motor housing
- Pre Filter fitted and grille closed

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Ensure the Pre-filter and Main Filter are correctly fitted to the Helmet and the Spring Clip retaining the Motor Housing is in place.

Motor and Cap Lamp Circuits

•Connect cap lamp into Adaptor unit.

•When fully located, motor should be running.

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Check Motor and Cap-lamp Circuits

The Adaptor Unit is the means through which the electrical supply is fed to the Fan motor.

To test the Lamp and Motor operation, the Cap-lamp should be presented to the Adaptor Key Spigot inverted. Turned through 180° clockwise until it locates fully into the Spring Contact. The Airstream Fan should then be running and tested in the normal way.

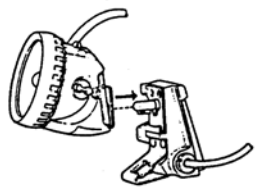
Note: A fully charged Battery MUST be used at the beginning of the work period.

Adaptor & Cap Lamp Fitting

•Connect adaptor into bracket on visor.

•Fit cap lamp

•Cables retained by clips on side and rear or helmet.



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Adaptor and Cap-Lamp Fitting

When the Helmet is required for use, the Adaptor should be placed in the Carrier Bracket on top of the Visor. The Cap-lamp is fitted to the Adaptor as illustrated in the figure The Cables are retained by the clips on the side and rear of the Helmet.

To avoid damage to the Adaptor when not in use, it should be returned to the Parking Bracket located on the rear left side of the helmet.

Helmet Shell

- Examine the helmet for signs of damage.
- Check the harness, seals and visor for damage.

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Check that the helmet shell is not broken, cracked or distorted.

Replace if necessary.
AS/NZS1800 advises that 3 years from date of issue is the ‘normal’ expected service life for a helmet shell but this can be shortened by harsh conditions or impacts. Replace if necessary

Adjustments

•Adjust the headband and if necessary helmet head height

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Adjustments

a) Headband size can be adjusted by:

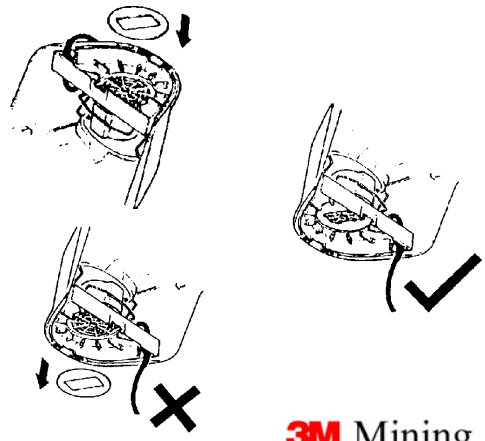
i) Pressing the edge of the Headband buckle & opening the Headband to its fullest extent.

ii) Placing the Helmet on the head & pulling the Strap through the Buckle until a firm comfortable fit is obtained.

b) Helmet head height can be adjusted by re-positioning the two Front Studs marked ‘A’ and the Rear Studs marked ‘B’ into the alternative slots in the Headband. (Ref. ‘B’ is marked on rear studs).

Airflow testing

•Check airflow using Airflow indicator over the circular grille on the motor housing



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Attach cap lamp and twist to turn motor on. Turn the Helmet upside down and remove the outer Grille and Pre-filter.

Place an Airflow Indicator (Part Number 060-44-00P) over the Circular Grille in the Motor Housing and turn the Helmet right way up.

If the indicator stays in place the airflow is sufficient. If it falls off the airflow is too low - refer to the Fault Location section of this instruction manual.

Cleaning

- All cleaning must be done in a safe area

- Avoid inhaling dusts or contaminants retained by the helmet

- DO NOT use petrol, degreasing fluids, solvents or abrasive cleaners on any part of the unit

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Cleaning

- Helmet, Visor, Head/Face Seal, Comfort band and Head band can be cleaned with mild detergent and water

- Motor Housing can be vacuumed to remove loose dust.

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Fault Location

Symptom	Possible Cause	Remedy
Increased Airflow	Filters Damaged	Replace filters
	Filters incorrectly fitted	Refit Filters
	Head, Temple or Face Seals damaged or incorrectly fitted	Refit or replace seals
Reduced Airflow	Filters clogged	Replace filters
	Motor housing clogged	Clean housing
	Discharged battery	Fit fully charged battery
No airflow	Battery disconnected	Reconnect battery
	Adaptor sub assembly fuse blown	Replace fuse
	Flat battery	Fit fully charged battery
	Motor failure	Replace motor

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Fault Location

In the event of a reduction or sudden increase of airflow, leave the contaminated environment immediately. Check:

a)That no accumulated dust is in the Motor Housing.

b)The Filters are clean, undamaged and fitted correctly.

c)The Temple Seal & Carrier and Head/Face Seal are undamaged, fitted and are sealing correctly.

d)The Cap-lamp Battery is connected and is fully charged, (substitution of batteries may be necessary).

If the Motor fails to operate, check the Cap-lamp/Adaptor and Battery System.

Airstream™ - Other Info

WARNING!

ANY ATTEMPT TO MODIFY THE AIRSTREAM HELMET, OR THE FITTING OF REPLACEMENT PARTS OR ACCESSORIES NOT APPROVED BY 3M AUSTRALIA PTY LIMITED, MAY SERIOUSLY REDUCE THE PROTECTION AFFORDED TO THE USER AND CAN INVALIDATE THE WARRANTY GIVEN BY 3M AUSTRALIA PTY LIMITED

Any questions or enquiries should be sought from your Airstream supplier or 3M Australia

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3M delivers

- **Global expertise – world leader in respiratory**
- **National trained sales force**
- **Specialist respiratory knowledge**
- **Significant R&D Investment ($AUD2b)**
- **Technical Centre of Excellence**
- **3 Full Time Qualified Hygienists**
- **Respiratory laboratory**
- **Site surveys at your request**
- **TechAssist Help Line: 1800 024 464**
- **Service Life software (Internet)**
- **Sales force enhancement tools eg. Electronic selectors (CD)**
- **Customised training programs**
- **Respirator Service Centre**
- **Representation on Australian Standards**
- **Quality assured**
  - **ISO 9001 – design/produce/install/service**
  - **ISO 9002 – excludes design**
  - **QS 9000 – Automotive industry AIC**
  - **ISO 14001 – Environmental management**

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THANK YOU