

QGN 22

Guidance Note for Management of Noise in Mines

Mining and Quarrying Safety and Health Act 1999

Coal Mining Safety and Health Act 1999

August 2014, Version 1

Acknowledgements

This guide received input from and review by Department of Natural Resources and Mines (DNRM) Mines Inspectorate (Occupational Hygiene); the Coal Mine Safety and Health Advisory Committee (CMSHAC) and the Queensland Mine Safety and Health Advisory Committee (QMSHAC). Organisations represented include: Construction Forestry Mining and Energy Union (CFMEU); DNRM Safety and Health; the Australian Workers Union (AWU); Queensland Resources Council (QRC), Electrical Trades Union (ETU), Australian Manufacturing Workers' Union and Queensland quarrying industry representatives.

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Guidance Note – QGN 22

Management of Noise in Mines

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Glossary

AS	Australian Standard
AS/NZS	Australian Standard / New Zealand Standard
CMSHA	<i>Coal Mining Safety and Health Act 1999</i>
DNRM	Department of Natural Resources and Mines
Excessive noise	Noise above the noise exposure criteria as set by Safe Work Australia
HPD	Hearing protection device
ISO	International Standard Organisation
$L_{Aeq,8h}$	<p>Eight hour equivalent continuous A-weighted sound pressure level in decibels, referenced to 20 micropascals, determined as per AS/NZS 1269.1</p> <p>This relates to the total amount of noise energy a person is exposed to in their working day and takes both time and noise level into account. Normalised to an eight hour work day.</p> <p>Note: Shift lengths greater than 10 hours and a working week greater than five days will require adjustment for shift length prior to comparison with noise exposure criteria (AS/NZS 1269.1, 2005).</p>
L_C , peak	<p>C-weighted peak sound pressure level in decibels, referenced to 20 micropascals, determined as per AS/NZS 1269.1</p> <p>Usually relates to impact or impulsive noises (such as hammering) and values above the peak can cause immediate damage to hearing.</p>
MQSHA	<i>Mining and Quarrying Safety and Health Act 1999</i>
NIHL	Noise induced hearing loss
NOHSC	National Occupational Health and Safety Commission
Noise	All sound in the workplace whether wanted or unwanted
SEG	Similar exposure group
SSE	Site Senior Executive
Tinnitus	Damage to the inner ear resulting in ringing in the ears or head

Units of measure

dB	Decibel used for measuring sound pressure levels
dB(A)	<p>A-weighted decibel. Refers to a standardised frequency response used in sound measuring instruments as specified in Australian Standard AS 1269.1. Historically it was developed to model the human ear response at low sound levels. However A-weighting is now frequently specified for measuring sounds irrespective of level and studies have shown a relationship between the long-term exposure to A-weighted sound pressure levels and hearing damage risk. [NOHSC: 2009 (2004)]</p>
dB(C)	<p>C-weighted decibel. Refers to a standardised frequency response used in sound measuring instruments, specified in Australian Standard AS 1269.1. Historically it was developed to model the human ear response at high sound levels. It is now used to measure peak noise levels. [NOHSC:2009 (2004)]</p>

Preface

Obligations under Queensland legislative and regulatory requirements

Relevant laws require risk to be eliminated or controlled to an acceptable level.

Obligations exist under the *Coal Mining Safety and Health Act 1999* (CMSHA), and the *Mining and Quarrying Safety and Health Act 1999* (MQSHA) to protect the safety and health of persons at mines; and to ensure that the risk of injury or illness to any person resulting from operations is at an acceptable level.

For a risk to a person to be at an acceptable level, operations at a mine must be carried out so that the level of risk from the operation is not only within acceptable limits but also as low as reasonably achievable.

The obligations and legislation provided in this guidance note are not exhaustive, and all obligation holders need to refer to the CMSHA or MQSHA and the *Coal Mining Safety and Health Regulation 2001* or *Mining and Quarrying Safety and Health Regulation 2001* for the most recent and relevant legislation that may apply. Legislation can be found at: http://www.legislation.qld.gov.au/Acts_SLs/Acts_SL.htm

1 Introduction

1.1 Background

Noise is a major hazard and effects are usually gradual over time

Exposure to high noise levels in mining continues to be a major hazard for workers. Workplace compensation data continues to show increasing trends of noise related deafness in workers. Overall exposure to noise in the work environment and non-working environment continues to rise, which if not managed will result in occupational noise induced hearing loss (NIHL).

If you must shout or raise your voice to be heard by a colleague one metre away, then it's likely your workplace noise levels are high and potentially dangerous, and the noise must be managed.

Managing noise risks will protect workers, improve working conditions and increase productivity

Managing noise related risks will help to:

- protect workers from hearing loss and disabling tinnitus (ringing in the ears or head)
- improve the conditions for communication and hearing of warning signals
- create a less stressful and more productive work environment (Safe Work Australia, 2011).

Occupational NIHL is preventable, although once acquired is irreversible

Exposure to excessive noise at work will lead to hearing impairment but is also associated with many other adverse health effects including annoyance, fatigue, hypertension and quality of life (Safe Work Australia, 2010).

Hearing loss is usually cumulative and increases with exposure – length of time exposed and level of noise. It is a common health problem, which can be difficult to detect as the effects build up gradually over time (Health and Safety Executive, 2013).



Hearing loss occurs due to damage to the inner ear hair cells

Occupational NIHL is mostly preventable, however once acquired is irreversible.

Hazardous noise may cause temporary hearing loss. Dependant on noise levels, after some time away from the noise, hearing may be restored (this is often experienced after a music concert). Further exposure to hazardous noise reduces the ear's ability to recover and hearing loss will become permanent.

Permanent hearing loss results from the irreversible destruction of inner ear hair cells. For sudden sharp, impulsive sounds above 140dB(C) this destruction may occur immediately (Safe Work Australia, 2011).

Management practices, workplace and equipment design can control occupational noise levels and limit worker exposure and thereby reduce occurrence of adverse outcomes (Safe Work Australia, 2010).

High incidence of NIHL in miners

In 2010–11, one quarter of workers compensation claims for miners in the .were due to deafness (Safe Work Australia, 2013).

Sound measured in dB(A)

Sound is measured in units called decibels. Exposure to sound at or greater than 85 dB(A) can cause NIHL. The louder the sound the shorter the amount of time it takes for NIHL to occur (National Institute on Deafness and other Communication Disorders, 2013).

An (A) weighting unit is applied to the decibel scale in Australia. The A weighting filter has been designed to have a similar frequency response to the ear and measurements made with this filter are expressed as dB(A). It provides a good indication of the subjective reaction to sound and of the potential for hearing damage.

The decibel scale used for noise measurement is a log scale and numbers cannot be subtracted and added as in other measurements. An increase of 3 dB on the noise scale means a doubling of noise energy. This means that the length of time a worker could safely be exposed to the noise is reduced by half for every 3 dB increase in noise level.

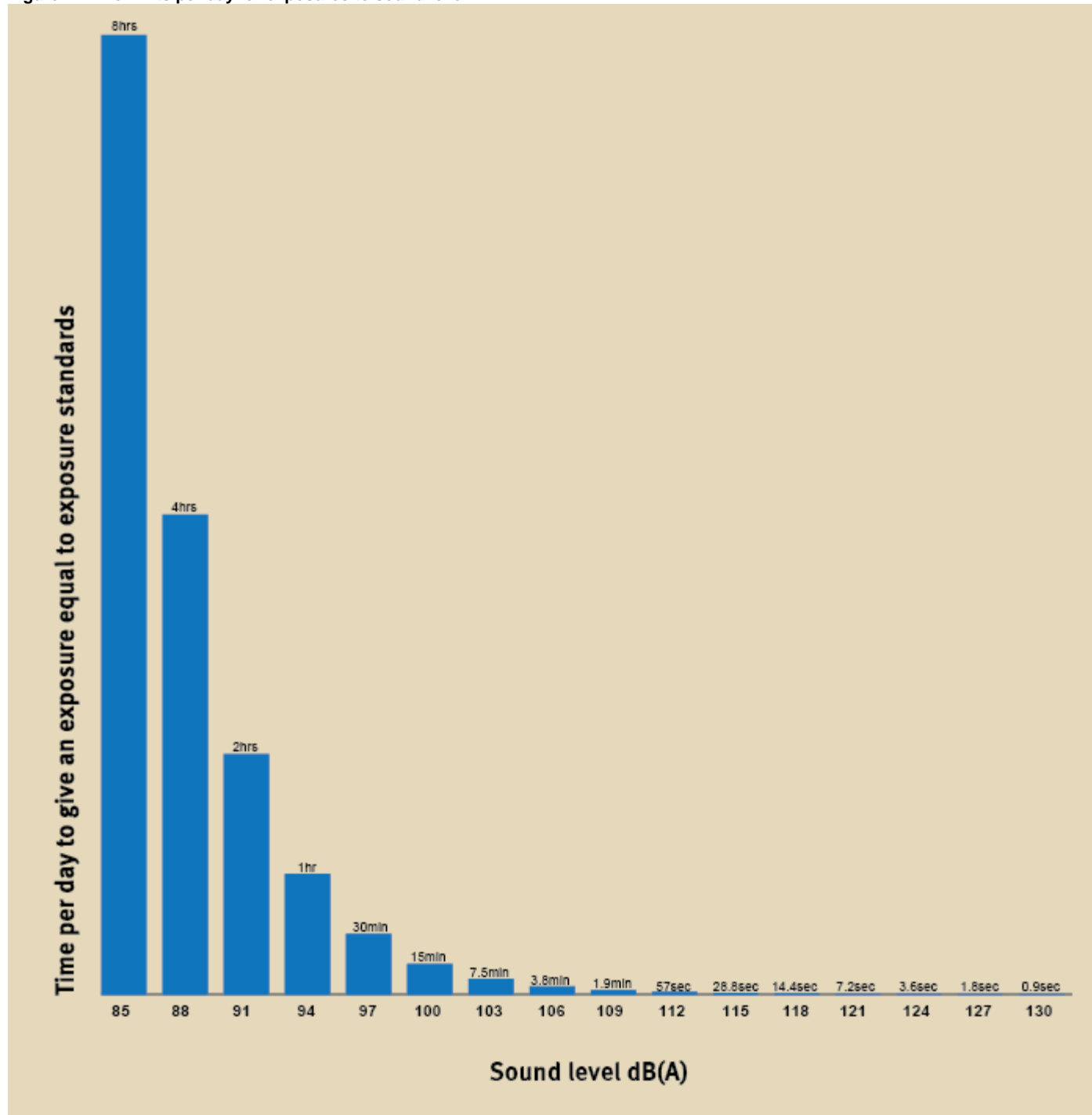
For example, if a worker can be exposed to 85 dB(A) for eight hours, then for a noise level of 88 dB(A), the exposure time can be only four hours before the exposure standard is exceeded (Safe Work Australia, 2011).

Table 1 below demonstrates the relationship between noise level and exposure time.

Table 1: Length of time for noise exposure before standard exceeded (Safe Work Australia, 2011)

Noise level dB(A)	Exposure time
85	8 hours
88	4 hours
91	2 hours
94	1 hour
97	30 minutes
100	15 minutes
103	7.5 minutes
106	3.8 minutes
109	1.9 minutes
112	57 seconds
115	28.8 seconds
118	14.4 seconds
121	7.2 seconds
124	3.6 seconds
127	1.8 seconds
130	0.9 seconds

Figure 1: Time limits per day for exposures to sound level



Provide education, information and training to workers

Education, information and training on noise awareness should be made available to all workers likely to be exposed to an equivalent eight hour noise level greater than 75 dB(A) ($L_{Aeq, 8hr} > 75 \text{ dB(A)}$) (AS/NZS 1269.0, 2005).

Noise exposure is cumulative (noise outside of work contributes to exposure)

Peak noise levels above 140 dB(C) can cause instant damage to hearing (Safe Work Australia, 2011). Workers who have significant occupational noise exposure should be informed that noise exposure is cumulative and exposure to noise outside of work contributes to their daily exposure and should be limited (AS/NZS 1269.0, 2005).

Chemical exposure and hand transmitted vibrations can cause and increase hearing loss

This means hearing damage builds up with exposure and may be aggravated through noise outside of work.

Exposure to some chemical substances and some medications can also cause hearing loss or make the effects of hearing loss worse. These substances are called ototoxic substances.

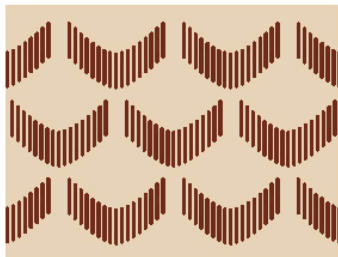
Common examples of ototoxins that may be present at mine sites include:

- lead
- arsenic
- solvents
- carbon monoxide
- some antibiotics, anti-inflammatories and aspirin medications.

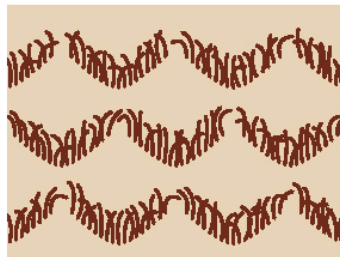
Exposure to hand transmitted vibrations can also worsen the effects of noise on hearing.

There is a greater likelihood of hearing loss with combinations of exposures to substances and substances and noise (Safe Work Australia, 2011).

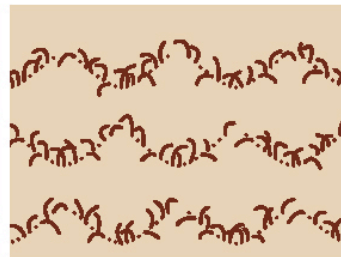
Figure 2 Hair cell damage relating to NIHL (Sourced from Centre for Hearing, Speech and Sound, May 2014.)



There are approximately 40,000 hair cells in the inner ear.



Loud noise damages the hair cells.



Too much noise damages the hair cells beyond repair, resulting in hearing loss.



1.2 Purpose of this document

The purpose of this guidance note is to provide information on how to manage risks associated with noise in mines

The purpose of this guidance note is to provide information to mining operations on how to systematically manage noise risks so that obligation holders comply with the legislative framework and reduce the incidence of NIHL in workers.

It sets out a risk management approach and the minimum requirements for a noise management plan for inclusion in the overall safety and health management system for a mine.

This document is not prescriptive, which means that individual operators and sites can develop a risk management plan that is specific to their needs. However, all plans should as a minimum consider and address where appropriate each of the main areas identified in this document.

2 Risk management

2.1 Introduction

Risk management is a continuous four step process:
1) Identify the hazard
2) analyse and evaluate the risk
3) identify and implement controls
4) monitor the effectiveness of the controls and improve them as necessary

The mine's risk management practices and procedures initially, should establish the risk management context (Standards Australia 2009a). The risk management context includes considering internal and external factors that influence the scope, objectives and key performance indicators for the risk management process (Standards Australia 2009a). Factors that could influence the risk context include:

- workers' exposure data obtained through occupational monitoring
 - changes to plant, processes or substances at the mine (including maintenance and construction)
 - changes to legislation
- or
- new knowledge about hazards or controls.

The legislated risk management process consists of:

1. hazard identification
2. risk analysis
3. risk control and reduction
4. risk monitoring and evaluation.

Further guidance about setting the risk management context and the risk management process is provided in the following references:

- *AS/NZS ISO 31000: 2009 Risk management – Principles and guidelines*
- *AS/NZS 1269.0: 2005 Occupational Noise Management Part 0: Overview and General Requirements*

The risk management process must be based on the best available information when assessing the level of risk

Risk management is based on information. That information can come from a variety of sources. These sources include:

- the experience of workers and supervisors
- industry historical data
- academic research
- equipment manufacturers
- the judgement of experts and workers
- other data, including worker exposure monitoring and health surveillance data.

Workers should be consulted during the risk management process

To be effective the risk management process must be based on the best available information (Standards Australia 2009a). The limitations of the data and information being relied on must be understood when assessing the level of risk (Standards Australia 2009a).

Workers need to be made aware of the physical, chemical, biological and psychological hazards at a mine (Standards Australia 2001). This includes having an understanding of the hazard and any risk controls relevant to their work and being able to recognise substandard conditions or practices that can lead to accidents, injuries or illness (Coal Mining Safety and Health Regulation (2001); Mining and Quarrying Safety and Health Regulation (2001); Standards Australia 2001).

Workers should be consulted during the risk management process or when changes in internal or external factors occur that alter the risk management context at a mine (Standards Australia 2009a).

2.2 Approach for assessing and managing occupational exposures

The risk management process may require specific risk assessment methods to manage occupational exposures such as noise

Assessing and managing risk associated with occupational exposures can be complex.

The approach to assessing risk around noise should be established by an appropriately qualified person.

AS1269.1 Appendix A provides guidance on an appropriately qualified person.

2.3 Hazard identification

Hazard identification is the process of anticipating or recognising plant, equipment, substances, processes, working arrangements or other environmental factors at a mine that could result in an accident, injury or illness

The Site Senior Executive (SSE) must ensure that hazard identification is done at the start of operations, throughout the mine's lifecycle and when changes occur that can affect the level of risk at the mine.

The operator must ensure that hazard identification is done during the mine's planning and design phases. This is the ideal time for a hazard such as noise to be anticipated as there is an opportunity for the operator to reduce risk to an acceptable level through the early application of the hierarchy of controls to:

- the mine plan, processing, and infrastructure design;
- the procurement and selection of plant 'buy quiet program', equipment and substances;
- working arrangements such as shift and roster design;
- other environmental factors such as prevailing weather conditions and proximity to local communities;

(Refer Table 4 for further explanation of hierarchy of controls)

Persons with an obligation under the CMSHA and MQSHA to manage risk at a mine must also identify hazards in the person's own work and activities at the mine.

To assist with the assessment of occupational exposures, workers with similar exposures can be grouped together for the purpose of

statistical analysis. Establishing a similar exposure group (SEG) can be used to reduce the number of samples and therefore the resources required to assess the risk of exposure, particularly for large work groups. The number of samples required for each SEG should be determined by an appropriately qualified person. When a baseline assessment of a SEG is completed it can be statistically analysed and the average exposure of the group compared with an exposure limit to determine if risk is at an acceptable level.

Further guidance about how to identify hazards associated with occupational exposures, establish SEGs and statistical considerations is provided in the following references.

- Simplified occupational hygiene risk management strategies: A guidebook for use in the Australian work environment, on how to meet Australian Safety and Compensation Council's requirements for employers to identify, assess and control risks arising from workplace exposures (Firth, van Zanten, & Tiernan, 2006)
- A strategy for assessing and managing occupational exposures (Ignacio & Bullock, 2006).
- Similar Exposure Groups Factsheet (available on the DNRM website)

Areas can be identified as potentially hazardous by conducting preliminary assessments.

A crude primary indicator of hazardous noise is if a worker has to raise their voice to talk to another worker about an arms length away in a noisy workplace.

Table 2 below provides noise levels in dB(A) as an indicator of common everyday noise levels.

Table 2: Point of reference sounds (Adapted from Centre for Hearing and Communication, 2014)

Home	Work	Recreation
55-70 dishwasher	95 power lawn mower	85 heavy traffic
75-85 flush toilet	95 electric drill	95-110 motorcycle
60-95 hair dryer	110 power saw, angle grinder	110 car horn
110 leaf blower	120 ambulance siren	110 MP3 player on high

Refer to Appendix 1 for mining specific noise examples.

In Appendix B of the code of practice – Managing Noise and Preventing Hearing Loss at Work – is a noise hazard identification checklist available at

<http://www.deir.qld.gov.au/workplace/resources/pdfs/noise-preventing-hearing-loss-cop-2011.pdf>

Regular inspections of the workplace will help to identify noise hazards. Use observations, discussions with workers and task based observations when possible. Take immediate action to control noise such as fixing loose panels on equipment vibrating during use, move non-operational workers away from



operational noise sources, and replace damping equipment on doors.

For current plant and equipment or when purchasing new plant and equipment, seek information on noise levels from the original equipment manufacturers.

A review of any workers' compensation data for hearing loss, and results of any audiometric testing can also help to identify if hearing loss can be attributed to specific tasks or SEGs, and the potential effects on other workers. Audiometric testing programs should comply with AS/NZS 1269.4:2014 Occupational noise management Part 4: Auditory assessment.

2.3.1 High noise is a hearing, health and safety hazard

Excessive noise may result in permanent hearing loss, interferes with communication, and increases the risks of fatigue, and cardiovascular problems

High noise levels can chronically interfere with communication and concentration.

Workers must be able to hear warning signals above any other noise in the workplace. Guidance on assessing the audibility of warning signals can be found in ISO 7731:2003 – Ergonomics – Danger signals for public and work areas – Auditory danger signals.



Persistent noise stress can increase the risk of fatigue and cardiovascular disorders including high blood pressure and heart disease.

Excessive noise may result in temporary or permanent hearing loss; the degree of which is largely determined by the intensity and duration of the sound as well as the person exposed to the sound such as their genetic make-up, health status and other factors. A common auditory effect is tinnitus – ringing in the ears.

Non-auditory effects of noise exposure and hearing loss

Physical effects	increased cardiovascular disease risk fatigue and sleeplessness increased accident and injury risk impaired communication.
Psychological and social effects	annoyance depression memory loss impaired decision making reduced quality of life lower morale and self-esteem social isolation social stigma difficulty forming and maintaining relationships.
Economic effects	employment and income disruption increased employee absenteeism increased employee turnover reduced productivity and performance.

Note: This list sourced from Safe Work Australia (2010) is not exhaustive.

2.4 Risk analysis and evaluation

Risk analysis and evaluation are the processes that determine the level of risk of injury or illnesses associated with a hazard and determines which risks need prioritisation and controls

For a health hazard such as noise, the risk is analysed using a combination of the consequence of exposure to the hazard and the likelihood that the measured level or workers' exposure will result in an adverse health effect (Firth, van Zanten & Tiernan 2006).

Where areas of potential noise hazard exist, the SSE should arrange for a competent person (guidance as per AS1269.1 Appendix A) to carry out detailed noise assessments, and establish a noise management plan.

This will help to:

- determine the exposure to noise of all workers likely to be exposed to excessive noise (reported as $L_{Aeq, 8hr}$ and L_{Cpeak});
- obtain specific information to help to decide appropriate measures to reduce noise
- check the effectiveness of control measures already in place
- assist selection of an appropriate level of hearing protection when other measures are not practical or will take some time to implement.

A continuous process of noise management should be employed to protect workers from hearing loss and create a less stressful and more productive work environment. As a minimum, follow up assessments should occur at least every five years (and when work practices change significantly) to monitor any changes in noise exposure (change in work process, plant deterioration, maintenance issues, and effectiveness of engineering controls).

The noise management plan should:

- have noise exposure goals
- have specific responsibilities for managers, supervisors and workers
- detail preferred methods for dealing with noise problems (AS/NZS 1269.0 2005).

Information gathered from sound level measurements and personal noise exposure measurement data can be used during the risk analysis process to identify the sources and causes of exposure, analyse the likelihood of exposure, and assess the effectiveness and efficiency of existing controls.



It will also show how many resources the mine may have to allocate to noise reduction work

During risk evaluation, personal noise exposure measurement data can be used to evaluate a worker's or SEG exposure by comparison with the appropriate exposure limit i.e. setting the exposure limit $L_{Aeq8 hr}$ 85 dB(A) (National Occupational Health and Safety Commission (NOHSC):1007, 2000) (or shift adjusted exposure limit) and L_{Cpeak} 140 dB(C) as the risk criteria.

Implementing controls for workers with exposure above the limit should have priority over implementing controls for workers below the exposure limit. Care must be taken as the exposure standard does

not represent a line between a healthy and unhealthy work environment. NOHSC:1007 (2000) says over long periods repeated exposure for some workers to noise between 75 and 85 dB may still present a small risk of NIHL.

When all exposures are below the exposure limit, consideration should be given to re-establishing the risk management context and lowering the risk criteria levels to 'as low as reasonably achievable'.

Safe Work Australia (2010) states '*...noise at an $L_{Aeq,8h}$ of 85 dB(A) and a peak noise level at 140 dB(C), ... protects most but not all people. Therefore, workplace noise should be kept lower than the exposure standard for noise if reasonably practicable.*'

In practice this means you should continue to reduce worker's exposure to as low as reasonably achievable as some workers hearing loss and other health effects can still occur below the exposure limit. The likelihood of effects at lower exposure levels is greater at mines where workers are also exposed to ototoxic chemicals.

Further guidance on how to analyse, comply with exposure limits and evaluate the risk associated with occupational noise exposures is provided in the following references.

- AS/NZS 1269.1: 2005 Occupational Noise Management Part 1: Measurement and assessment of noise immersion and exposure
- Managing noise and preventing hearing loss at work – Code of Practice. (see Safe work Australia website).

2.4.1 Exposure limits for noise

Noise exposure limits

$L_{Aeq, 8hr}$ 85dB(A)

The NOHSC:1007 (2000) specifies exposure to noise is measured at the worker's ear position without taking into account any protection which may be afforded by personal hearing protection device (HPD).

Table 3: National standards for occupational noise exposure

Eight hour equivalent continuous A-weighted sound pressure level	$L_{Aeq, 8hr}$	85dB(A)
C-weighted peak sound pressure level	$L_{C, peak}$	140dB(C)

2.4.2 Adjusting noise exposure levels for non-standard work schedules

If the shift length is longer than 10 hours, noise exposure levels should be adjusted to account for less recovery time between shifts

The $L_{Aeq,8h}$ exposure limit was established based on the assumption that exposure occurs in the course of an eight hour working day over a five day working week, and there are two days without exposure (recovery) in every seven days.

Because many mining work schedules do not conform to this assumption, the noise exposure level is adjusted to compensate for the increased exposure during longer work shifts and decreased recovery time between shifts.

If a worker does more than 10 hours a shift then consideration must

be given to the increased duration of exposure and reduced recovery time between exposures. AS/NZS 1269.1 provides advice for adjustments to normalised work exposure when working extended shift lengths.

Further consideration must be given when extended shift lengths are worked for more than five consecutive days. The rationale for adjusting the measured noise exposure level must be established by an appropriately qualified person (guidance provided in AS1269.1 Appendix A), who has a sound understanding of the reasoning behind the type of adjustment applied to the measured noise exposure level.

$L_{C, peak}$ noise levels are not dependent on time and therefore do not require any adjustment.

Further guidance about how to adjust exposure limits is provided in *AS/NZS 1269.1: 2005 - Occupational noise management. Part 1: Measurement and assessment of noise immission and exposure.*

2.5 Risk reduction and control

Key measure of success of risk reduction is when comparing noise exposure levels against risk criteria

Risk reduction is the process of eliminating a hazard or minimising the likelihood of injury or illness occurring (Standards Australia 2009a).

Research suggests the occurrence of NIHL (a wholly preventable disease) is still prevalent in the resources industry due to:

- reliance on personal hearing protection
- lack of knowledge on the effects of noise exposure
- low perceived risk of hearing loss
- lack of managerial commitment and support (Safe Work Australia, 2010).

To be successful, a 'whole of mine' approach is required to control exposure to noise. This will require the co-ordination of expertise and require a high level of process discipline in many functions including but not limited to :

- mine operations
- maintenance
- mine engineering
- safety and health
- training
- supply and procurement.

Controls that should be considered to reduce worker exposure to noise include:

- workplace design to trap noise
- buy quiet initiatives
- noise dampening equipment such as mufflers and silencers
- minimising impacts and drop heights of objects on hard surfaces
- turning down volume controls
- fan speeds and speeds of other components
- maintenance strategies
- work practices
- enclosed cabins
- education and training
- personal protective equipment.

The key measure of successful risk reduction is improvement against the risk criteria in the sound pressure level or noise exposure level after the selected controls have been implemented.

2.5.1 The hierarchy of controls

Examples of the hierarchy of control for noise

Persons with an obligation under the *Coal Mining Safety and Health Act 1999* (CMSHA) or the *Mining and Quarrying Safety and Health Act 1999* (MQSHA) to manage risk at a mine must, as far as reasonably practicable, apply hazard controls using the hierarchy of controls.

The hierarchy of controls should be applied to ensure workers' exposure to noise does not exceed the exposure limit. Rarely will a single control 'fix' noise problems; solutions are best found from interventions with multiple controls.

Research has shown to have effective noise control, regulatory enforcement and education for all concerned is vital in achieving reductions in NIHL (Safe Work Australia, 2010).

Examples of the use of the hierarchy of control for noise are provided in Table 4.

Table 4 - Examples of controls for noise

Elimination of the hazard	<ul style="list-style-type: none"> Eliminate the source of the noise completely by ceasing to use a noisy machine or a process that introduces noise into the work environment
Substitution with a lesser hazard	<ul style="list-style-type: none"> Substitute the noisy machine or process with a quieter one Ask about equipment noise emission levels. Purchase or hire from suppliers with noise control as a standard part of machinery, not as optional extra 'buy quiet' Change the way the job is done – use low noise working processes, such as bending metal in a vice as it is quieter than hammering into shape
Isolation of workers from the hazard	<ul style="list-style-type: none"> Use enclosure, barriers, distance, and sound absorbing surfaces to isolate the source of noise from people, such as sound absorbing surfaces in engine bays, enclosed cabins Certain activities should be done remotely away from the workshops, for example sandblasting or arc-gouging
Engineering controls	<ul style="list-style-type: none"> Modify the machine or process to reduce the noise being emitted such as ensuring optimal fan speeds and securing vibrating surfaces Control of noise emission along the transmission path

Administrative controls	<ul style="list-style-type: none"> • Do work that is noisy when fewer workers will be exposed • Change procedures to do tasks in a quieter manner (for example, gluing or bending rather than hammering) • Provide education and training programs. They should include as a minimum description and nature of noise including health effects, exposure limits, sources and causes of noise, outcome of risk analysis and evaluation for the operation, an outline of the risk management plan including goals and the role of supervisors and workers, the controls used to manage noise, risk monitoring activities, process for recognition and reporting substandard practices and conditions • Educate workers on the dangers of exposure to loud noise and the effect of hearing loss on quality of life • Educate workers about the available noise control and hearing loss prevention options. Records of training should be kept • Increase the visibility of noise control regulations on site • Do a cost benefit analysis for noise control options • Ensure maintenance programs are completed to schedule and measurement of noise immission to original equipment manufacturer values <p>Reliance on administrative controls will require regular checks to ensure compliance</p>
Personal protective equipment	<ul style="list-style-type: none"> • HPDs should be suitable to the noise levels. Overprotection has many disadvantages including difficulty in communicating and hearing warning signals, feelings of isolation and discomfort • Training, comfort and fit testing should occur before using HPDs • Ensure appropriate maintenance and storage facilities for HPDs • Example of available HPDs include, Howard Leight VeriPRO, 3M E-A-Rfit Validation System <p>Hearing protection should only be used:</p> <ul style="list-style-type: none"> • when the risks arising from exposure cannot be eliminated or minimised from other more effective controls • as an interim measure to more effective controls • when extra protection is needed above implemented noise control

	measures
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Safe Work Australia (2010, 2011)

Further guidance about solutions for noise control is provided in *AS/NZS 1269.2: 2005 - Occupational noise management. Part 2: Noise control management*.

2.6 Risk monitoring

Risk monitoring is the process of ensuring risk controls are effective; gathering further information to improve risk analysis; and indentifying changes in the risk management context and emerging risks

Risk monitoring is the process of monitoring and reviewing all parts of the risk management process and can be a periodic or unplanned activity (Standards Australia 2009a).

The SSE must ensure the mine and local environment is monitored throughout the lifecycle of operations at the mine and when changes occur that can affect the level of risk at the mine.

Persons with an obligation under the CMSHA or MQSHA to manage risk at a mine must monitor the level of risk and the adverse consequences of any residual risk that exists.

The aims of risk monitoring are to:

- review progress with the implementation of controls
- ensure controls are working as designed
- incorporate new research, trends or industry data into risk management processes
- obtain additional information to improve the risk analysis process
- ensure the risk management context and risk management processes are based on 'best available information', including emerging risks, advances in technology, new research, or industry trends.

Continuous monitoring of noise reduction efforts is useful to keep noise risks under control. Monitoring can include:

- periodic audits of management systems
- regular inspections of plant, equipment and work processes
- ongoing monitoring of condition and using noise control equipment and personal protective equipment
- assessment of noise levels on a regular basis and after any changes that significantly alter noise exposure.

2.6.1 Risk communication

There is an obligation to provide information to workers so they can do their job and not be exposed to an unacceptable level of risk.

All persons with an obligation under the Act to manage risk at a mine should be informed of their role in reducing noise.

The SSE should ensure there are formal opportunities to pass on information to enable adequate planning and control of operations for incident prevention and for the level of hazards present in the mine's work environment.

For example, noise exposure monitoring results for a SEG of workers can be used to highlight exposure outcomes, educate the workforce and help with practical solutions.

In addition all workers who participate in personal noise monitoring programs should be provided with a copy of their individual exposure results and given a basic interpretation of the recorded level.

2.6.2 Health surveillance

Health surveillance is a type of risk monitoring used to detect the effects of hazard exposure.

Health surveillance is a risk monitoring activity that can be used to assess if controls are working as designed or to identify trends or emerging risks to workers' health.

Audiometric testing should be considered for workers who are exposed to noise above the exposure limit set by Safe Work Australia or by the organisation's noise policy (whichever is lower) and/or ototoxic agents (Appendix C, AS/NZS 1269.0). The intention of audiometric programs are:

- identification and documentation of hearing loss
- early detection of deterioration of hearing in workers exposed to excessive noise
- to direct workers with hearing loss to appropriate rehabilitation programs
- provide communication or warning systems that may be required for workers with hearing loss such as volume controlled telephones and signs.

It is recommended that workers' exposure monitoring results be discussed with an experienced medical practitioner to determine if a health surveillance program is appropriate and to determine the frequency of any audiometric testing.

All audiometric testing results should be discussed and explained with the workers in simple terminology.

All audiometric testing should be performed as per AS/NZS 1269.4. It should be noted that audiometric testing is not a protective measure for noise exposed workers but is part of a comprehensive noise management program (Safe Work Australia, 2011).

2.6.3 Monitoring workers' exposure

Noise monitoring must meet certain requirements for it to be valid.

Monitoring is required when a hazard such as noise has the potential to exceed exposure limits; or the level of risk from the hazard may vary.

When workers or SEG noise exposure level measurements are used for comparison with an exposure limit, the monitoring must be conducted at the workers ear position (without taking into account any protection, which may be afforded by personal hearing protectors) and, unless otherwise stated, must meet relevant Australian Standards for noise measurement and assessment.

Sound pressure level measurements not measured at the worker's ear position cannot provide personal exposure information and should never be used to demonstrate compliance with an exposure limit.

Area sound pressure level measurements can be useful particularly when identifying specific noise sources, producing noise contour maps, establishing hearing protection zones or for assessing the effectiveness of implemented control measures.

Further guidance about measurement and assessment of noise is provided in the AS/NZS 1269.1: 2005 - Occupational noise management. Part 1: Measurement and assessment of noise immission and exposure.

A noise monitoring program can be used to assess if a workers' exposure to noise is at an acceptable or unacceptable level.

The approach to implementing a noise monitoring program should be established by an appropriately qualified person (Guidance on appropriately qualified person as per AS1269.1 Appendix A).

Exposure assessment requires a sound understanding of the:

- work environment
- workforce
- work processes and equipment
- nature of the hazard
- establishment of a SEG
- strategies for assessing exposure
- methods of sampling and analysis
- relevant statistical techniques
- interpretation of results.

The noise monitoring program should be documented and state the exposure assessment goals and strategy. The program should be incorporated into the noise management plan.

The monitoring program will:

- determine the noise exposure of workers or SEGs in terms of $L_{Aeq,8h}$ and L_{Cpeak}
- obtain more specific information that will help to decide what measures to take to reduce noise
- check on the effectiveness of any control measures which are already in place
- assist in selection of HPDs to supplement other controls, where other measures not practicable or where controls will take some time to implement.

Further guidance about how to establish a monitoring program is provided in the following references.

- Simplified monitoring strategies: A guidebook on how to apply NOHSC's exposure standards for atmospheric contaminants in the occupational environment to Australian hazardous substance legislation (Grantham, 2001).
- A strategy for assessing and managing occupational exposures (Ignacio & Bullock, 2006).

Changes to plant or processes and the results of previous noise exposure assessments can be used to determine how often worker exposure should be reassessed

Reassessment of worker exposure is required throughout the lifecycle of operations at a mine and when changes occur that can significantly alter the level of risk at a mine. Change management practices and procedures should require reassessment of worker exposure when there has been change to plant or processes at the mine.

Management of change is not the only reason to conduct risk monitoring. Reassessment of worker exposure can also be used to verify the effectiveness of newly implemented risk controls and also to detect subtle deterioration of these risk reduction measures over time.

The frequency and purpose of reassessment required for each SEG should be determined by an appropriately qualified person (Guidance provided by AS1269.1 Appendix A).

An assessment should be carried out at least every five years to monitor changes in work practices and as a measure of deterioration of equipment, changes in work processes, new production processes and effectiveness of engineering noise controls (AS/NZS 1269.1).

Note: Five yearly assessments are a minimum. A continuous process of noise management should be employed to protect workers from hearing loss and create a less stressful and more productive work environment.

Determination of the frequency of reassessment should be based on the results of previous monitoring. In some cases monitoring may be infrequent or not recommended.

For example, where the previous average exposure of the SEG is very low, for example, < 10% of the exposure standard, reassessment is not warranted, unless a significant change occurs. Similarly, where the average SEG exposure is many times higher than the exposure standard, reassessment is not justified until risk reduction measures have been implemented.

It should be noted that where SEG exposure is many times higher than the exposure standard, some form of risk monitoring may still be required to determine if the hearing protection factor of HPDs continues to remain adequate for the level of exposure.

Further guidance about how to establish the frequency of risk monitoring and exposure reassessment is provided in the following references.

- Simplified monitoring strategies: A guidebook on how to apply NOHSC's exposure standards for atmospheric contaminants in the occupational environment to Australian hazardous substance legislation (Grantham,2001)
- A strategy for assessing and managing occupational exposures (Ignacio & Bullock,2006)

3 Noise management plan

Where noise is a hazard at a mine, a noise management plan should be developed and documented in consultation with mine workers

It is recommended that a documented and auditable hazard management plan is established if it is identified that workers may be exposed to noise above exposure limits at the mine.

The management plan should:

- align with the goals and objectives of the mine's safety and health policy and management system
- be established in consultation with mine workers and the mine's risk management practices and procedures
- address all relevant operations at the mine
- be integrated and compatible with the mine's safety and health management system.

To be effective, the noise management plan should cover some minimum requirements

The purpose of a management plan is to consolidate information about the hazard. It should identify, analyse and assess risk, document controls and provide references to existing elements of the mine's safety and health management system.

The noise management plan should include or make reference to the following minimum requirements.

- Facility description, that describes the source and magnitude of the hazard.
- Objectives, targets and performance indicators, including achievement timeframes.
- Statement designating responsibility for achievement of objectives and targets referenced to the mine's management structure.
- Demonstrated access to competencies in:
 - workers' noise exposure level monitoring and analysis
 - sound pressure level measurements and checks
 - noise control engineering
 - health surveillance.
- Risk identification and analysis outcomes.
- Risk reduction controls to limit worker's exposure including:
 - elimination
 - substitution
 - isolation
 - engineering (including maintenance of engineering controls)
 - administrative controls (including policies, procedures and rules, induction, education and training requirements)
 - using personal protective equipment.
- Risk monitoring requirements including:
 - noise monitoring program
 - sound pressure level measurements and checks
 - audiometric testing
 - record keeping requirements (process for communicating and reporting sub-standard practices/conditions; and the occurrence of incidents or ill health)
 - provision for periodic review and improvement of the plan.

The effectiveness of the noise management plan must be reviewed and audited by the operator of the mine.

The operator of the mine is required to review and audit the effectiveness of the mine's safety and health management system including subsystems such as the noise management plan to ensure risk to persons from operations is at an acceptable level.

Further guidance about how to review the effectiveness of the noise management plan is provided in the following reference available on the DNRM website.

Guidance Note QGN09 – Reviewing the effectiveness of safety and health management systems. (see DNRM website)

Appendix 1 - Examples of mining noise exposure levels

Underground mining

Operation/task		
Longwall mining		
• beside operating shearer and chain conveyor	94	1 hr
• beside operating shearer	90	2.5 hrs
Shaft sinking		
• on stage beside operator with grab working	106	4 mins
• on stage only air hydraulic motor working	110	90 secs
Underground coal transport		
• shuttle car discharge coal onto belt (high rate)	93	80 mins
• at drivehead at junction of conveyors, coal running	94	1 hr
Roof bolting		
• Falcon, roof bolting in operation	112	58 secs
• Borer, Joy single boom drill	96	38 mins
Continuous miner	94	1 hr
• Joy CM, miner filling, beside operator		
Crusher	99	19 mins
Underground		
• ventilation fans	90 - 100	15 mins – 2.5 hrs
• jumbo drill	103 - 106	8 – 9 mins

Surface mining

Operation/task	Sound level dB(A)	Maximum unprotected exposure time
Coal preparation plant		
• beside crusher mill	102	10 mins
• beside operator of vibrating screens	98	24 mins
Processing plant equipment		
• vacuum pumps	96–100	15 – 38 mins
• chutes and hoppers	100–108	2–15 mins
Earthmoving equipment		
• front end loader	104–108	2–6 mins
• dragline engine room	92–101	12–100 mins
Surface mining equipment		
Electric shovels	75–90	0–2.5 hrs
Haul trucks	84–109	9 hrs–11 secs
Grader	85–100	8 hrs–15 mins

Adapted from Coal Services, 2013, Managing noise in the coal industry to protect hearing, NSW Government.

Appendix 2 - How to wear soft foam earplugs

To get the best protection from your soft foam earplugs, remember to roll, pull, and hold when putting them in. Use clean hands to keep from getting dirt and germs into your ears!

1. Roll

Roll the earplug up into a small, thin 'snake' with your fingers. You can use one or both hands.



2. Pull

Pull the top of your ear up and back with your opposite hand to straighten out your ear canal. The rolled-up earplug should slide right in.



3. Hold

Hold the earplug in with your finger. Count to 20 or 30 out loud while waiting for the plug to expand and fill the ear canal. Your voice will sound muffled when the plug has made a good seal.



Check the fit when you're all done. Most of the foam body of the earplug should be within the ear canal. Try cupping your hands tightly over your ears. If sounds are much more muffled with your hands in place, the earplug may not be sealing properly. Take the earplug out and try again.

Available from <http://www.cdc.gov/niosh/mining/content/earplug.html>

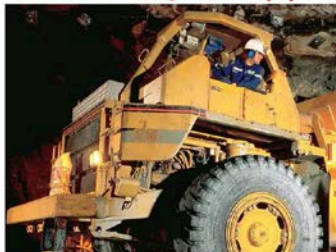
Also view <http://www.youtube.com/watch?v=5nGO0qNTCd8>

Appendix 3 – Prevent –think about design and ‘buy quiet’

Department of Natural Resources and Mines

PREVENT

Think about design and ‘buy quiet’



Thinking about design

When designing an operation or workplace layout, you should consider:

- all sources of noise,
- the interaction between sound waves, and
- how sound interacts with the environment by passing through or reflecting from surfaces or materials.

Sound waves are:

- attenuated (weakened) by absorption in air,
- refracted (bent) by winds and thermal gradients,
- directionally affected (blocked) by barriers,
- diminished with distance, and
- cancelled or amplified by reflections.



Why is managing noise important?

Occupational noise-induced hearing loss is the biggest compensable disease in Australia. The annual national compensation cost is estimated to be more than \$30 million, and the real cost is likely to be ten times this.

Available data for mining operations show that some employee groups (e.g. underground) are at particular risk.

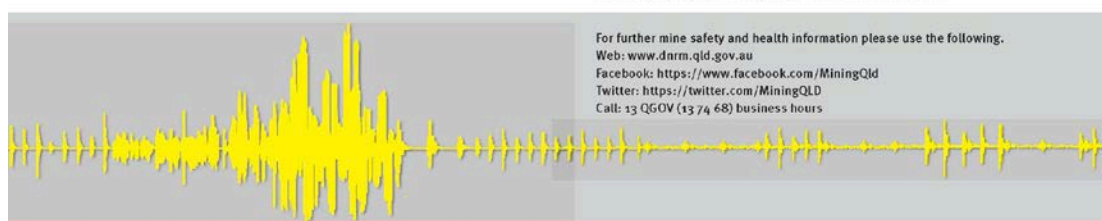
Not only are there significant hearing threshold shifts in some sections of the workforce from age 40 onwards, but initial health assessments done when people join the industry show that many already have some hearing loss. Although more prevalent in those who are 40 and older when they start, noise-induced hearing loss is being recorded for workers in the 20 to 39 age group.

So it is vital that hearing is protected at work and elsewhere.

Managing noise

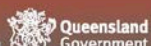
- Choose equipment conforming with noise standards (i.e. ‘buy quiet’)
- Specify noise performance criteria on engineering contracts (e.g. crusher design and construction)
- Use noise barriers, baffles or enclosures for particularly noisy equipment (e.g. crushers, compressors, grinders, pumps, gearboxes) or work (e.g. welding, sheet metal work)
- Position equipment in sheltered locations (e.g. behind earth mounds)
- Operate equipment within specification and capacity (e.g. don't overload)
- Use noise abatement accessories for earth-moving equipment (e.g. sound hood, mufflers)
- Use noise-attenuating jackets around impact equipment (e.g. jackhammer)
- Use noise-absorbing pads on the foundations of vibrating equipment (e.g. crusher)
- If practicable, turn equipment off when not in use
- Keep equipment in good condition
- Ensure site personnel understand their role in managing noise on site

Content provided by the Government of Western Australia, Department of Mines and Petroleum



For further mine safety and health information please use the following.
Web: www.dnrm.qld.gov.au
Facebook: <https://www.facebook.com/MiningQLD>
Twitter: <https://twitter.com/MiningQLD>
Call: 13 QGOV (13 74 68) business hours

Great state. Great opportunity.



Note: This is available to print as a poster by downloading it from the DNRM website.

Appendix 4 – Protect at work and home

Department of Natural Resources and Mines



PROTECT

At work and home

120 dB: Underground drilling

120 dB: Surface drilling

60 dB: Normal conversation

110 dB: Angle grinder

140 dB: Jackhammer

110 dB: Mill

110 dB: Haulage truck

140 dB: Jet plane taking off

110 dB: Maximum volume for MP3 players

110 dB: Chain saw

3 dB increase = doubling of sound energy

Once the damage is done, there is no cure

What are the signs of hearing injury?

- Sounds or speech seem muffled
- Difficulty telling words apart or picking out a voice in a crowd
- Distorted sense of loudness or hypersensitivity to sounds—sufferers may ask people to speak up, then complain that the person is shouting
- Ringing in the ears (tinnitus)
- Needing to excessively increase the volume of a television, radio or portable sound device in order to hear them
- Difficulty hearing properly on the telephone
- Difficulty hearing and understanding when children speak

What you can do everywhere

- Turn down the volume, particularly if you are wearing earphones or earbuds
- Noisy work at home or when out and about is just like noisy work at work, so protect your hearing the same way
- Get your hearing tested if you suspect you have a hearing problem

What you can do at work

- Use the noise control equipment provided and ensure it works
- Use hearing protection, such as earmuffs, earplugs, or both, and ensure it is adequate
- Put on your hearing protection before entering noisy areas
- Don't remove your hearing protection to talk in noisy areas
- Minimise the time you are exposed to noise
- Look after your earmuffs as damaged protectors won't work properly
- Insert earplugs correctly
- Don't re-use earplugs as this may cause ear infections
- Report any problems with hearing protectors or noise control equipment to your supervisor
- Ensure you are not exposed to ototoxins (i.e. 'ear poisons' such as solvents and lead)

Content provided by the Government of Western Australia, Department of Mines and Petroleum

How do I know when it is too noisy?

If you must shout or raise your voice to be heard by a workmate one metre away, it is likely that your workplace noise levels are high and potentially dangerous. Typical noise readings for some common activities are shown.

Ask whether your workplace has done a noise survey and what the results were. Also, find out whether a survey was done following implementation of the noise action plan to determine the effectiveness of noise control measures.



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Facebook: <https://www.facebook.com/MiningQld>
Twitter: <https://twitter.com/MiningQLD>
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Appendix 5 – Protect your hearing

Department of Natural Resources and Mines

Protect your hearing



Noise-induced hearing loss

Noise-induced hearing loss resulting from injury to the inner ear following prolonged exposure to noise can occur very slowly over a number of years, with changes not noticed from day to day. It can also occur very quickly following exposure to short-term excessive noise. Unfortunately, any hearing injury is irreversible and the hearing loss is permanent. This will significantly affect your quality of life.

If you must shout or raise your voice to be heard by a colleague one metre away, then it's likely that your workplace noise levels are high and potentially dangerous, and the noise must be managed.

What are the signs of hearing injury?

- Sounds or speech seem muffled
- Difficulty telling words apart or picking out a voice in a crowd
- Distorted sense of loudness or hypersensitivity to sounds - sufferers may ask people to speak up, then complain that the person is shouting
- Ringing in the ears - tinnitus
- Needing to excessively increase the volume of a television, radio or portable sound device in order to hear them
- Difficulty hearing properly on the telephone
- Difficulty hearing and understanding when children speak

What can you do to protect your hearing?

- Use the noise control equipment provided and ensure it works properly
- Use hearing protection, such as earmuffs, earplugs, or both
- Put on your hearing protection before entering noisy areas
- Don't remove your hearing protection to talk in noisy areas
- Minimise the time you are exposed to noise
- Look after your earmuffs. Damaged protectors won't work properly
- Insert earplugs correctly
- Don't re-use earplugs as this may cause ear infections
- Report any problems with hearing protectors or noise control equipment to your supervisor
- Get your hearing tested if you suspect you have a hearing problem

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4 References

Centre for Hearing and Communication, 2014, Common environmental noise levels factsheet viewed 18 February at <http://www.chchearing.org/noise-center-home/facts-noise/common-environmental-noise-levels>

Centre for Hearing, Speech and Language, 2014, Sound Chart, viewed 28 May 2014 at <http://www.chsl.org/soundchart.php>

Firth I, van Zanten D, & Tiernan G, 2006, Simplified occupational hygiene risk management strategies: A guidebook for use in the Australian work environment, on how to meet Australian Safety and Compensation Council's requirements for employers to identify, assess and control risks arising from workplace exposures, AIOH, Victoria

Grantham D, 2001, Simplified monitoring strategies: A guidebook on how to apply NOHSC's exposure standards for atmospheric contaminants in the occupational environment to Australian hazardous substance legislation, AIOH, Victoria

Health & Safety Executive, 2013, Controlling Noise at Work viewed 9 January 2013 at <http://www.hse.gov.uk/pubns/indg362.pdf>

Ignacio J, & Bullock W, 2006, A strategy for assessing and managing occupational exposures, 3rd edition, AIHA, Virginia

National Institute on Deafness and other Communication Disorders, 2013; Noise Induced Hearing Loss, viewed 10 January 2014 at <http://www.nidcd.nih.gov/health/hearing/pages/noise.aspx>

National Occupational Health and Safety Commission, 2000, National standard for occupational noise, [NOHSC: 1007 2000] 2nd edition, Australian Government, Canberra

Queensland Government, 2012, Mining and Quarrying Safety and Health Act 1999, Office of the Parliamentary Counsel, Queensland

Queensland Government, 2012, Mining and Quarrying Safety and Health Regulation 2001, Office of the Parliamentary Counsel, Queensland

Safe Work Australia, 2010, Occupational Noise Induced Hearing Loss in Australia, Safe Work Australia, ACT viewed http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/539/Occupational_Noise_induced_Hearing_Loss_Australia_2010.pdf

Safe Work Australia, 2011, Managing Noise and Preventing Hearing Loss at Work, Code of Practice, Safe Work Australia, ACT

Safe Work Australia, 2012, Occupational Disease Indicators 2012 <http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/Occupational-Disease-Indicators-2012.aspx>

Safe Work Australia, 2013, Compendium of workers' compensation statistics Australia 2010-11, Safe Work Australia, ACT, pg 83 <http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/766/Compendium%202010-11.pdf>

Standards Australia, 2001, AS/NZS 4804:2001 – Occupational health and safety management systems: General guidelines on principles, systems and supporting technique, Standards Australia, New South Wales

Standards Australia, 2005, AS/NZS 1269.0:2005 Occupational Noise Management Part 0: Overview and General Requirements, Standards Australia, New South Wales

Standards Australia, 2005, AS/NZS 1269.1:2005 Occupational Noise Management Part 1: Measurement and Assessment of noise immission and exposure, Standards Australia, New South Wales

Standards Australia, 2005, AS/NZS 1269.2:2005 Occupational Noise Management Part 2: Noise Control Management, Standards Australia, New South Wales

Standards Australia, 2005, AS/NZS 1269.3:2005 Occupational Noise Management Part 3: Hearing Protector Program, Standards Australia, New South Wales

Standards Australia, 2005, AS/NZS 1269.4:2014 Occupational Noise Management Part 4: Auditory assessment, Standards Australia, New South Wales

Standards Australia, 2009a, AS/NZS ISO 31000:2009 – Risk management: Principles and guidelines, Standards Australia, New South Wales

Standards Australia, 2009b, AS/NZS 1715:2009 - Selection, use and maintenance of respiratory protective equipment, Standards Australia, New South Wales