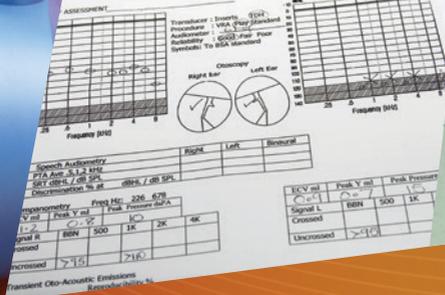


GUIDELINE

Management of noise in Western Australian mining operations



GUIDELINE

Management of noise in Western Australian mining operations



Government of **Western Australia**
Department of **Mines and Petroleum**
Resources Safety

Disclaimer

The information contained in this publication is provided in good faith and believed to be reliable and accurate at the time of publication. However, the information is provided on the basis that the reader will be solely responsible for assessing the information and its veracity and usefulness.

The State shall in no way be liable, in negligence or howsoever, for any loss sustained or incurred by anyone relying on the information, even if such information is or turns out to be wrong, incomplete, out-of-date or misleading.

In this disclaimer:

State means the State of Western Australia and includes every Minister, agent, agency, department, statutory body corporate and instrumentality thereof and each employee or agent of any of them.

Information includes information, data, representations, advice, statements and opinions, expressly or implied set out in this publication.

Loss includes loss, damage, liability, cost, expense, illness and injury (including death).

Reference

The recommended reference for this publication is: Department of Mines and Petroleum, 2014, Management of noise in Western Australian mining operations — guideline: Resources Safety, Department of Mines and Petroleum, Western Australia, 50 pp.

ISBN 978 1 92 1163 92 0

© Department of Mines and Petroleum 2014.

Except where the Copyright Act otherwise allows, reproduction in whole or part of this publication will be permitted only with the prior written permission of the Department of Mines and Petroleum. Applications for permission should be addressed to the Manager Safety Communications, Resources Safety.

This publication is available on request in other formats for people with special needs.

This publication is also available in digital format (PDF) online at www.dmp.wa.gov.au/ResourcesSafety

Further details of publications produced by Resources Safety can be obtained by contacting:

Resources Safety — Publications

Department of Mines and Petroleum
100 Plain Street
EAST PERTH WA 6004

Telephone +61 8 9358 8002 (general queries)
+61 8 9358 8154 (publication orders)

NRS 13 36 77

Facsimile +61 8 9358 8000

Email ResourcesSafety@dmp.wa.gov.au
(general queries)

RSDcomms@dmp.wa.gov.au
(publication orders)

Contents

Foreword	IV
1 Introduction	1
2 Noise exposure	4
3 Noise report	6
4 Noise control plan	8
5 Managing noise	12
Appendix 1 Legislative provisions	19
Appendix 2 Selected standards	20
Appendix 3 Glossary	21
Appendix 4 Noise exposure	25
Appendix 5 Typical mine noise levels	27
Appendix 6 Noise report	30
Appendix 7 “Buy quiet” programs	40
Appendix 8 Personal hearing protectors	47
Appendix 9 Personal noise exposure assessments	48

Guidelines

A guideline is an explanatory document that provides more information on the requirements of legislation, details good practice, and may explain means of compliance with standards prescribed in the legislation. The government, unions or employer groups may issue guidance material.

Compliance with guidelines is not mandatory but they could have legal standing if it were demonstrated that the guideline is the industry norm.

Who should use this guideline?

This guideline should be used by anyone planning or conducting mining operations in Western Australia.

Foreword

This guideline is issued by Resources Safety under the *Mines Safety and Inspection Act 1994*, and has been endorsed by the Mining Industry Advisory Committee (MIAC).

The Act

The *Mines Safety and Inspection Act 1994* (the Act) sets objectives to promote and improve occupational safety and health standards within the minerals industry.

The Act sets out broad duties, and is supported by regulations together with codes of practice and guidelines.

Regulations

The Mines Safety and Inspection Regulations 1995 (the regulations) provide more specific requirements for a range of activities. Like the Act, the regulations are enforceable and breaches may result in prosecution, fines, or directions to cease operations and undertake remedial action.

Standards

Although specific versions of Australian and other standards may apply under the regulations, references to standards in this guideline are undated and it is good practice to consult the latest versions where applicable.

Application

The provisions of this guideline apply to all mines as defined in section 4(1) of the Act.

1 Introduction

1.1 Background information

Prolonged exposure to high levels of noise can result in permanent and irreversible damage to hearing. The only effective preventative measure is to control noise exposure before hearing loss occurs.

In common with most other heavy industries, mining can expose workers to high noise levels. Drills, shovels, crushers, mills, screens and many other items of mining and mineral processing plant are inherently noisy, and most require some form of operator attendance.

Noise-induced hearing loss entails substantial economic costs. As well as the financial cost, there is a reduction in quality of life for a person with severely impaired hearing. Mining companies recognise noise as a hazard requiring control, and most have noise control programs in place. However, in many cases where action has been taken to reduce the risk of noise-induced hearing loss, it has focussed primarily on protecting people rather than reducing noise emission by engineering means.

All mines should be able to demonstrate that the risks associated with exposure to noise are being effectively managed, particularly noise-induced hearing loss. This guideline describes how noise exposure is measured (Chapter 2), including some of the more obvious sources and levels of noise in mines. It outlines the requirements for a written noise report (Chapter 3) and noise control plan (Chapter 4). Chapter 5 recommends ways to control noise in the workplace and reduce exposure.

1.2 Legislative framework

Duty of care

Under the general and specific provision for duty of care in section 9 of the *Mines Safety and Inspection Act 1994* (the Act), it is the responsibility of employers to provide, so far as is practicable, a working environment that is free from hazards. This encompasses the provision of safe working conditions and work practices appropriate to the particular circumstances existing in each workplace. This requirement includes the hazard of noise and the prevention of noise-induced hearing loss.

In addition, employers and self-employed persons have a duty under section 12 of the Act to take reasonable care to ensure their own safety and health at work. There are also general duties for workers under section 10 of the Act that require them to protect themselves and others from occupational hazards.

Employers should consult with and secure workers' active cooperation in protecting their health and eliminating noise hazards where practicable. They should establish, by joint agreement (e.g. through the safety and health committee process), procedures to minimise exposure to excessive noise.

Specific requirements

Specific regulatory requirements for noise control are described in Part 7, Division 1 of the *Mines Safety and Inspection Regulations 1995* (the regulations). The information in this guideline will assist employers and workers in understanding their obligations and rights under those specific regulations, which are listed in Appendix 1.

The regulations emphasise the need for engineering controls to reduce noise levels. Where it is demonstrably impracticable to eliminate excessive noise levels through engineering techniques and administrative arrangements, hearing protectors may be necessary. However, hearing protectors should only be viewed as an interim protective measure, to be used while permanent engineering solutions are being investigated and developed.

Australian Standard AS/NZS 1269 *Occupational noise management* provides guidance on effective methods of managing workplace noise and minimising noise-induced hearing loss. This standard and others referenced in the guideline are listed in Appendix 2.

Appendix 3 is a glossary of terms and abbreviations used in this guideline.

Other legislation

Under the *Workers' Compensation and Injury Management Act 1981*, employers must arrange baseline hearing tests for all workers in prescribed workplaces. It is the employer's responsibility under this legislation to arrange and pay for all WorkCover WA audiometric tests. Further information is available at www.workcover.wa.gov.au in the publications and forms section.



2 Noise exposure

2.1 Measuring noise exposure

Exposure to noise must be determined according to the procedures in AS/NZS 1269.1 *Occupational noise management – Measurement and assessment of noise immission and exposure*.

Noise exposure is measured to determine the need for noise control strategies — not to ascertain the true noise exposure to the worker's ear.

The attenuation provided by hearing protectors, such as ear plugs or muffs, varies widely depending on how well they fit and the length of time that they are worn. Consequently, any personal hearing protectors a person may be wearing are not taken into account when making noise measurements and calculations to ensure compliance with the regulations.

2.2 Action level for noise

There is a regulatory requirement for specific action to be taken when people are exposed to either:

- an average noise level of more than 85 dB(A) for an eight-hour working day ($L_{Aeq,8h}$)
or
- a peak noise level in excess of 140 dB(lin).

Appendix 4 shows the relationship between noise level and exposure duration if a worker's exposure ($L_{Aeq,8h}$) is to remain below the action level of 85 dB(A).

It is widely accepted that, in order for a noise level to be acceptable (although not necessarily “safe”), the $L_{Aeq,8h}$ should be not more than 85 dB(A) at the receiver's ears. Workplace noise levels below 85 dB(A) are therefore desirable. A company may adopt internal management action levels below those specified and such an approach is encouraged.

Appendix 5 illustrates some typical noise levels associated with plant used in mining operations, including attenuated examples where noise control measures have been successfully implemented.

Adjustment for extended work shifts

Although the regulations refer to eight-hour shifts, longer shifts are commonly worked throughout the Western Australian mining industry. These shifts involve greater risks to workers' hearing than indicated by the noise exposure level of $L_{Aeq,8h}$.

The noise exposure of workers engaged in duties on extended work shifts ($L_{Aeq,T}$, where T is equivalent to the time exposed) should first be normalised to an eight hour exposure, before being adjusted using the values given in Table 1. These values provide appropriate adjustments to the $L_{Aeq,8h}$ for shifts of durations of ten hours or longer. These adjustments compensate for the reduced recovery time from the effects of noise exposure, such as temporary threshold shift, between work shifts.

Table 1 Adjustments to normalised noise exposure level ($L_{Aeq,8h}$) for extended work shifts (from AS/NZS 1269.1, table 2)

Shift length (h)	Adjustments to $L_{Aeq,8h}$ (dB)
< 10	+ 0
10 to < 14	+ 1
14 to < 20	+ 2
20 to 24	+ 3

3 Noise report

3.1 Purpose of report

A noise report must be prepared as soon as practicable, but not later than 12 months from the commencement of mining operations. The report provides information on the typical noise exposure of all people at risk and outlines areas that contribute most to personnel over-exposure. It helps management to:

- decide what measures should be taken to reduce noise
- review the effectiveness of such measures.

The report may cover the whole workplace or only part of it, such as a crushing plant or workshops.

In general terms, the report is a working document that has a significant bearing on the effectiveness of the noise management program, particularly formulation of a noise policy and noise control plan.

3.2 Additional reports

An increase in noise exposure can result from:

- higher noise levels
- a longer time exposed to noise
- increased frequency of exposure to noise.

Another noise report is required if the increase is likely to be 5 dB or more.

Noise reports are required every five years until all exposures are below the action level. Once a noise report has been prepared, no further noise reports are required if introduced control measures have proved effective in maintaining noise at or below the action level, and are continuously monitored for effectiveness.

Additional noise reports may be requested by a Department of Mines and Petroleum inspector if warranted by the noise climate in or around a mine.

3.3 Report preparation

Noise reports must be based on data collected by an approved noise officer using approved procedures and approved sound measuring equipment. However, the following options are available for preparation of a noise report:

- engage a noise officer to carry out a survey at the mine
or
- use data obtained from other mines with processes or plant of the same design and function that are operated in the same manner.

The approved procedures listed in Appendix 6 set out the methods to ensure regulatory compliance for the noise report.

Note: Where campaign-style exploration is conducted on a lease, item (b) of “Approved manner for preparing noise reports” in Appendix 6 may assist exploration managers to achieve legislative compliance.

3.4 Notification requirements

The State Mining Engineer must be notified as soon as possible that a noise report has been prepared. The notification form is available at www.dmp.wa.gov.au/ResourcesSafety in the forms section.

The contents of noise reports must be communicated to everyone at the workplace, and anyone else the responsible person considers to be at risk. The noise reports must also be made available on request to any mines inspector, or worker at the mine who is exposed to noise. Options for communicating the report results include in-house training sessions, newsletters, circulars and noise hazard maps.

A hardcopy or electronic version of the current noise report and immediate previous one, if any, must be kept at the mine.

4 Noise control plan

4.1 Purpose of plan

The noise report forms the basis of the risk assessment used to devise the risk management action plan for noise. The report provides direction on the ranking of noise problems and an evaluation of available noise control treatments.

The resultant noise control plan must be prepared and implemented within six months of completion of a noise report relating to a mining workplace. It is a written document listing the noise control treatments that have been decided upon, and a timetable for their implementation.

4.2 Contents of plan

A noise control plan should include:

- a brief description of the mine, or part of the mine, and the workers to whom the plan relates
- a statement of noise objectives in terms of levels and exposure for the operators
- a brief description of the engineering and administrative noise control measures proposed by the noise officer
- a detailed description of the site's agreed engineering and administrative noise control measures, timeframes for their completion and persons responsible for implementation
- the expected reduction in noise and exposure levels resulting from implementation of engineering and administrative noise control measures
- where appropriate, a summary of required noise specifications for new or replacement plant, and approximate dates of expected purchase and installation.

4.3 Noise control policy

To support development of an effective noise control plan, the mine should develop a noise control policy stating major noise control objectives and the means for achieving them. The policy should provide managers with a foundation for planning, budgeting and reviewing progress, and evidence of compliance with regulatory requirements. It should be developed in consultation with safety and health representatives or committees.

The key elements of a noise control policy are described below.

Goals for noise exposure and peak noise levels at the mine

Specify goals such as:

- no worker's exposure ($L_{Aeq,8h}$) to exceed 85 dB(A) by a specified target year
- no worker to be exposed to noise with a level exceeding 140 dB(lin) peak.

Design goals for new plant

Set a design goal for new work areas so that workers' noise exposure is maintained at the lowest possible level.

Selection and purchase of quiet plant

Integrate the noise control policy with the rest of the organisation's structure to ensure "buy quiet" procedures (Appendix 7) are used in the selection of new plant. This minimises the need for adding noise controls later and allows for progressive replacement of existing noisy plant.

Noise control in temporary work areas

Clearly state a commitment to noise control in temporary work areas. For example:

“Any temporary work area should be screened or isolated to ensure that noise levels generated do not adversely affect workers’ hearing. If necessary, entry to such sites must be restricted to personnel wearing approved hearing protectors.”

Agreements with contractors regarding noise control and provision of information

Ensure the policy commits to provide all contractors on the mine with the information necessary to allow them to comply with the noise control and personal hearing protection procedures applicable to the site, and that contractors provide information on any noise hazards they are bringing onto site.

Audiometric testing

Include a provision for applicable workers to undergo WorkCover WA baseline hearing tests within 12 months of commencing employment, as required by the *Workers’ Compensation and Injury Management Act 1981*.

Establish a program for workers exposed to noise levels above the action level to have monitoring audiometric tests in accordance with AS/NZS 1269.4 *Occupational noise management – Auditory assessment* at a frequency appropriate to the noise exposures.

Following a baseline hearing test, workers may make a request to their employer in writing for subsequent testing to be more frequent.

Funding for noise control programs

Include a provision for the allocation of funds to implement the most cost-effective noise control program. This process should progressively reduce and, where possible, eliminate noise hazards.

Noise control policy and plan review period

Review the policy and plan annually and adjust to include controls implemented in the preceding twelve-month period, and any suggestions for improvements where necessary.



5 Managing noise

5.1 Reducing noise as far as practicable

The potential risk to hearing from exposure to occupational noise should be as low as practicable, irrespective of whether or not noise is below the action level.

In the context of regulations relating to noise, the term “practicable” involves weighing the seriousness of the noise situation against the feasibility of noise control measures. The feasibility is determined by technical, operational and economic criteria. If noise control measures are technically and operationally feasible, cost factors will require evaluation. In particular, the cost-effectiveness of various noise control measures, such as isolation or shielding, needs to be assessed before adopting the solution aimed at the maximum noise reduction.

Since determining what is practicable involves considering risk acceptance, workers should be consulted on the implementation of “reasonably practicable” control measures. Where they exist, safety and health representatives and the site’s safety and health committee provide a means through which to solicit workforce participation.

All noise control measures recommended by an approved noise officer should be assessed to determine their practicality. Records of these assessments and their outcomes should be kept.

5.2 Role of manufacturers, designers and suppliers

There are no specific regulatory requirements to be addressed by manufacturers, designers or suppliers with respect to the generation of noise. However, the general duty of care provision in section 14 of the Act places certain obligations on them to protect workers from being exposed to hazards, which would include noise.

Design of new plant

Noise control should begin with the design and planning of new installations and processes. It should be based on relevant technical knowledge, including:

- knowledge of the noise characteristics of the plant and processes to be used
- knowledge of suitable construction methods and materials
- possible isolation of operators from high noise that is difficult to control
- possible isolation of those noise sources to reduce noise impact on adjacent areas.

Preference should be given to materials and structures having a high noise attenuation factor.

Manufacture and supply of new plant

Manufacturers and suppliers should:

- ensure any new plant, including suitable noise control devices, is designed so that the noise emitted is at the lowest practicable level
- implement a testing program to assess the potential for noise hazards arising from use of their product
- provide information concerning the installation of noise-reducing attachments to maximise noise control efficiency
- provide adequate information on whether, and to what extent, a risk of noise-induced hearing loss exists as a result of the proper use of their product
- provide full information about levels of noise from their product that may give rise to a noise hazard.

Installation of new plant

Once suitable plant has been chosen, those responsible for its installation should consider:

- the number of workers likely to be exposed to the resulting noise
- the acoustic characteristics of the work environment
- the noise already present in the work environment.

Upgrade of plant or processes

Manufacturers, designers and suppliers involved in the upgrading of plant and processes should consider the quietest, most effective way of doing so. They should also ensure that the proposed plant or process is accompanied by documentation on the maintenance of noise control attachments.

5.3 Reduction of noise that exceeds the action level

Specific noise control methods should be used where people receive, or are likely to receive, noise above the action level. The term “likely to receive” is used when either:

- a formal noise report has not yet been carried out, but a preliminary survey or spot check shows that noise may be above the action level
or
- noise tests carried out on a given day show levels below the action level, whereas on another typical day, noise may be above the action level.

A clear hierarchical structure of noise control methods should be established.

Each responsible person should make a genuine attempt to reduce the noise using engineering methods such as those detailed in AS/NZS 1269.2 *Occupational noise management – Noise control management*.

If the noise is still above the action level after engineering controls are in place, the responsible person should then seek to reduce the length of time that workers are exposed to noise (e.g. by administrative arrangements, such as job rotation, or other measures as described in AS/NZS 1269.2).

If these two methods are exhausted and the noise remains above the action level, the responsible person must issue suitable personal hearing protectors to each affected person. All practicable noise control measures must still be implemented, even if they do not reduce the noise to below the action level.

5.4 Personal hearing protectors

Selection

Hearing protectors must be selected in accordance with the approved procedure in Appendix 8.

People who require, or are likely to require, personal hearing protectors must be supplied with them on an individual basis. All hearing protectors must reduce noise to below criterion sound pressure levels when calculated in accordance with AS/NZS 1269.3 *Occupational noise management – Hearing protector program*.

Attention should also be paid to the risk of overprotection at attenuated values below 70 dB(A), which may lead to a sense of isolation in the wearer and, consequently, difficulty in hearing warning signals, or a weakening of speech communication.

Signage

Signs displaying the symbol for the wearing of hearing protectors must be displayed at appropriate locations. The content, construction, location and maintenance of signs should be in accordance with AS/NZS 1319 *Safety signs for the occupational environment*.

During the noise survey, determine the extent of the affected area around a noise source where the noise level is above the action level so signage can be appropriately located.

The display of warning signs in a dynamic and changing working environment, such as underground mining operations, requires a practical approach in its application. For example, use the shaft entry to display signs instead of a working face.

Additional arrangements should be made to ensure all workers recognise the circumstances for which hearing protectors are required. Methods for achieving this include:

- attaching prominent warning notices to items of plant, where appropriate, to indicate the need for hearing protectors
- providing written instructions on how to recognise circumstances in which hearing protectors are needed.

5.5 Information and training

Each responsible person must provide:

- to anyone likely to be exposed to noise above the action level, instruction and training regarding:
 - causes and consequences of noise-induced hearing loss and impairment (e.g. tinnitus)
 - proper selection, care, use and limitations of personal hearing protectors
 - purpose of noise assessments and relationship between noise levels and exposure durations
 - location of noise sources within the work environment (Appendix 5)
 - identification of plant and areas giving rise to a noise hazard
 - quieter work techniques and practices
 - maintenance of noise control equipment
 - actions the responsible person is taking to reduce noise
 - possible alterations to work schedules and operating times for noisy plant aiming to reduce the length of time a person is exposed to noise
 - the hearing conservation program at the mine
 - availability of training packages and educational aids
 - the duty of care of workers
 - possible disciplinary actions for refusal to wear hearing protectors

- appropriate information and training to ensure that every supervisor, foreman or similar person knows of every work area under his or her supervision where hearing protectors are required to be worn, and the purpose and limitations of the hearing protectors provided .

Details of any instruction, training, retraining, assessment or reassessment on noise protection provided to a worker should be recorded by the responsible person and the record kept for a minimum of two years.

5.6 Role of workers

Everyone employed in a mine has responsibilities under the general duty of care provision of the Act. These duties require all workers to protect themselves and others from noise-induced hearing loss by:

- warning other people of the danger related to noise exposure resulting from plant start-ups or entry to noisy areas
- operating plant in a manner that produces the lowest practicable amount of noise
- ensuring that, while plant is operating, they can hear warning signals during noisy operations
- following the responsible person's instructions relating to steps to reduce noise, the length of time people are exposed to noise, and the use, storage and cleaning of personal hearing protectors
- taking care not to misuse or damage any noise control equipment or personal hearing protectors
- not modifying or damaging part of the plant or noise control equipment that may result in an increase of noise level
- making use of noise control devices and techniques
- reporting, to the responsible person, situations at the mine that may cause a noise hazard, such as defective plant and noise control equipment, wrongly fitted replacement parts or plant in need of maintenance

- reporting, to the responsible person, any immediate hearing loss resulting from exposure to noise at a mine, including any auditory effects such as tinnitus (e.g. ringing in the ears)
- cooperating with the responsible person, or a delegate completing a noise review, noise control study or noise report, by providing information to support noise assessment and control
- attending training and audiometric testing sessions.

5.7 Monitoring personal noise exposure

The monitoring of workers' exposure to noise is an important part of the risk management process. It allows existing noise control measures to be assessed to confirm their continued effectiveness.

A noise dosimeter (also known as a personal sound exposure meter) should be used to regularly measure personal noise exposure with the aim of evaluating the average exposure of workers to noise during a normal shift. The recommended procedure for approved noise officers undertaking personal noise exposure recordings is described in Appendix 9.

Appendix 1 – Legislative provisions

The parts of the Mines Safety and Inspection Regulations 1995 that are directly applicable to this guideline are listed below.

Mines Safety and Inspection Regulations 1995

Part 7 – Occupational health

Division 1 – Noise control

- r. 7.1 Terms used
- r. 7.2 All measurements to be as if ear unprotected
- r. 7.3 Action level noise
- r. 7.4 Noise to be reduced as far as practicable
- r. 7.5 Reduction of noise
- r. 7.6 Personal hearing protectors
- r. 7.7 Duty to inform, instruct and train persons about hearing risks
- r. 7.8 Noise report to be prepared
- r. 7.9 Additional noise report to be prepared
- r. 7.10 Noise reports
- r. 7.11 Duties after noise report is prepared

Note: The only authorised versions of the Mines Safety and Inspection Act 1994 and regulations are those available from the State Law Publisher (www.slp.wa.gov.au), the official publisher of Western Australian legislation and statutory information.

Appendix 2 – Selected standards

Standards Australia

AS/NZS 1269	<i>Occupational noise management</i>
AS/NZS 1270	<i>Acoustics – Hearing protectors</i>
AS/NZS 1319	<i>Safety signs for the occupational environment</i>
AS/NZS 2399	<i>Acoustics – Specifications for personal sound exposure meters</i>
AS 2533	<i>Acoustics – Preferred frequencies and band centre frequencies</i>
AS/NZS 4476	<i>Acoustics – Octave-band and fractional-octave-band filters</i>
AS IEC 60942	<i>Electroacoustics – Sound calibrators</i>
AS IEC 61672	<i>Electroacoustics – Sound level meters</i>

International Electrotechnical Commission

IEC 61672	<i>Electroacoustics – Sound level meters</i>
-----------	----------------------------------------------

Appendix 3 – Glossary

Action level	The sound pressure level above which a specific action must be taken
Approved noise officer	A person who has been approved as a noise officer by the State Mining Engineer for the purposes of the regulations
Attenuate	To decrease in intensity
A-weighted (A-wtd)	Refers to a standardised frequency response used in sound measuring instruments as specified in AS IEC 61672.1 <i>Electroacoustics – Sound level meters – Specifications</i> . It corresponds approximately to the human ear response at low sound levels
C-weighted (C-wtd)	Refers to a standardised frequency response used in sound measuring instruments as specified in AS IEC 61672.1. It corresponds approximately to the human ear response at high sound levels
dB	Abbreviation for decibel
dB(A)	A-weighted decibel
dB(C)	C-weighted decibel
dB(lin) or dB(Z)	Unweighted decibel

Decibel	The unit used to indicate the relative magnitude of sound pressure level and other acoustical quantities. The range of sound pressures commonly encountered is very large so a logarithmic scale is used, with the decibel as the unit of measurement. On the decibel scale, the threshold of hearing occurs at a sound pressure level of about 0 dB and the threshold of pain occurs at about 120 dB. As the decibel is used to describe the level of other quantities, such as sound power and vibration acceleration, it is necessary to refer to the specific quantity being measured, for example, $L_{Aeq,8h}$ or L_{peak}
$L_{Aeq,T}$	An A-weighted L_{eq} measured over a time T
$L_{Aeq,8h}$	Eight-hour equivalent continuous A-weighted sound pressure level in dB(A) referenced to 20 micropascals — the steady noise level that would, in the course of an eight-hour period, cause the same A-weighted sound energy as that due to the actual noise over an actual working day. $L_{Aeq,8h}$ is determined in accordance with AS/NZS 1269.1
L_{eq}	An average value based on the sound energy received over some known time. The L_{eq} is the continuous or constant SPL necessary to give the same energy as the actual fluctuating SPL (during the same measurement time)



L_{peak}	Peak noise level — the linear (unweighted) peak hold sound pressure level in decibels referenced to 20 micropascals and measured by a sound level meter complying with AS/NZS 1269.1
Linear-weighted	Sound pressure levels measured with no weighting or bias to any frequency and expressed in units of dB(lin) or dB(Z)
Noise exposure	The amount of sound energy the unprotected ear of a person is exposed to, given as L _{Aeq,8h} or L _{peak}
Octave band analysis	Analysis of the frequency content of noise into octave bands
Octave band filter	A filter that attenuates all noise except that falling between two frequencies an octave apart. Octave band filters are used to measure what frequencies are present in a given noise
Personal sound exposure meter (PSEM)	An instrument for measuring noise exposure by automatically integrating sound energy over a measurement period and providing a measure of its magnitude
Sound level meter (SLM)	An instrument comprising a microphone, amplifier and indicating device, having a declared performance, and designed to measure a frequency-weighted and time-weighted value of the sound pressure level
Sound power	Total sound energy radiated per unit time



Sound power level	Relative magnitude of sound power, customarily expressed in decibels referenced to 1 picowatt
Sound pressure	Alternating component of the pressure at a point in a sound field
Sound pressure level (SPL)	Relative magnitude of sound pressure, customarily expressed in decibels referenced to 20 micropascals
Temporary threshold shift (TTS)	A temporary shift of the auditory threshold resulting from auditory fatigue, which is the temporary loss of hearing after exposure to sound
Unweighted	See linear-weighted



Appendix 4 – Noise exposure

Table A4.1 Relationship between noise levels and exposure durations to give $L_{Aeq,8h} = 85$ dB(A)

Noise level ($L_{Aeq,T}$) dB(A)	Exposure duration
81	14.0 h
82	12.0 h
83	10.0 h
84	9.0 h
85	8.0 h
86	6.4 h
87	5.0 h
88	4.0 h
89	3.2 h
90	2.5 h
91	2.0 h
92	1.6 h
93	1.3 h
94	1.0 h
95	48 min
96	38 min
97	30 min
98	24 min
99	19 min
100	15 min
101	12 min
102	10 min
103	8 min
104	6 min
105	5 min



Noise level (LAeq,T) dB(A)	Exposure duration
106	4 min
107	3 min
108	2 min
109	115 sec
110	90 sec
111	72 sec
112	58 sec
113	46 sec

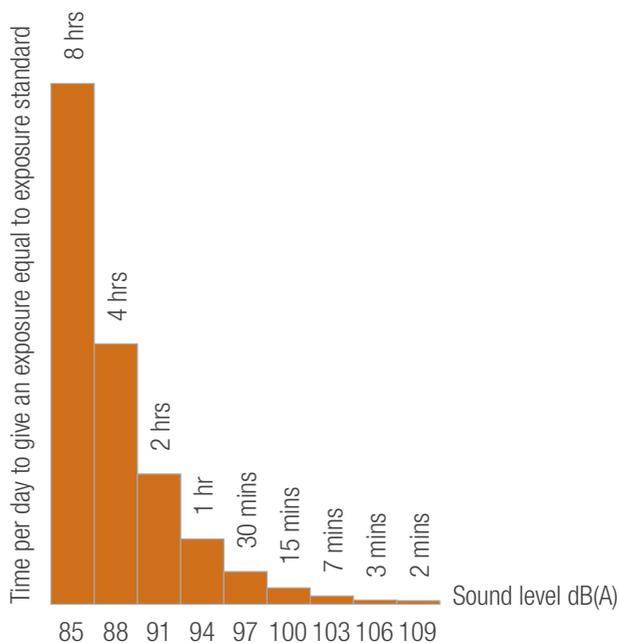


Figure A4.1 Time per day to give an exposure equal to exposure standard

Appendix 5 – Typical mine noise levels

Unattenuated (or unquieted)
 Attenuated (or quieted)

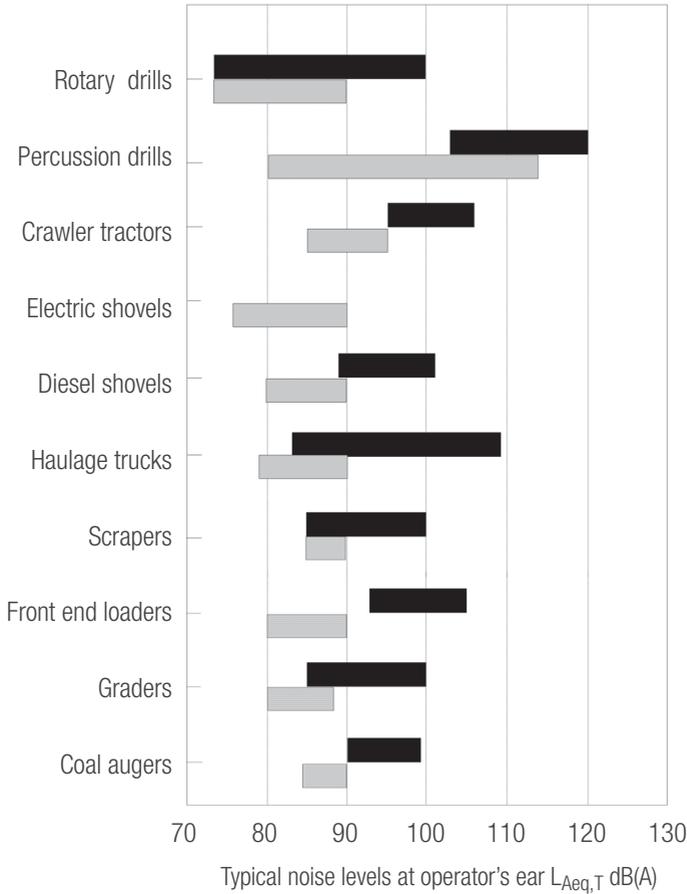


Figure A5.1 Typical noise levels associated with surface mining plant



■ Unattenuated (or unquieted) ■ Attenuated (or quieted)

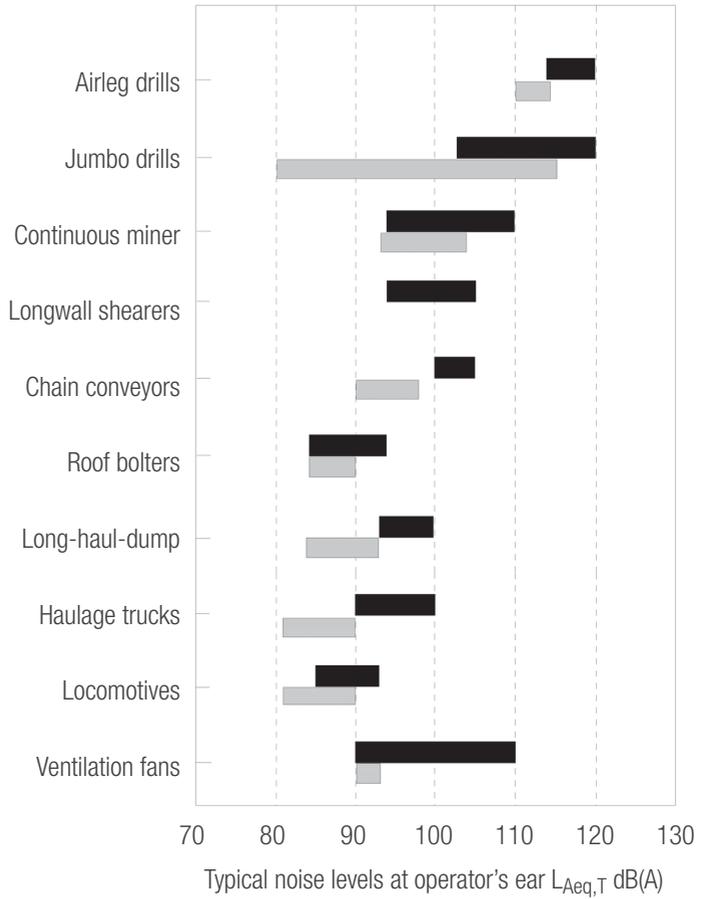


Figure A5.2 Typical noise levels associated with underground mining plant

■ Unattenuated (or unquieted) ■ Attenuated (or quieted)

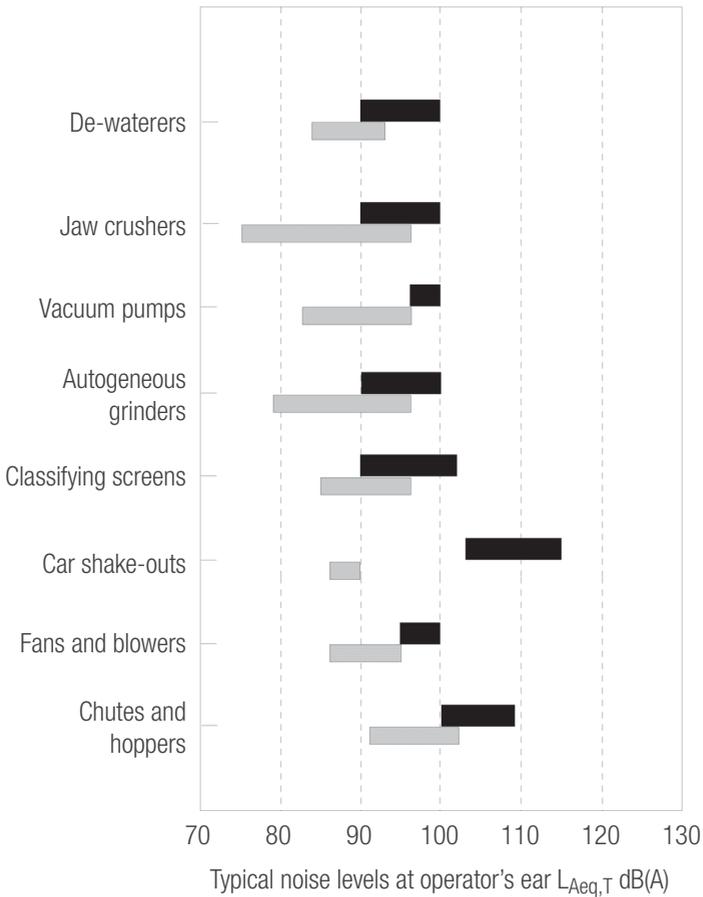


Figure A5.3 Typical noise levels associated with processing plant



Appendix 6 – Noise report

Each responsible person at a mine must ensure that a noise report is prepared in the manner and form approved in relation to the workplace or type of workplace.

The responsible person must ensure that the noise data on which a noise report is based, or which comprise a noise report, are collected by a person approved to collect those data (a noise officer).

A noise officer must use only approved procedures and approved sound measurement equipment to collect the data to be used for a noise report.

The State Mining Engineer has approved the following with respect to noise regulation.

Approved manner for preparing noise reports

The responsible person must ensure a noise report is prepared:

- (a) by an approved noise officer who has conducted noise measurements at the responsible person's workplace
or
- (b) using data obtained by noise officer(s) in a sample of workplaces that have processes or items of plant the same as those at the responsible person's workplace and which are used to perform the same functions
or
- (c) using a combination of (a) and (b).

In the case of (b), the noise data must be verified by an inspector.

Approved form of noise reports

A noise report must contain the items listed below.

- A copy of the notification of a noise report to the State Mining Engineer.
- A summary of actions that are still needed at the particular workplace in order to fully comply with the Act and regulations with respect to noise.
- A brief description of the workplace and work processes.
- Since the last report (if any):
 - a summary of engineering noise controls and noise management measures taken in the preceding five years or since the last report
 - a comparison of noise levels and noise exposures with those in the last report (if any).
- Results tabulated in approved formats:
 - noise measurement results (Table A6.1)
 - evaluation of normalised total daily noise exposure levels ($L_{Aeq,8h}$) (Table A6.2)
 - extent of affected area:
 - represented by contours on a floor plan
 - nominated as a radius around a particular machine or task
 - described in writing (e.g. entire shed, 7 metres in all directions)
 - information used for selection of personal hearing protectors (Table A6.3)
 - selected personal hearing protectors (Table A6.4).
- Any relevant information not contained in the results tables that may be needed to compare results in previous or future reports.
- General noise control advice and comments.
- The full name and signature of the noise officer(s) who collected the noise data.
- The noise officer's registration number and expiry date.
- An appendix on the measurement method, sound measurement equipment used and calibration certificates.

Table A6.1 Approved format for recording noise measurements results

Date:

Item no.	Noise source (make, model and description)	Operating conditions and process	Measurement position	$L_{Aeq,T}$ dB(A)	Peak noise level dB(lin)	Extent of affected area*

*Area where $L_{Aeq,T}$ exceeds 85 dB(A), given as a radius in metres or reference to an attached floor plan

Table A6.2 Approved format for recording the evaluation of normalised total daily noise exposure levels ($L_{Aeq,8h}$)

Occupation	Measured noise level $L_{Aeq,T}$ dB(A)	Duration of exposure T_i (h)	Pascal-Squared Pa^2	Partial noise exposure $E_{A,T}$ Pa^2h	Total daily noise exposure $E_{A,T}$ Pa^2h	Normalised noise exposure level $L_{Aeq,8h}$ dB(A)	Adjustments to $L_{Aeq,8h}$ dB(A)	Adjusted $L_{Aeq,8h}$ dB(A) (if applicable)
Item no.								

Note: Refer to table E2 in AS/NZS 1269.1 for conversion of decibel to Pascal-squared values and determination of $L_{Aeq,8h}$ levels



Table A6.3 Approved format for recording information used for selection of personal hearing protectors

Occupation Item no.	Octave band level: centre frequency										or	C-wfwd $L_{eq,T}$ dB	
	31.5	63	125	250	500	1000	2000	4000	8000	16000			

Table A6.4 *Approved format for recording selected personal hearing protectors*

Task	Selected hearing protector (class, make and model)	Effective attenuated level $L(\text{eff})_{Aeq,T}$

Approved procedure for collection of data by a noise officer

In collecting data for a noise report, a noise officer must:

- make either direct measurements or use an approved sampling procedure
- delineate all areas where $L_{Aeq,T}$ exceeds 85 dB(A) or peak noise level exceeds 140 dB(lin)
- evaluate the noise exposures ($L_{Aeq,8h}$) needed to identify those areas exceeding the action level
- where practicable, ensure that the conditions prevailing during the assessment are those likely to produce typical noise emissions and record any conditions that are not typical
- record items of plant or processes, with the potential to cause the action level to be exceeded, that have not been able to be assessed and that will require additional measurements in the future
- use approved sound measurement equipment that has been calibrated by an approved method, at an approved calibration laboratory, within the two years preceding each day of use

- check the sound measurement equipment with a reference sound source immediately before and after measurements are taken, and reject results if there is a discrepancy of more than ± 0.5 dB in the reference level, or $\pm 10\%$ in the reference noise exposure reading
- if the atmosphere is explosive or flammable, use apparatus, equipment or procedures that will not jeopardise safety
- assess the adequacy of the noise reduction afforded by any personal hearing protectors already in use and, if inadequate, recommend an appropriate hearing protector classification to assist in the selection of adequate protectors
- complete the results tables required by the approved form for noise reports.

Approved sampling procedure

If, at one or more workplaces, each responsible person has several items of plant of the same design or type that are used to perform the same function, a noise officer may measure the noise from a sample of the items and apply the highest result to the rest of the items.

A noise officer must:

- for a total of N items, select the minimum sample size, “ n ”, either
 - using the rule:
 - if N is less than 6, $n = N$
 - if N is between 6 and 24 inclusive, $n = 6$
 - if N is more than 24, $n = 25\%$ of N , or
 - according to Table A6.5
- where practicable, randomly select “ n ” items to be measured
- measure the $L_{Aeq,T}$ for each item in the sample, at the person’s position likely to give the highest result, during identical typical operating conditions

- for the item giving the highest $L_{Aeq,T}$, measure the other indices needed to complete all columns of the noise report results form
- if the L_{peak} measured is close to the action level, measure the L_{peak} for all “n” items
- complete the results tables required by the approved form for noise reports.

Figure A6.6 Selection of sample size

Total number of items, N	Size of sample, n
6-8	6
9-11	7
12-14	8
15-18	9
19-26	10
27-43	11
44-50	12
more than 50	14

Approved sound measurement equipment

Sound measuring equipment must meet or exceed the requirements of AS IEC 61672 or IEC 61672 *Electroacoustics – Sound level meters* for Class 1 or Class 2 meters.

If a personal sound exposure meter is used, it must meet or exceed the requirements of AS/NZS 2399 *Acoustics – Specifications for personal sound exposure meters*.

All auxiliary instruments, such as tape recorders, data recorders and level recorders, used to measure noise levels must meet or exceed the relevant precision requirements of AS IEC 61672 sound level meters for at least Class 2 instruments.

Octave band filters must comply with the Class 1 requirements given in AS/NZS 4476 *Acoustics – Octave-band and fractional-octave-band filters*. The nominal centre frequencies of the frequency bands must correspond to those of AS 2533 *Acoustics – Preferred frequencies and band centre frequencies*.

Reference sound sources used with any sound level meter or auxiliary instrument must comply with at least Class 2 specification of AS IEC 60942 *Electroacoustics – Sound calibrators*.

Approved calibration laboratories for sound measurement equipment

Laboratories must be accredited by the National Association of Testing Authorities (NATA) or another accreditation body that is a member of the International Laboratory Accreditation Cooperation (ILAC) for the relevant sections of the standards listed above.

Approved calibration methods for sound measurement equipment

Calibration methods must be those methods adopted by approved laboratories when testing in accordance with the relevant sections of the standards listed above for approved sound measurement equipment.

Tests not in strict accordance with the relevant standard are acceptable provided the methods used are those methods adopted by NATA- or ILAC-accredited laboratories when testing in accordance with the terms of their accreditation.

A test certificate must be issued showing the results of the calibration. The certificate need not give individual details of calibration results, but there must be sufficient information to identify the particular instrument calibrated, and the results of that calibration in terms of the instrument satisfying (or otherwise) all the tests conducted. The certificate must show the clause number of the relevant Standards to which the instrument has been calibrated.

Complete details of test results must be made available if requested.

To ensure reliability, all sound level meters, filter sets, personal sound exposure meters and acoustic calibrators must be fully tested in an approved laboratory at intervals not exceeding two years.



Appendix 7 – “Buy quiet” programs

The mines safety legislation places legal obligations on manufacturers and suppliers to inform prospective buyers about any health risk, including excessive noise, associated with the operation or use of their products. In addition, complementary legal obligations have been imposed on employers to ensure any plant purchased is as free as possible from health risks to workers.

Noise information provided by suppliers can vary considerably if measurements are made in a non-standard acoustical environment and under operating conditions that differ from those of the proposed installation. It is important, therefore, to standardise the noise testing information provided by suppliers. The noise emission data for optional noise accessories should also be submitted for assessment.

The next issue for buyers to consider is how to establish a maximum acceptable noise level for any new item of plant. This will be determined by the overall noise exposure level set by the company as its goal for working areas. However, in order to keep workplace noise below a certain limit, the noise output of individual items will usually need to be well below that limit. This will ensure the progressive replacement of existing noisy plant with quieter plant at a rate that is practicable for the company, and avoids the need to retrofit costly noise controls at a later date.

An effective “buy quiet” program (Fig. A7.1) requires the coordinated action of several groups of personnel. Specific procedural arrangements should be made to ensure that:

- staff preparing purchase requests or tenders for potentially noisy plant specify maximum acceptable noise emission values (Fig. A7.2)
- those who approve invitations to tender, the final purchase, and the release of new plant verify that noise aspects have been properly considered and specified
- noise is taken into account in the final selection of the item to be purchased (Fig. A7.3)

- upon delivery, the appropriate technical department, or a consultant engaged for this purpose, determines that the noise specifications have been met (Fig. A7.4)
- before approving final payment, the purchasing department verifies with the technical department that the noise generated by the plant while operating is acceptable.

Acoustical test conditions should be standardised to ensure that noise emitted during tests is representative of the noise produced by plant under typical conditions of use.

There is no simple relationship between the noise emitted by any item of plant and the noise exposure values that will be encountered by operators or bystanders when the plant is operating at a mine site. Noise levels up to 15 dB higher than those declared during pre-delivery tests can be expected due to reverberation, different operating conditions, or contribution to the overall noise level by neighbouring plant. Consequently, meaningful assessment of the operator's noise exposure can only be undertaken after delivery and installation on site.

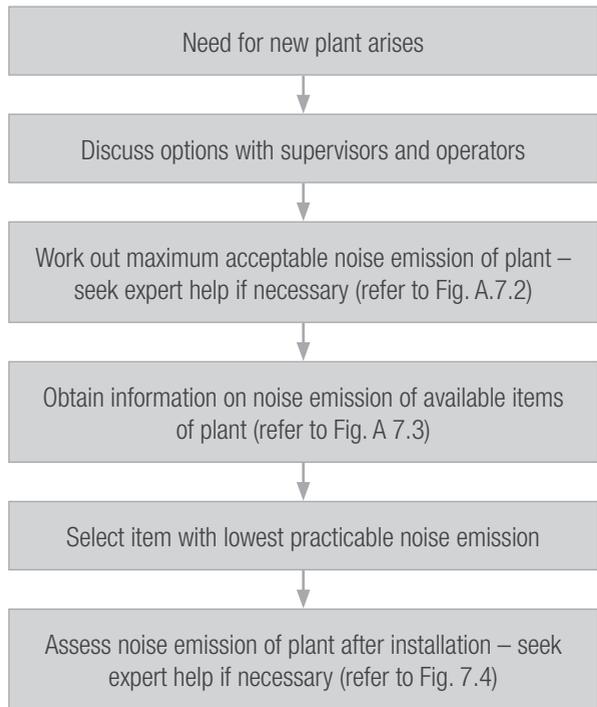
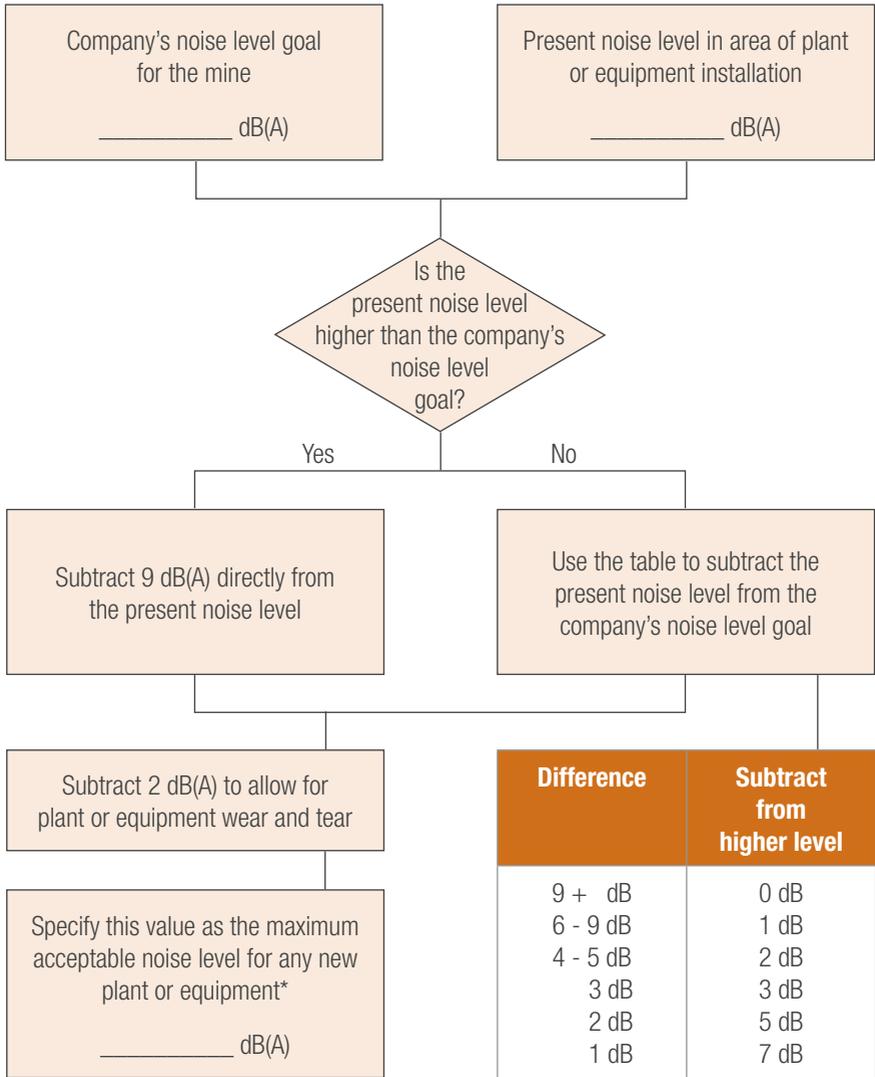


Figure A7.1 Steps involved in the “buy quiet” process



* If more than one new item is being installed, subtract further:

- 2 dB(A) – for two new items
- 5 dB(A) – for more than two items

Figure A7.2 Flow diagram showing the process for calculating the maximum acceptable noise level for any new plant

1. Manufacturer or supplier

Name

Address

Phone

Fax

Email

2. Plant or equipment tested

Description

Make

Model

Serial no.

Noise-reducing attachments fitted, methods to minimise noise during operation or other factors related to noise hazard

3. Tests

Operating conditions (e.g. speed, load, material being processed, feed rate)

Acoustical conditions (reverberant, semi-reverberant or free field)

Instrumentation used (e.g. sound level meters, integrating sound level meters)

Measurement position (e.g. operator's ear level, distance 1.0 m, height 1.5 m)

Title or number of specific test standard followed (if any)

	Range	Mean
$L_{Aeq,T}$	_____ to _____	_____ dB(A)
$L_{Ceq,T}$	_____ to _____	_____ dB(C)
L_{peak}	_____ to _____	_____ dB(lin) peak
Sound power (if applicable)	_____ to _____	_____ dB(A)

Date issued

Figure A7.3 Example of noise information provided by manufacturers or suppliers

Notes:

- The continuous A- or C-weighted sound pressure level ($L_{Aeq,T}$ or $L_{Ceq,T}$) should be measured over a complete operating cycle or the average of several cycles.
- $L_{Aeq,T}$ and peak noise level (L_{peak}) may be used to estimate the likely noise exposure for the operators.
- If measured as a sound pressure level, subtract 8 dB(A) from the value quoted before entering the result in the top box.



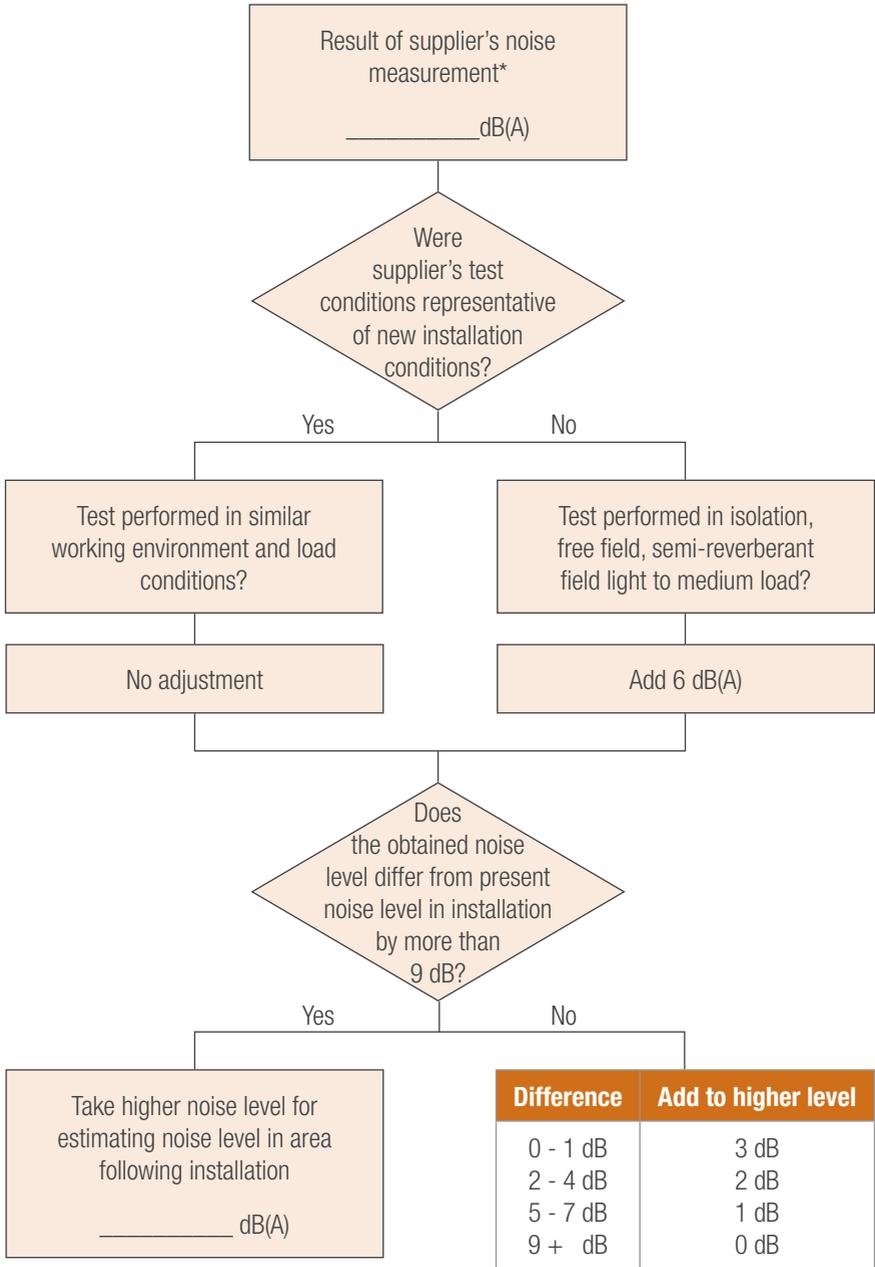


Figure A7.4 Flow diagram showing the process for estimating the noise level following the installation of plant

Appendix 8 – Personal hearing protectors

Without limiting any duty to reduce noise, the responsible person must provide personal hearing protectors, selected and maintained as approved, to anyone receiving, or likely to receive, workplace noise above the action level.

The approved procedure for selection and maintenance of personal hearing protectors is described below.

- Provide personal hearing protectors selected in accordance with AS/NZS 1269.3 that, when properly worn, will reduce the risk to hearing to below that associated with the action level.
- The protector must have passed the physical tests specified in AS/NZS 1270 *Acoustics – Hearing protectors*, and its attenuation data must have been obtained by following the procedures listed in this standard, by a laboratory accredited for the purpose by NATA or another ILAC member body.
- The protector must be reasonably comfortable to wear, and compatible with work requirements and other protective clothing and equipment worn.
- Where used, reusable personal hearing protectors, such as ear muffs, must be provided, maintained and stored in accordance with AS/NZS 1269.3.

Note: The suitability of personal hearing protectors depends on factors such as the designated attenuation, how well the item fits, and whether it is worn properly. Fit testing is recommended to determine the effectiveness of protectors for each worker.

- If disposable personal hearing protectors, such as ear plugs, are used, an adequate supply must be readily accessible.
Note: Where disposable ear plugs are used, providing a range of sizes allows workers to choose protection suited to their ear canals, thus supporting a better fit.
- The wearing of personal hearing protectors must not adversely affect the health or safety of the wearer or any other person.



Appendix 9 – Personal noise exposure assessments

Employers have a legal responsibility to ensure that workers' exposure to noise is regularly assessed. Worker noise exposure should be one element of the occupational hygiene risk assessment undertaken by companies and forms part of the agreed monitoring program submitted to the Department of Mines and Petroleum.

By taking regular measurements with a noise dosimeter (also known as a personal sound exposure meter), the average exposure of workers to noise during a normal shift can be evaluated. The current noise controls can then be assessed to ensure they continue to reduce the risk to as low as is reasonably practicable. The following procedure for recording personal noise exposures will assist approved noise officers with this task.

Measuring personal noise exposure

To ensure representative results (i.e. measured over a representative period and adjusted for shift length), explain to the workers who will be wearing dosimeters:

- why and how the sampling is being done, including the importance of not touching, tapping or interfering with the microphone
- that they need to operate plant and perform tasks under normal conditions.

The general procedure for taking measurements is described below.

- Check that the instrument battery life is at least double the time required for the measuring period.
- If applicable, check the instrument sampling mode.
- Check the calibration of the instrument and adjust settings if required.

- Secure the microphone to the collar or on the shoulder of the worker selected for sampling. Refer to the manufacturer's user manual for any specific requirements regarding orientation of the microphone.
- Start the recording session and note the start time.
- At the end of the measurement period, stop the recording session, remove the dosimeter from the worker and record the final readings.
- Recheck the dosimeter's calibration. If the instrument is not within the calibration limits of ± 0.5 dB then the results are invalid (refer to AS/NZS 1269.1).
- Record all measurement data.
- Distribute copies of noise exposure recordings to test participants. Explain the results and ensure that their hearing protectors adequately protect against the recorded noise exposure levels.
- Review controls currently in place to reduce the noise level to as low as reasonably practical. Where improvements can be achieved, make recommendations to the Registered Manager.

Sample size

For mining operations, the sample size should allow for each worker exposed to noise above the action level to be tested for noise exposure at least every five years.

Refer to the current noise report of the mine to ascertain the number of workers exposed to noise above the action level. Divide that figure by five to obtain the minimum number of samples to be measured annually.

Frequency of testing

Workers at higher risk due to their exposure to elevated noise levels should be tested more frequently than every five years. Table A9.1 shows the testing intervals for different exposure levels.

Table A9.1 Testing intervals for different personal exposure levels

Noise exposure ($L_{Aeq,8h}$) (dB(A))	Noise dosimetry interval
Up to 90	Every 5 years
90 to 100	Every 3 years
Above 100	Every 2 years



Resources Safety

Department of Mines and Petroleum
100 Plain Street
EAST PERTH WA 6004

Telephone +61 8 9358 8002

NRS 13 36 77

Facsimile +61 8 9358 8000

Email ResourcesSafety@dmp.wa.gov.au

Website www.dmp.wa.gov.au/ResourcesSafety



Government of Western Australia
Department of Mines and Petroleum
Resources Safety