Noise Code of Practice 2004

Workplace Health and Safety Queensland

Department of Justice and Attorney-General

Queensland Government

Noise Code of Practice 2004

Important information about the code

- The code replaces the *Workplace Health and Safety (Noise) Advisory Standard* made on 3 December 1998.
- The code was made on 2 March 2004.
- The code commenced on 8 March 2004.
- The code was amended on 28 April 2006 and 5 December 2008.
- The code expires 10 years after it commenced.

What is this code of practice about?

The purpose of the *Noise Code of Practice 2004* is to give practical advice about identifying sources and levels of noise, assessing exposure to noise and eliminating or minimising noise exposure as a risk to health and safety at the workplace.

Workplace health and safety obligations

The *Workplace Health and Safety Act 1995* (the Act) places obligations on people at workplaces to ensure workplace health and safety. Workplace health and safety is ensured when people are free from death, injury or illness or risk of death, injury or illness caused or created by any workplace, work activities, relevant workplace areas or plant or substances for use at a workplace. Ensuring workplace health and safety involves identifying and managing exposure to risks at your workplace.

Obligation holders

In regards to noise the following persons may have obligations under the *Workplace Health and Safety Act 1995:*

- persons conducting a business or undertaking (this includes employers and self-employed persons)
- persons in control of workplaces
- principal contractors
- designers of plant
- manufacturers of plant
- suppliers of plant
- erectors and installers of plant
- manufacturers of substances for use at workplace
- suppliers of substances for use at workplace
- designers of buildings or other structures used as workplaces
- persons in control of relevant workplace area
- persons in control of fixtures, fittings or plant included in relevant workplace area
- owners of specified high risk plant.

Persons may owe obligations in more than one capacity, for example an employer may also be a person in control of a workplace and/or a person who conducts a business or undertaking.

Obligations of a person who conducts a business or undertaking (a 'relevant person')

The *Workplace Health and Safety Act 1995* places obligations on a person who conducts a business or undertaking. The Act refers to a person who conducts a business or undertaking as a 'relevant person'. The obligations apply whether or not:

- the relevant person conducts the business or undertaking as an employer, self-employed person or otherwise
- the business or undertaking is conducted for gain or reward
- a person works on a voluntary basis.

Relevant persons have an obligation to ensure:

- the workplace health and safety of their workers and any other persons is not affected by the conduct of the relevant person's business or undertaking
- their own workplace health and safety.

The term 'relevant person' is also used in the *Workplace Health and Safety Regulation 2008.*

Where this code of practice provides advice to employers and self-employed persons on managing exposure to risks, other persons who conduct a business or undertaking may also find this advice applicable depending on their circumstances.

How can I meet my obligations?

Under the Act, there are three types of instruments to help you meet workplace health and safety obligations – regulations, ministerial notices and codes of practice.

If there is a regulation or ministerial notice about a risk, you must do what the regulation or notice says.

If there is a code of practice about a risk, you MUST either:

(a) do what the code says

(b) do all of the following:
   - adopt and follow another way that gives the same level of protection against the risk
   - take reasonable precautions
   - exercise proper diligence.

If there is no regulation, ministerial notice or code of practice about a risk, you must choose an appropriate way to manage exposure to the risk and take reasonable precautions and exercise proper diligence to ensure that your obligations are met.

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1. What is noise?

Noise is unwanted sound[1] that may damage a person's hearing. Noise or sound consists of relatively small changes in atmospheric pressure. The changes are detected by the eardrum and carried to hair cells in the inner ear. These hair cells convert the pressure changes to electrical pulses which are sent to the brain. The brain is then able to process these electrical pulses into meaningful sounds.

The amount of damage caused by noise depends on the total amount of energy received over time. This means as noise becomes louder it causes damage in less time.

Sound pressure level[2] is measured in decibels (dB). The decibel scale is logarithmic, or compressed, as the human ear is capable of hearing a broad range of sound pressures[3] .

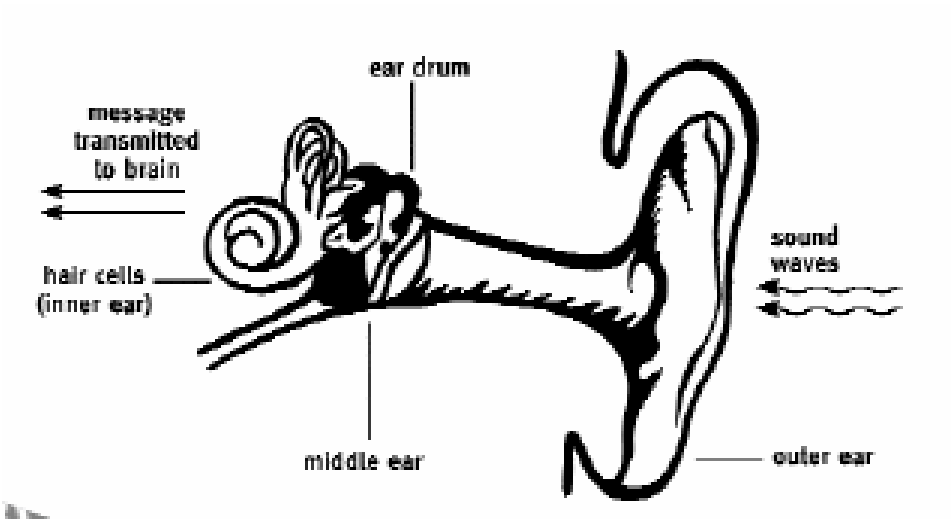
For every unit change in sound pressure there is a greater than unit decibel change. For example:

- an increase of 3dB represents an approximate doubling of the sound energy
- an increase of 10dB represents an approximate 10 fold increase in sound energy and will sound twice as loud to our ears.

1.1 What is excessive noise?

Excessive noise is defined in the *Workplace Health and Safety Regulation 2008* and means a level of noise above:

- $L_{Aeq,8h}$ of 85 dB(A) - that is, an 8 hour equivalent continuous A-weighted[4] sound pressure level of 85 dB(A)[5] , referenced to 20 micropascals



[1] 'sound' means small fluctuations in the air pressure that result in a wave capable of exciting in a listener the sensation of hearing.
[2] 'sound pressure level (SPL)' means the relative magnitude of sound pressure, customarily expressed in decibels referenced to 20 micropascals.
[3] 'sound pressure' means the alternating component of the pressure at a point in a sound field.
[4] 'A-weighted' means a standardised frequency response (in dB(A)) used in sound measuring instruments and corresponding approximately to the human ear response.
[5] 'dB(A)' means A-weighted decibels.

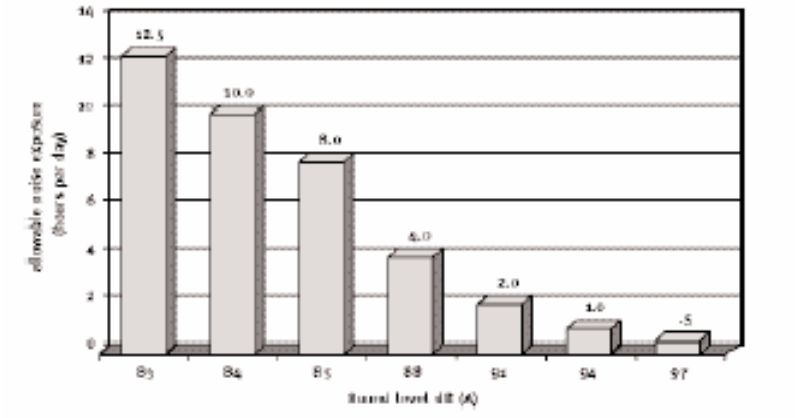
- LC,peak of 140 dB(C) - that is, a C-weighted[6] peak sound pressure level of 140 dB(C)[7] , referenced to 20 micropascals.

What does LAeq,8h of 85 dB(A) mean?
$L_{Aeq,8h}$ of 85 dB(A) means the actual energy of varying noise levels experienced over a working period is equivalent to 8 hours of a continuous steady A-weighted sound pressure level of 85 dB(A).

In simple terms, this can be shown in the following graph which has a range of time/sound level variations equivalent to a daily noise exposure[8] level. For example, a person exposed to a continuous sound pressure level of 94dB(A) over a period of 1 hour has experienced the same noise exposure as a person that is exposed to a continuous sound pressure level of 85 dB(A) over 8 hours. The graph demonstrates the allowable noise exposure, in hours per day for various sound levels.

Scientific evidence indicates that continuous exposure levels above 85 decibels, during a normal 8 hour working day, represent an unacceptable risk to the hearing of those exposed.

Daily noise exposure levels



What does LC,peak of 140 dB mean?
LC,peak of 140 dB(C) means a C-weighted peak sound pressure level of 140 dB(C). Levels of noise above LC,peak of 140 dB(C) can cause immediate hearing damage. This is often referred to as 'acoustic trauma' and can result from an event that causes very loud noise, for example, an explosion or drop forcing.

1.2 How is a person's hearing damaged?

A person's hearing ability can become temporarily or permanently impaired if the person's unprotected ear is exposed to excessive noise.

Temporary hearing impairment is known as temporary threshold shift and may be experienced as dull hearing. It may also cause ringing in the ears after noise exposure. Recovery from temporary threshold shift may take from a few seconds to several days or weeks, depending on the severity of the noise exposure. However in many cases, 'normal' hearing returns overnight giving the false

[6] 'C-weighted' means a standardised frequency response (in dB(C)) used in sound measuring instruments and corresponding approximately to the human ear response.
[7] 'dB(C)' means C-weighted decibels.
[8] 'noise exposure' means the amount of sound energy the unprotected ear of a person is exposed to, given as LAeq,8h or as Lpeak.

impression that the person has fully recovered. A person who experiences temporary threshold shift repeatedly can suffer permanent hearing damage if noise exposure continues.

The severity of noise induced permanent threshold shift will vary with the characteristics of the noise. The level, duration and pattern of noise exposure and a person's own susceptibility to hearing impairment determine the severity of damage.

Hearing damage of this type is often accompanied by a permanent ringing, buzzing or roaring sounds in the ears, which is known as tinnitus.

1.3 What are the effects of noise exposure?

Exposure to excessive noise
Noise at the workplace is a major cause of deafness in Queensland. Not only does workplace noise cause deafness, it can also contribute to increased absenteeism and worker turnover, as well as lowered work performance. It can also contribute to workplace injuries and accidents.

Occupational noise induced hearing loss is a major compensable industrial disease in Australia and entails substantial economic and social costs.

A person working with or near noisy machinery or equipment may be affected by high direct or ambient noise[9] and may develop noise-induced hearing loss (NIHL) as a result of working under those conditions. Both temporary threshold shift and permanent hearing damage can affect a person's social and work life.

Some of the effects of noise-induced hearing loss[10] include:

- At first, dulled hearing and ringing in the ears. If exposure continues, the next phase is a reduced ability to hear high pitched sounds, for example, the letters F, S, T, K and C. This is followed by a more noticeable hearing impairment.

Other effects are:

- raised blood pressure
- increased heart rate and stress resulting in irritability and headaches, and
- reduced ability to hear malfunctioning equipment, alarm signals or verbal warnings.

Permanent and severe tinnitus may disrupt sleep, reduce concentration and lead to irritability or depression. Vibration effects from exposure to excessive noise can also affect a person's sight, for example, loss of clarity, colour perception and night vision.

Permanent NIHL cannot be reversed or cured. People suffering from NIHL often have communication and personal relationship problems. They also experience social isolation and degradation of the quality of life. Family and friends are often also affected and experience the secondary effects of the condition.

Hearing aids may be of some benefit in overcoming some of the problems but normal hearing can never be fully restored. Twenty percent of people affected by NIHL also suffer from tinnitus, or ringing in the ears. Severe tinnitus can be experienced by the sufferer 100% of the time.

[9] 'ambient noise' means the all-encompassing noise associated with an environment, being a composite of sounds from many sources near and far.
[10] 'noise-induced hearing loss' means hearing impairment arising from exposure to excessive noise at work. Occupational noise-induced hearing loss is also commonly known as industrial deafness.

Exposure to low level noise
Relatively low noise levels, like those in offices, typically range between LAeq,8h 40 and 75dB(A). These noise levels depend on the interior construction of the workplace and the activities carried out. Under these conditions, low noise levels are not capable of causing NIHL. However, they are known to cause stress and other adverse health effects in some cases.

People may experience stress in different ways. For example, stress can take the form of fatigue, anxiety, depression, hostility or aggression.
Noise may lead to:
- loss of concentration
- speech interference, and
- stress.

Stress related symptoms include:
- irritability, headaches, moodiness and insomnia, and
- disturbance of psychomotor reactions.

The body will try to cope with a situation of intrusive background noise by adapting its biological functions. These adjustments are made by increasing the heart rate and raising the blood pressure. Also, more hormones like adrenaline and cortisol are released into the body. Under stressful working conditions, prolonged high levels of these hormones may lead to more serious health effects.

Health effects may consist of:
- raised blood pressure and heart rate, including the risks of stroke and heart attack
- reduced immune response, and
- gastric ulcers.

Exposure to both excessive or low levels of noise can result in:
- increased absenteeism
- reduced productivity due to fatigue and low concentration
- increased production costs
- reduced quality of work/product/service, and
- reduced ability to communicate, for example, difficulty in holding a telephone conversation.

These results can be avoided if an employer or other obligation holder takes steps to manage the risks from exposure to noise at the workplace.

2. Responsibilities

2.1 Obligation holders

The following persons have responsibilities under the *Workplace Health and Safety Act 1995* to ensure protection for workers from excessive noise:
- employers
- persons conducting a business or undertaking
- persons in control of workplaces
- principal contractors
- designers, manufacturers and suppliers of plant

- erectors and installers of plant, and
- workers and other persons at a workplace.

Steps these persons can take to manage noise exposure at work include:
- carrying out a risk assessment to determine the risks from noise exposure
- developing a noise control policy and hearing conservation program, and
- providing workers with information on noise, the risks from noise exposure and the control measures put in place at the workplace.

Information
Providing information about noise is one way to help ensure workers' health and safety. Information can be in different forms, for example, brochures, guides, signs, symbols, diagrams and videos. Most importantly, information should be easy to understand. This means considering the literacy levels and different languages used by workers.

Information can include:
- what noise is
- the range of health effects that can result from exposure to noise
- disadvantages to a person's work and social life due to adverse health effects from noise exposure
- details about noise exposure at the workplace
- reasons for using noise control measures
- specific control measures required for each worker's job (this may include instruction in the correct use and maintenance of noise control equipment and correct methods of operation for minimising noise levels)
- the noise control policy and hearing conservation program and timetable for future improvements
- the arrangements for reporting defects likely to cause excessive noise at work
- when and how to use personal hearing protectors provided and their proper care and maintenance, and
- obligations of obligation holders and workers.

Consultation
Consultation between obligation holders (particularly relevant persons who may be employers) and workers at the workplace can help achieve workplace health and safety. Consultation should take place early in the planning stage for the introduction or purchase of any potentially noisy plant or changes to existing plant at the workplace.

Consultation with those affected should be undertaken when a risk assessment is being carried out at the workplace.

Consultation is effective when:
- Workers have an opportunity to participate in consultation.
- There is a workplace health and safety officer and/or workplace health and safety representative who has access to relevant information on noise risks at the workplace and enough time to consider the implications of this information.

Training
Training workers is an important part of a prevention strategy that can help achieve workplace health and safety.

The objectives of training should be to:

- Minimise NIHL and tinnitus by an approach that emphasises engineering noise control measures.
- Recognise and promote an understanding of the nature of noise-related health effects, including the cumulative effects of workplace noise and other exposures to noise such as domestic and leisure activities and ototoxins[11].
- Promote the adoption of a systematic approach to the management of exposure to excessive noise.

Those who require training include:

- managers and supervisors of workers who may be exposed to risks from exposure to excessive noise at work
- workers who may be at risk from exposure to excessive noise and/or ototoxins at work
- workplace health and safety committees and workplace health and safety representative(s), and
- staff responsible for purchasing plant, noise control equipment, personal hearing protectors and design, layout, organisation and scheduling of work.

Training methods, content and materials will vary for each group in the organisation and should be tailored to meet specific needs. The workplace noise control policy and hearing conservation program should be readily available to all participants. Topics that should be covered in training include:

- The effects of noise on hearing and health and the occupational and social effects of NIHL.
- The obligations of relevant persons who may be employers and workers.
- An overview of the noise control policy and hearing conservation program for the workplace.
- The nature and location of noise hazards in the workplace associated with the technology, plant and/or work practices workers use at work.
- The nature of the general noise control measures in use or planned for the workplace. The specific control measures necessary in each worker's own job (this can include instruction in the correct use and maintenance of exhaust silencers, enclosures and other measures that minimise noise levels).
- When and how to use personal hearing protectors provided (this can include selection – for example, what types are available - fitting, proper care and maintenance).
- The arrangements for reporting defects in plant or the workplace that are likely to cause exposure to excessive noise.
- The purpose and nature of audiometric testing[12].
- Reasons why levels of noise above $L_{Aeq,8h}$ of 85 dB(A) and $L_{C,peak}$ 140 dB(C) are 'excessive' and create risks to workplace health and safety.

3. Noise assessments

A noise assessment may be simple or quite complex, depending on the type of workplace, the number of workers and the information already available regarding noise exposure levels. The detail and accuracy needed will depend on individual circumstances.

[11] 'ototoxin' means a chemical that may cause hearing loss, independent of noise exposure, or which may potentiate noise-induced hearing loss by synergistic effects.

[12] 'audiometric test' means the measurement of the hearing threshold levels of a person by means of monaural pure tone air conduction threshold test

3.1 When should a noise assessment be done?

Obligation holders should carry out noise assessments when workers and others may be exposed to risks from noise levels above $L_{Aeq,8h}$ 85 dB(A) and/or $L_{C,peak}$ 140 dB(C), (i.e. excessive noise). If noise exposure is marginally below $L_{Aeq,8h}$ 85 dB(A) the noise levels should be reassessed whenever any changes that may increase noise exposure are made.

A noise hazard identification checklist is supplied in Appendix 1. This checklist can be used as a preliminary assessment to indicate whether a more detailed assessment is required.

3.2 What is the aim of a noise assessment?

Noise assessments vary depending on the severity of the risks at the workplace. The general aim of a noise assessment is to:

- Identify all persons likely to be exposed to excessive noise. Generally, this will involve the evaluation of $L_{Aeq,8h}$ and measurements of peak noise levels where relevant.
- Obtain information on noise sources and associated work practices. This information will help decide what measures should be taken to reduce noise levels.
- Check the effectiveness of measures taken to reduce noise exposure or the risks from noise exposure. If a base-line has been established in a more comprehensive assessment and there has been no change at the workplace it may be possible to restrict future surveys. These surveys would measure noise levels at a few defined positions and under a restricted range of working or loading conditions of the equipment involved.
- Help choose appropriate personal hearing protectors for persons exposed to risks from excessive noise.
- Define hearing protection areas at work.

3.3 How often should noise assessments be carried out?

The period between carrying out noise assessments can be decided by employers in consultation with workers. Noise assessments should be repeated at least every five years or whenever there is:

- installation, adjustment or removal of plant
- any change in workload or equipment operating conditions likely to cause a significant change in noise levels
- a change in building structure likely to affect noise levels, or
- modification of working arrangements affecting the length of time workers are exposed to noise.

Noise assessment records should be made available in a consistent format and be available for inspections by management, workers and any workplace health and safety representatives and relevant authorities. Where possible, the records should be kept at or near the workplace to which they apply. Where this is not possible, for example, at a workplace where construction work is being performed, the records should be kept available at an appointed office.

3.4 How to carry out a noise assessment

This depends on the type of workplace, the number of persons at risk from noise exposure and the information already available on noise levels at the workplace.

If there is no prior information available, an assessment should establish if there are excessive noise levels at the workplace.

In some cases, more complex measurements are required to determine a person's exposure to noise with acceptable accuracy, or for the selection of personal hearing protectors. For example, octave band analysis[13] of the noise may be desirable if it contains intense tonal, high frequency or low frequency components. Other situations which may warrant more complex measurement include workplaces with variable noise levels over the period of a day (or longer period) and jobs where workers move in and out of areas where excessive noise exists.

More detailed information on noise measurement and recording is available in *AS/NZS 1269.1 – Occupational Noise Management – Measurement and assessment of noise immission and exposure.*

A person who carries out a noise assessment should meet the competency requirements of Appendix A of *AS/NZS 1269.1 Occupational Noise Management - Measurement and assessment of noise immission and exposure,* including:

- knowledge of the aim of an assessment
- the correct way of using instruments and their limitations
- the normal operating conditions of the workplace, and
- relevant Australian Standards and statutory requirements.

Information about instruments used in the monitoring of noise at the workplace is given in Appendix 2.

Results of noise assessments

Where a noise assessment shows that workers are exposed to excessive noise, steps to prevent the risks from such noise exposure must be taken.

Low level noise assessment

When noise levels may fall in the $L_{Aeq,8h}$ range of 55 to 85 dB(A) and workers or others have indicated that a problem exists with this level of noise, a noise assessment should be carried out. Where the assessment shows a risk exists, elimination, engineering or administrative control measures should be implemented.

4. How should noise be managed?

4.1 Risk management

The best way to manage noise is to:

- identify the hazard (noise and its source)
- assess the risks that may result because of the hazard
- decide on the control measures to prevent or minimise the risks
- implement the control measures, and
- monitor and review the effectiveness of the measures.

This is called 'risk management'. It is a systematic and logical way to ensure workplace health and safety. A risk assessment should consider the risks to all persons at the workplace who may be affected by noise exposure, including subcontractors and members of the public.

[13] 'octave band analysis' means analysis of the frequency content of noise into octave bands.

If a risk assessment shows noise exposure is a risk to workplace health and safety, an employer should develop a noise control policy and hearing conservation program to implement control measures and manage risks from noise exposure at the workplace.

For more information about the risk management process see the *Risk Management Code of Practice.*

4.2 What is a noise control policy?

A noise control policy sets goals for noise exposure levels to be achieved and sets out the broad strategies for achieving these goals.

A noise control policy should cover issues like:

- goals for noise exposure and peak noise levels
- design goals for new workplaces and plant
- selection and purchase of quiet plant
- noise controls for temporary work areas and situations
- agreements with contractors for the responsibility of noise control and provision of information
- audiometric testing and availability of records
- funding for a hearing conservation program, and
- the period of review for the hearing conservation program.

An obligation holder who develops a noise control policy should consult with workers and any workplace health and safety representatives at the workplace about the content of the policy. Copies of the noise control policy should be available to all workers and workplace health and safety representatives on request and form a basic part of the information, induction and training activities at the workplace. This information should also be made available to inspectors on request.

4.3 What is a hearing conservation program?

A hearing conservation program sets out the ways to achieve goals for noise exposure levels. It may cover issues like:

- nominating a person to be responsible for overseeing implementation of the program
- carrying out preliminary noise checks to assess if problems with noise exposure are likely to exist
- choosing the type and detail of noise assessments to be carried out, the period between assessments and who should carry them out
- developing a program to choose new or replacement plant likely to minimise noise exposure
- deciding if engineering noise control measures are possible and the priorities to be given to sources of noise
- choosing suitable administrative noise control measures
- choosing, providing and maintaining suitable personal hearing protectors appropriate to work conditions
- identifying hearing protection areas by the use of appropriate signs
- providing induction and on-going training and education to workers
- providing audiometric testing as soon as possible after the commencement of employment, to determine base level hearing measurements
- providing audiometric testing periodically, to determine any hearing loss
- maintaining relevant records and making them available to certain persons. The records should be kept in a form easily understood by those likely to be at risk from noise exposure

- developing monitoring procedures like:
  - checking noise control measures are maintained in good order and used during the operation of noisy machinery, for example, silencers and enclosures
  - checking the noise level to make sure hidden defects are not causing excessive noise levels, and
  - monitoring the use of personal hearing protectors and checking that hearing protectors are maintained in good condition.

5. What are noise control measures?

Noise control measures are ways to manage the risks from exposure to noise. The following control measures are listed in order of the most effective way of managing risks from noise:

- elimination
- engineering controls
- administrative controls, and
- personal hearing protectors.

One control measure may prevent the risks from exposure to excessive noise; however, usually a combination of control measures has to be used. In line with risk management principles elimination, engineering and administrative control measures are preferred because they actually reduce a person's exposure to noise. Personal hearing protectors reduce the risks from exposure to excessive noise but do not actually reduce noise exposure.

5.1 Elimination - new plant and workplaces

There are several cost-effective noise control measures a person can use when buying new plant or setting up a new workplace. These include the design of the installation area and the design and construction of the new workplace.

Invitations to tender for the supply of new plant should specify a maximum acceptable level of noise emission. If plant is to be purchased directly, without tender, noise emission data should be obtained from suppliers to enable the plant with the lowest possible noise level to be selected. Guidance for designers, manufacturers, importers, and suppliers of plant on the presentation of information about noise levels emitted by plant is provided in Appendix 3.

New workplaces and installation sites for new plant in existing workplaces should be designed and constructed to ensure exposure to noise is as low as possible. If new plant is likely to expose persons to excessive noise, design features should include engineering noise control measures. These measures can reduce noise to as low a level as possible.

Plant should be designed to prevent or minimise any risks to health or safety resulting from the emission of noise. Where plant is to be designed for a particular workplace, designers should:

- obtain agreement with the client on goals for noise reduction, be aware of the noise control policy for the workplace and set up a budget that will allow for effective noise controls at the design stage
- consider the effect on overall noise levels of building reverberation[14], the building layout and the location of workstations relative to plant
- consider the transmission of noise through structures and ducts

[14] 'reverberation' means the persistence, by echo or reflection, of sound in an enclosure after the emission by the source has stopped.

- design for acoustical plant rooms and control rooms where appropriate
- design acoustic treatments for external environment control in a way that will reduce internal noise and design acoustic treatments for internal environment control in a way that will reduce external noise, and
- design plant to eliminate or control any risks to the hearing or health of persons resulting from noise emissions.

5.2 Engineering controls - existing plant and workplaces

Once a noise assessment has been carried out and the need to reduce the noise exposure is established, the task of controlling the noise can be addressed. Priority should be given to those noise sources that contribute the highest noise exposure levels to the largest number of persons.

The need for noise control should be taken into account when deciding production methods or processes.

There are three basic engineering noise control measures for managing noise levels:
- engineering treatment of the source
- engineering treatment of the noise transmission path, and
- engineering treatment at the receiver.

Engineering treatment of the source
Engineering treatment of the source is the preferred method of permanently removing the problem of noise exposure due to machinery or processes at the workplace. All noise-emitting objects generate airborne energy (noise) and structure-borne energy vibrations. The treatment of these noise problems may require modification, partial redesign or replacement or the noise emitting object.

Subjective inspection or acoustical measurement of the source can identify how and where the noise is generated. Some problems can be solved by relatively inexpensive and simple procedures. Noise sources which are more difficult may require advice from specialists. This approach could provide the most satisfactory results. A person who understands noise and the operation of the machine or process is able to consider a range of options for treating noise at the source. Engineering noise control measures can be specifically targeted at the machine and its parts, or towards the actual processes, including material handling systems.

General noise control solutions and examples of particular engineering noise control measures that can be carried out on machines include:
- Eliminating or replacing the machine or its operation by a quieter operation with equal or better efficiency, for example, by replacing rivets with welds.
- Replacing the noisy machinery by installing newer equipment designed for operation at lower noise levels. Machinery power sources and transmissions can be designed to give quiet speed regulation, for example, by using stepless electric motors. Vibration sources can be isolated and treated within the machine. Cover panels and inspection hatches on machines should be stiff and well damped.
- Correcting the specific noise source by minor design changes, for example, avoiding metal-to-metal contact by using plastic bumpers, replacing noisy drives with quieter types or using improved gears.
- Maintaining a high standard of plant and equipment maintenance to reduce noise levels to as low as practicable. Badly worn bearings and gears, poor lubrication, loose parts, slapping belts, unbalanced rotating parts and steam or air leaks all create noise which can be reduced by good maintenance. Plant and equipment resulting in excessive noise should be repaired immediately.

- Correcting the specific machine elements causing the noise by a local source approach. This is preferable to considering the entire machine as a noise source. Examples of this include the addition of noise barriers, noise enclosures, vibration isolation mountings, lagging to dampen vibrating surfaces, mufflers or silencers for air and gas flows, or reducing air velocity of free jets. These may be considered as a solution for the individual noise producing elements of the total operation.
- Separating the noisy elements that need not be an integral part of the basic machine. For example, moving pumps, fans and air compressors that service the basic machine.
- Isolating the vibrating machine parts to reduce noise from vibrating panels or guards.

Noise exposure can also be reduced by adopting less noisy processes, for example, mechanical pressing rather than drop forging. Where possible, metal-to-metal impact should be avoided or reduced. Vibration of the surfaces of the machine or the material being processed can be reduced by adequate stiffness and damping, by careful dynamic balancing where high speed rotation is used and by using suitable materials.

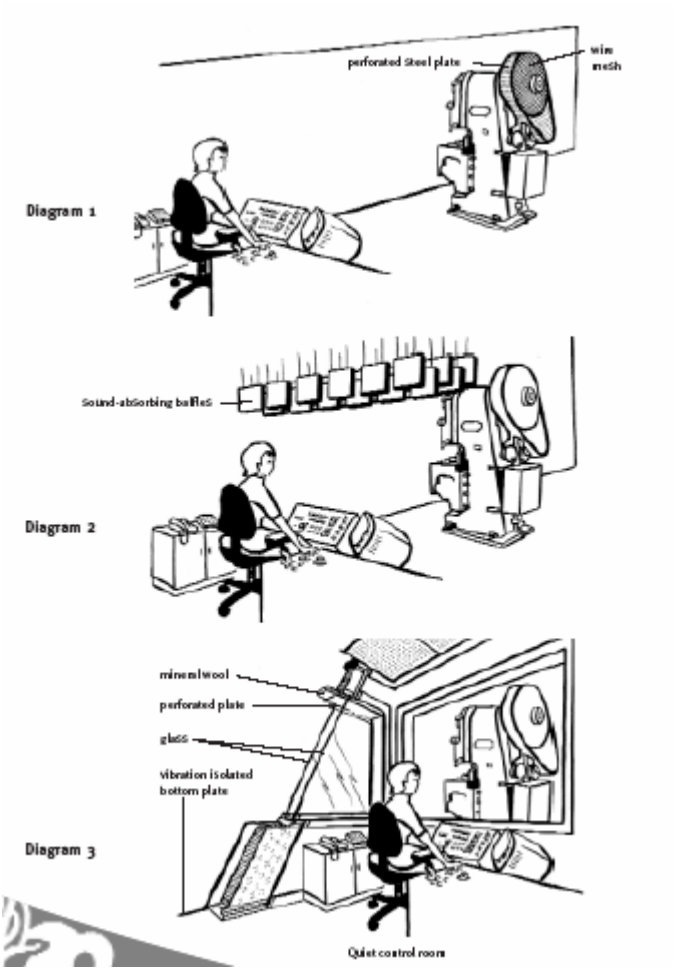
Material handling processes can also be modified to make sure that impact and shock noise sources during handling and transport are minimised as far as possible. This may be achieved by:
- minimising fall height of objects on to hard surfaces
- stiffening and/or fixing damping materials to tables, walls, panels or containers where they are struck by materials or items during processing
- absorbing shocks by providing wear resistant rubber or plastic coatings
- using conveyor belts rather than rollers, which are more likely to rattle, and
- controlling the speed of processes to match practical or realistic production rates. This can result in a smoother flow of production with less noise created by stop-start impact noise.

Engineering treatment of the noise transmission path
It may not be possible to change or modify the noise-generating equipment or processes by engineering treatment of the source. In this case, engineering treatment of the noise transmission path between the source and the workers or other persons should be investigated. Engineering treatment of the noise transmission path includes isolating the noise-emitting object(s) in an enclosure, or placing them in a room or building away from the largest number of workers, and acoustically treating the area to reduce noise to the lowest possible levels.

Consider the following when carrying out engineering treatment of the noise transmission path:
- Noise levels do fall over distance without any engineering treatment. Distance is often the cheapest solution. However, it may not be effective in reverberant conditions.
- Erect a noise barrier between the noise source and the listener. Sometimes a partial barrier can be effective. Where either area has a false ceiling, make sure the dividing wall extends to the true ceiling. All air gaps in the wall should be closed and airtight.
- Once a noise barrier is erected, further treatment may be necessary. This could include the addition of absorbing material on surfaces facing the noise source.
- Materials that are good noise barriers, for example, lead, steel, brick and concrete, are poor absorbers of sound. The denser and heavier the material, the better the noise barrier will be.
- Good sound absorbers, for example, certain polyurethane foams, fibreglass, rockwool and thick pile carpet, are poor barriers to the transmission of sound. Absorbers work because they allow sound to travel through their material turning the sound energy into heat energy.
- Walls and machine enclosures should be designed to minimise resonances that will transmit acoustical energy at the resonant frequency to the protected area. This can be achieved by placing reinforcement or bracing in strategic areas during construction or modification.
- Reduce the reverberation of the room where noise is generated as far as possible. This is best achieved by the introduction of acoustically absorbent material(s). The presence of

reverberation in a room shows the need for absorbing material. Excessive reverberation produces unpleasant and noisy conditions that can interfere with speech communication.

Note: Reduction of the reverberation of a room may not lead to significant reduction of the noise exposure level of people close to the source but will be useful for people further away from the source.



Examples of engineering control measures (above)

Diagram 1 – Engineering treatment at the source
Installation of a perforated sheet metal and wire mesh cover, to replace previous solid metal cover over belt drive and flywheel. Sound radiation is reduced at the source.

Diagram 2 – Engineering treatment of the noise transmission path
Hanging of sound absorbing baffles in the noise path provide low frequency absorption and are easy to install.

Diagram 3 – Engineering treatment at the receiver
When noise cannot be contained at the source or the path it may be necessary to provide a quiet control room. A well-insulated room is built and the floor plate is isolated from machinery vibrations.

These principles can be put to use by:

- using a sound-reducing enclosure which fully encloses the machine(s)
- separating the noisy area and area to be quietened by a sound reducing partition
- using sound-absorbing material on floors, ceiling and/or walls to reduce the sound level due to reverberation
- using sound-absorbing baffles between workers and the noise source, and
- using acoustical silencers in intake and exhaust systems associated with gaseous flow activity, for example, internal combustion exhaust systems or air conditioning systems.

Engineering treatment at the receiver
Where noise cannot be adequately reduced at the source, the environment in which the worker conducts work should be looked at to see if it is desirable to protect the worker(s) instead of enclosing the sound sources. In this case, design of a sound-proof room or sound reducing enclosures should follow the same control principles as for the control of noise at the noise transmission path, or improving the acoustic qualities of the structure between a noisy workplace and an administration area or supervisor's office etc.

Inspection and maintenance of controls
Vibration mountings, impact absorbers, gaskets, seals, silencers, barriers, absorptive materials and other equipment controlling noise levels should be inspected and maintained regularly to make sure they continue to be effective.

5.3 Administrative noise control measures

Administrative noise control measures should be used when it is not possible to reduce noise exposure through engineering noise control measures. Administrative noise control measures include:

- organising schedules so that noisy work is done when as few as people as possible are present
- notifying people in advance when noisy work is to be carried out so they can limit their exposure to it
- keeping people out of noisy areas if their job does not require them to be there
- sign posting noisy areas
- providing quiet rest areas for food and rest breaks, and
- limiting the time workers spend in noisy areas by moving them to quiet work areas before their daily noise exposure levels are exceeded.

It is not always possible to reduce noise emissions for some machines and equipment, for example, large ball mills, angle grinders and explosive powered tools. In these cases, the operator should be protected through the best available means possible. If administrative control measures are relied on, there should be regular checks to ensure that they are fully and correctly complied with.

The following administrative noise control measures can be used depending on the noise levels at the workplace.

Equipment maintenance programs
In most cases maintaining machines and equipment in good condition will reduce noise. Reductions of machine noise by up to 10dB(A) can be achieved this way. Greater reductions can be accomplished depending on the types of machines and equipment. The maintenance program should include any modifications and/or additions for example, noise mufflers, vibration isolators, duct silencers. This should occur as noise levels can increase due to inadequate maintenance, clogging up or changes to machine settings or machine operations.

'Buy quiet' program
Opportunities for implementing a 'buy quiet' program arise when:
- plans are being made for the building and setting up of a workplace
- expansion or refurbishment of the workplace is being considered, and
- new plant and equipment is to be purchased.

Quieter production and handling of materials should be considered when new plant or equipment is being purchased. Prospective suppliers should be required to specify the expected sound pressure levels from the plant in operation, as well as the possibility for further noise reductions and associated costs. This will allow for a comparison of similar plant from competing suppliers. Purchasers can compare this information with their own targets for noise levels.

Acceptable maximum noise levels for plant and equipment should be specified if tenders are invited. Noise levels from new plant should not increase the current noise levels in the workplace. This should be included in the specification.

Job rotation
Job rotation involves changing tasks performed by workers so they are not exposed to risks from excessive noise, for example, if a worker is exposed to noise at a level of 94dB(A) for one hour, the worker should spend the rest of the shift in a work area, eg an office situation, quiet enough so that he or she is not further exposed to risks from noise and the total daily noise exposure level does not exceed $L_{Aeq,8h}$ 85dB(A). It should be noted that noise exposure at a level of 94dB(A) for one hour is a daily noise exposure equivalent to $L_{Aeq,8h}$ 85dB(A).

5.4 Personal hearing protectors

A personal hearing protector is a device, or pair of devices, designed to be worn over or inserted in the ears of a person to protect hearing. It is not appropriate to use personal hearing protectors in low noise environments, that is $L_{Aeq,8h}$ 55-85 dB(A). Noise levels in this range should be controlled by elimination, engineering or administrative control measures.

Personal hearing protectors should be used when levels of excessive noise cannot be reduced by using other control measures. Workers or others at the workplace should be:
- supplied with personal hearing protectors
- instructed in their correct usage
- instructed to wear them when exposed to noise, and
- monitoring the wearing of them by workers.

Personal hearing protectors should not be used as a substitute for engineering or administrative noise control measures. Hearing protectors should normally be regarded as an interim measure while reduction of noise exposure is being achieved by other control measures.

In noisy areas removing personal hearing protectors for even short periods will significantly reduce their effectiveness. This can result in inadequate protection and cause irreversible hearing damage. Taking hearing protectors off for even 15 minutes in a day (3% of an 8 hour day) can expose a worker to excessive noise. Hearing protectors need to be worn 100% of the time to be effective.

There are some problems with wearing personal hearing protectors for long periods in certain environments. Some of these problems, like the risk of ear infections, can be reduced by regular brief periods in quiet areas, without the hearing protectors. This practice should be included in a personal hearing protection program.

A personal hearing protection program is a plan for protecting a person's hearing and includes regular hearing testing. A personal hearing protection program can be adopted where technical problems make it impossible to reduce exposure to excessive noise by engineering or administrative noise control measures, or delay their implementation.

Hearing protection areas

Areas where persons may be exposed to excessive noise should be signposted as 'hearing protection areas'. The boundaries of these areas should be clearly defined. No person, including visitors, manager or supervisor, should enter a hearing protection area during normal operation unless they wear appropriate personal hearing protectors. This is regardless of how long the person spends in the hearing protection area.

Signs used to identify these areas should conform to *Australian Standard 1319 - Safety signs for the occupational environment.* Correct selection can be confirmed with a supplier of workplace health and safety signs. Additional signs within the hearing protection areas may also be necessary.

Alternative arrangements for defining hearing protection areas should be made in consultation with workers if sign-posting is not possible. This should be done to make sure workers and others can recognise situations where personal hearing protectors are required.

Methods of achieving this include:

- attaching prominent warning notices to tools and equipment to show that personal hearing protectors must be worn when operating them
- providing written and verbal instructions on how to recognise circumstances in which personal hearing protectors are needed, and
- effective supervision of identified 'hearing protection areas'.

Selection of personal hearing protectors

It is important to ensure that personal hearing protectors will provide wearers with reliable adequate protection. Personal hearing protectors should be selected in accordance with AS/NZS 1269.3 and

should comply with the requirements of *Australian Standard/New Zealand Standard AS/NZS 1270 Acoustics – Hearing Protectors.* The attenuation values used in all selection procedures should be derived from attenuation measurements made in accordance with AS/NZS 1270.

Suppliers should provide full information on the attenuation provided by the protectors, including the SLC80 ratings, Class[15] and octave band attenuation values. Supplier's reports should be available to workers and workplace health and safety representatives. Additional information is available in the National Acoustics Laboratories' publication *Attenuation and use of Hearing Protectors*.

When adequate hearing protection can be given by personal hearing protectors, the user should be allowed to choose from the range of appropriate protectors. Individual selection of personal hearing protectors should be based on:

- The degree of protection required in the worker's environment. Personal hearing protectors with unnecessarily high attenuation (noise reduction) may cause communication difficulties and ultimately be unsuitable because of discomfort and inconvenience.
- Suitability for use in the type of working environment and the job involved. For example, ear plugs are difficult to use hygienically in work that requires them to be inserted with dirty hands. For these jobs, ear muffs might be better. On the other hand, ear muffs can be more uncomfortable in hot environments, or may make it difficult for the wearer to enter a confined space or to wear a helmet.
- The comfort, weight and clamping force of the hearing protector.
- The fit to the user. Individual fitting is necessary for optimum protection. This should be checked while the user is wearing other regularly used items that might affect the performance of the hearing protector. For example, spectacle wearers should be fitted with earmuffs while wearing their normal spectacles. Disposable plugs do not need individual fitting. However, the ability of the material to conform to the user's ear canal should be taken into account.
- The safety of the wearer and fellow workers. For example, the suitability for use with any other personal protective equipment that might be required, like safety helmets or respiratory protective equipment. By correctly selecting personal hearing protectors, warning sounds will not be masked when the protector is worn. The use of personal hearing protectors may make it more difficult for workers to hear sounds, especially if they already have a hearing deficiency. Particular care needs to be exercised in these cases.

[15] 'Class' means a hearing protector classification for noise exposure levels as specified by AS/NZS 1269 .3.

Inspection and maintenance
Employers, or other obligation holders, should ensure that workers' personal hearing protectors are regularly inspected and maintained. Workers should inspect personal hearing protectors regularly to detect and report damage or deterioration.

Obligation holders should ensure that a system is instituted to determine appropriate maintenance of personal protective equipment.

This system should cover at least:
- the responsibilities for maintenance
- the designation of personnel
- storage procedures
- cleaning procedures
- checking procedures, and
- criteria for replacement.

Further information can be found in *AS/NZS 1269.3*.

Information and training
Employers, or other obligation holders, should explain the need for personal hearing protectors before they are issued to workers. Workers should be given guidance in the selection of appropriate personal hearing protectors and instructed that the selection of an appropriate personal hearing protector is based on the amount of attenuation required for the environment and task to be undertaken. Instruction in their use, fitting, care and maintenance should be repeated at regular intervals. Employers, managers and supervisors should lead by example and ensure that personal hearing protectors are used correctly where and when required. Workers who have been properly instructed in the use of personal hearing protectors, should wear them where and when required.

6. Audiometric testing

The hearing of workers exposed to noise can be monitored through regular audiometric examinations. Audiometric testing is when a person's hearing threshold levels are measured by monaural pure tone air conduction threshold tests. While testing is not a preventive mechanism in itself, and is only relevant in the context of a comprehensive hearing conservation program, it is an important part of managing the risks from noise exposure at the workplace. Any changes in a person's hearing levels revealed by audiometric testing should be investigated as to their cause(s) and the need for corrective action. An audiometric testing program should be available to any worker likely to be regularly at risk from exposure to excessive noise levels at work.

Note: As a precautionary measure the audiometric testing program could also be made available to workers exposed to workplace ototoxins or acoustic incidents. (see Appendices 4 and 5)

Testing scheme
All testing should be done by an appropriately trained and experienced person, who is selected by management in consultation with workers and workplace health and safety representatives at the workplace. A person who carries out audiometric testing should use procedures and equipment that comply with *AS/NZS 1269*. The audiometric testing scheme should include an initial reference test, with periodic monitoring audiometric testing to follow. The initial reference audiogram[16] should be taken before exposure to noise occurs or as soon as the worker starts work. Monitoring audiometric

[16] **'audiogram'** means a chart or table relating a person's hearing threshold levels for pure tones to frequency

testing should be conducted within 3 months of beginning work, for comparison with the initial reference audiogram[16], and then 12 months of the initial work exposure. In the absence of significant threshold shift or change in the work situation, it may then be sufficient to repeat the test at yearly intervals.

Note: At high daily noise exposure level (e.g.>100dB(A)) more frequent audiometric testing may be desirable. Monitoring audiometric testing should be scheduled well into the work shift so that comparison with the reference audiogram will reveal any temporary threshold shift due to inadequacies in the use of personal hearing protectors.

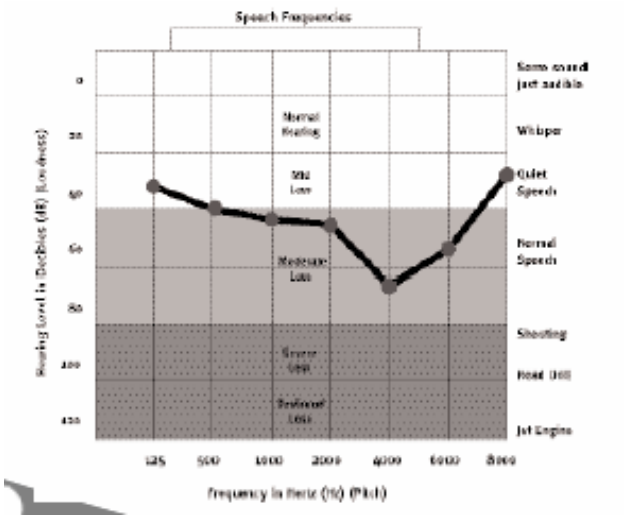
Each worker's hearing, and the correct type of personal hearing protectors for the job, should be discussed with that worker. Proper fitting of personal hearing protectors should be ensured at the completion of the examination. Instructions on their use should be repeated at future audiometric testing sessions.

Assessment of audiograms
Audiograms should be assessed and action taken in accordance with Section 9 of AS/NZS 1269.4.

When workers are found to have sufficient hearing loss to interfere with the safe performance of their jobs and communication, all practicable steps should be taken to modify the work environment such as volume control telephones, acoustically treated meeting areas with low noise and low reverberation, and supplementary visual warning signals. Where these cannot remedy the situation, workers should be offered alternative work that does not put them at risk to excessive noise.

Test results
Workers should be requested to have a further audiometric examination when the deterioration in hearing threshold level between the initial reference audiogram and any later monitoring audiogram show a:

- shift in average threshold at 3000, 4000, or 6000Hz greater than or equal to 5dB, in either ear
- change in mean threshold greater than or equal to 10dB at 3000 and 4000Hz, in either ear



- change in mean threshold shift greater than or equal to 15dB at 6000Hz, in either ear
- threshold shift greater than or equal to 15dB at 500, 1000, 1500, or 2000Hz, in either ear, or
- threshold shift greater than or equal to 20dB at 8000Hz, in either ear.

The audiometric examination should occur on another day, after 16 hours in quiet (less than 75 dB[A]) conditions. If the threshold shift is confirmed the worker should be referred for specialist audiological or medical advice concerning the cause of the shift.

If, following referral, future audiograms reveal additional deterioration equalling or exceeding 5 dB at 3000 Hz, 4000 Hz or 6000 Hz, the worker should be referred for further specialist audiological or medical advice. If future tests reveal no additional deterioration no referral is necessary. If the characteristics of hearing loss are consistent with exposure to noise, the worker's noise exposure and hearing protection should be assessed.

Accumulated deterioration in hearing from the initial reference audiogram discovered over multiple tests should be referred for specialist audiological or medical advice. For example if an audiometric test revealed deterioration of 4 dB at 3000Hz from initial testing and a subsequent test 12 months later revealed a further 4 dB deterioration then a total of 8 dB deterioration at 3000Hz has occurred in 2 years. A referral is therefore required as a shift greater than 5dB has occurred since the initial reference audiogram was taken.

Results should be given to workers by the appropriately trained and experienced person either immediately or as soon as practical of the audiometric testing. Results should be accompanied by a written explanation which can be easily understood. This should help the worker understand what the results mean and if there are any implications. Test results are confidential and consideration to the storage and communication of this information should be given. Individual results should be given to other parties only with the written permission of the worker. Unidentifiable individual results and group data should be accessible to the relevant employer, workplace health and safety representative(s) and the relevant authority for the development or assessment of noise control policies.

Action to be taken when threshold shifts are detected

When temporary or permanent threshold shifts are revealed by audiometric tests or new tinnitus reported, action should be taken to inform the responsible obligation holder to arrange to:

- review the worker's job to identify any changes that may have caused an increase in exposure to noise

- re-determine exposure to noise, if necessary
- determine whether anything can be done to reduce the levels of noise to which the worker is exposed and the durations of exposure
- verify the nominal performance of the worker's hearing protector is adequate for the level of exposure to noise
- examine the hearing protector carefully and ensure it is not worn or damaged
- check the worker is able to fit the hearing protector properly
- check the hearing protector fits the worker closely and there are no leakage paths
- ask the worker if he or she has any difficulty using the hearing protector
- check the worker actually uses the hearing protector correctly, and
- deal with any problems revealed by the above procedures, calling on expert advice as necessary.

Updating of reference audiograms

The reference audiogram should be updated whenever a significant permanent threshold shift has occurred or every ten years, whichever occurs sooner. After a significant permanent threshold shift has been found and medically assessed, the employer, or other obligation holder, should ensure that an updated reference audiogram is obtained for the worker. Subsequent monitoring audiograms should then be compared with the most recent reference audiogram. Records of previous reference audiograms should be retained.

Records

Where audiometric test records of workers are given to the employer, they should be kept for the worker's period of employment. The records should be kept in a safe, secure place and held as 'confidential' documents during the worker's period of employment. When a worker's period of employment ends, those records should be given to the worker.

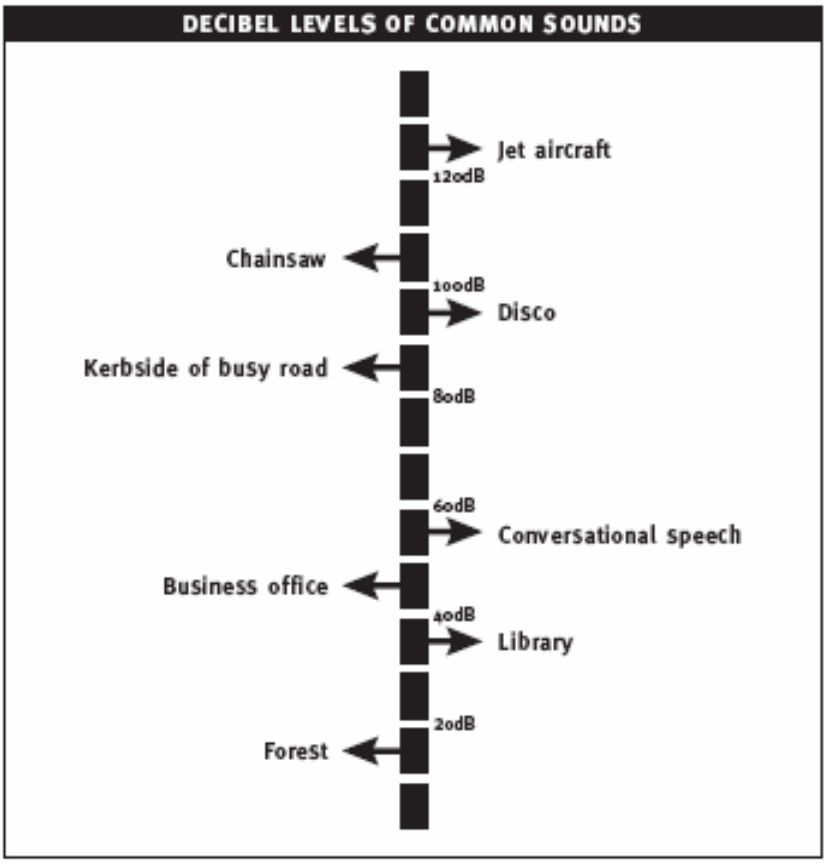
Further information

Further information can be found in *AS/NZS 1269.4*.

Appendix 1 – Noise hazard identification checklist

Description of work location:_____
Task at workstation:_____
Assessed by:_____
Employee representative:_____Date:_____
Yes to any of the following indicates the need for a detailed noise assessment.

1. Is a raised voice needed to communicate with someone about one meter away?	Yes No
2. Do people working in the area notice a reduction in hearing over the course of the day? (This reduction might not be noticed until after work.)	Yes No
3. Do workers experience any of the following? (a) ringing in the ears (tinnitus) (b) the same sound having a different tone in each ear (c) blurred hearing.	 Yes No Yes No Yes No
4. Are any long-term workers hard of hearing?	Yes No
5. Are personal hearing protectors provided?	Yes No
6. Are signs, indicating that personal hearing protectors should be worn, posted at the entrance or in the work area?	Yes No
7. Have there been any workers' compensation claims for noise-induced hearing loss?	Yes No
8. Does any equipment have manufacturer's noise information (including labels) that indicates noise levels equal or greater than any of the following: (a) 80 dB(A) LAeq,T? (b) 130 dB peak noise level? (c) 88 dB(A) sound power level?	 Yes No Yes No Yes No
9. Do the results of audiometry indicate that past or present workers have hearing loss?	Yes No
10. Does the noise in any part of the workplace sound as loud or louder than 85 decibels using the scale Decibel Levels of Common Sounds?	Yes No
11. Are any of the workplace ototoxins listed in Appendix 6 being used in the workplace?	Yes No


DECIBEL LEVELS OF COMMON SOUNDS
Jet aircraft
120dB
Chainsaw
100dB
Disco
Kerbside of busy road
80dB
60dB
Conversational speech
Business office
40dB
Library
20dB
Forest

Appendix 2 – Instruments for assessing noise levels

A sound level meter (SLM) is an instrument consisting of a microphone, amplifier and indicating device. The meter has a declared performance, and is designed to measure a frequency - weighted and time-weighted value of the sound pressure level.

Sound level meters and integrating averaging sound level meters should comply with the specifications of Australian Standards AS IEC 61672.1 and AS IEC 61672.2 respectively. Sound exposure meters should comply with the specifications of Australian New Zealand AS/NZS 2399.

SLMs have four principal grades of precision:

Type/Description	**Tolerance**
0-Laboratory reference meter	± 0.4dB
1-Precision	± 0.7dB
2-General Purpose	± 1.0dB
3-Survey	±1.5dB

Noise assessments should be performed with Type 2 general purpose meters, or better. Type 3 survey meters are usually inexpensive but may have wide precision tolerances and some models cannot be calibrated. Type 3 survey meters are only suitable for preliminary noise checks to find out whether more accurate assessments are needed.

The SLM may have an integrating function that enables the meter to process a continuous, variable, intermittent or impulsive signal to give a single integrated level or L_{eq} for the sampling period. A meter with this function is an integrating sound level meter (ISLM).

The SLM may also have a peak detector indicating characteristic. This is necessary to measure the C-weighted peak sound pressure level. The term, peak sound pressure level, should not be confused with the maximum sound pressure level.

A sound exposure meter (SEM) or noise dose meter is an instrument for measuring noise exposure by automatically integrating sound energy over a measurement period and displaying the result. The instrument may be worn by the person concerned, or placed at a suitable location to estimate the noise exposure received by one or more persons, stationary or otherwise for a given period, for example, a working day.

The SEM records the personal noise exposure of the worker. Some SEMs can record a time history of a worker's noise exposure for the measurement period. A typical time history report will provide a histogram of minute by minute noise exposure levels. This is an advantage in identifying major contributors to the average daily noise exposure that can then be further investigated with a hand-held meter.

The following points should be considered when using a SEM:

- Reflection of sound from the clothes and body can cause an increase of about 1 to 3 dB.
- The microphone should be attached as close as possible to the ear. For example, if the microphone is attached to the lower part of the collar or pocket, it may be much closer to a noise source than the ear and an unduly high result will be recorded. Also, the body may shield a noise source.
- The assessment of exposure over just one day may not give a representative sample.
- If possible, it is best to take measurements over a few days.

It is advisable to check the SEM results with a hand held SLM. Some SEMs do not measure impulse sound adequately.

Meters should be checked with an acoustic calibrator[17] immediately before and after measurements are taken. A full calibration of acoustic measuring systems should be performed at regular intervals not exceeding two years by a laboratory that produces test reports recognised by the National Association of Testing Authorities, Australia, covering the relevant accredited tests.

[17] '**acoustic calibrator**' means a device for applying a sound pressure of known level to the microphone of a sound measuring system, for the purpose of calibration.

Appendix 3 – Guidance material for designers, manufacturers and suppliers of plant on the presentation of information about noise levels generated by plant

Introduction

This guidance material is designed to help:

- Designers, manufacturers and suppliers of plant to provide information on noise levels generated by plant.
- Purchasers make an informed choice when purchasing plant, by being able to assess and compare suppliers' noise level information. This information will usually be obtained from tests under standardised conditions. However, the plant may generate different noise levels in the workplace and it is the responsibility of the employer purchasing the plant to assess noise levels in the workplace.

The reasons for providing information on noise levels to prospective purchasers are:

- noise levels are a significant factor in decisions on the purchase or hire of plant, because buying 'quiet plant' is a highly cost effective way to control workplace noise
- provision of information encourages purchasers to buy quieter products, and
- low noise work environments contribute favourably to the reduction of occupational noise-induced hearing loss and improvement of the health and wellbeing of workers at the workplace.

Information on noise

Information on noise levels should be:

- Collected by a competent person according to good measurement practice as defined in relevant international or local Standards. This ensures a reasonable standard of accuracy.
- Presented in a clear, understandable format.
- Technically complete and clear.
- Representative of noise likely to be emitted by plant under typical conditions of usage.

The minimum testing information which should be supplied to the purchaser is listed in Table A. Where relevant information on test procedures is contained in a test standard or a test report, reference to the standard or the report should be included. Information should be provided on peak noise levels, where relevant, as well as on continuous noise levels. The manufacturer/ supplier should be able to provide a full test report when requested.

Where there is a selection of noise measurement results available, the preferred measurement, for this standard, is the sound pressure level at the operator's ear position.

Table A - Minimum noise testing information to be specified by the manufacturer or supplier

Supplier's details e.g. name, local address, telephone and/or facsimile number email.

Manufacturer's details e.g. name, local address, telephone and/or facsimile number.

Details of the plant tested (including any noise controls) e.g. make, model, serial number, relevant capacity/rating.

Title or number of specific test standard or code followed (if any) and details of any departures from the Standard. E.g. if a machine needed to be mounted differently to the method given in the Standard, the alternative mounting should be described.

Details of operating conditions if not specified in the Standard, or if no specific test standard is available for the type of plant being tested. E.g. test machine load, speed, type of material processed, details of installation and mounting of test machine, details of test environment, description of measurement instrumentation and procedure. Reference to a test report containing this information will suffice.

Measurement position(s) (e.g. operator's ear position or 1 metre from machines).

Index measured (e.g. sound pressure level or sound power level[18]).

Frequency weighting (e.g. A, C or linear).

Time Weighting (e.g. Leq, or LPeak).

Sound level or levels determined in testing, and at what measuring position(s).

Units of measurement (e.g. dB re: 20 micropascals).

Date issued.

Suggested proforma for presentation of information on noise levels generated by plant
A suggested proforma for the presentation of information on noise levels generated by plant follows. However, the information may be presented in any convenient way that will bring it to the purchaser's attention. For example, a catalogue or operating instructions would be suitable, provided the information is complete.

[18] 'sound power level' means the relative magnitude of sound power, customarily expressed in decibels referenced to 1 picowatt.

Supplier/Manufacturer		
Supplier:		
Name		
Address		
Phone/Facsimile		
Manufacturer:		
Name		
Address		
Phone/Facsimile		
Details of plant tested		
Description of item		
Make		
Model Serial No.		
Noise reducing attachments fitted		
Test procedures		
Operation conditions		
Test environment		
Test standard followed		
Number		
Title		
Clauses		
Departures from standard		
Measurement method if no standard followed		
Results		
Sound pressure levels in decibels		
Measurement position		
Time weighting (fast, slow, Leq)		
	Range	**Mean**
A-weighted	To	dB(A)
C-weighted	To	dB(C)
C-weighted, peak	To	dB(C) peak
Sound power level	To	dB(A)
Date issued		

Appendix 4 – Ototoxins

Introduction

4.1 Exposure to certain chemical substances may result in hearing loss. These substances are called ototoxins. They may damage the cochlea in the inner ear and/or the auditory neurological pathways. Hearing damage is more likely if exposure is to a combination of substances or to a combination of the substance and noise.

4.2 Ototoxins can be divided into two general classes: workplace chemicals and medication.

Workplace chemicals

4.3 Research is still being carried out to establish human exposure response relationships for workplace ototoxins, either alone or in combination with noise. Exposure standards for chemicals and noise have not yet been altered to take account of increased risk to hearing.

4.4 Until revised standards are established it is recommended that workers exposed to any of the substances listed in Table 1 be included in audiometric testing programs and that information on ototoxins be included in training sessions. Annual audiograms are highly recommended for workers whose airborne exposures (without regard to respiratory protection worn) are at 50% or more of the (former) NOHSC National Exposure Standard[19] or the substance in question, regardless of the noise level.

4.5 Some potential ototoxins may be absorbed through the skin (See Table A3). If such skin exposures cannot be controlled and are chronic, annual audiograms are also recommended. Control measures should be implemented in the workplace to eliminate or reduce exposure to ototoxins. Personal protective equipment is the least preferred of these controls.

4.6 For workers currently participating in an audiometric testing program due to excessive noise, suitably trained reviewers of the audiometric data should be alert to possible additive or synergistic effects between the exposure to noise and ototoxins and, if necessary, suggest reducing exposure to one or both.

4.7 Activities where noise and ototoxins often combine include: painting; printing; boat building; construction; furniture making; manufacture of metal, leather and petroleum products; fuelling vehicles and aircraft; fire fighting and weapons firing.

4.8 Personal protective equipment may need to be supplied for the handling of ototoxins.

Medication

4.9 Some medications have been identified as ototoxins such as some anti-cancer, anti-inflammatory, anti-thrombotic, anti-malarial and anti rheumatic drugs, loop diuretics and antibiotics.

Information about the possible hearing loss effects of these drugs should be included in training programs and workers should be encouraged to discuss any concerns they may have about their own medication with their doctor or pharmacist.

[19] National Occupational Health and Safety Commission. Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:1003(1995)], Australian Government Publishing Service, Canberra, 1995.

Further information
Further information on the research being undertaken in this area can be found at www.cdc.gov/niosh/topics/noise/.

Notes:
1. Research in this area is ongoing. Substances have been included in this table based on the priority list given in a paper by Morata[20].
2. Other substances with similar molecular structures and other heavy metals should not be assumed to have no ototoxic effects simply because no clear evidence is presently available.
3. Skin absorption has been listed based on the substance having an 'Sk' notice in the (former) NOHSC National Exposure Standard[21].

[20] Morata, T.C., *Chemical Exposure as a Risk Factor for Hearing Loss*. JOEM, Vol. 45, Number 7 July 2003.
[21] National Occupational Health and Safety Commission. *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment* [NOHSC:1003(1995)], Australian Government Publishing Service, Canberra, 1995.

Table 1 – Potential workplace ototoxins

Type	Name	Skin absorption
Solvents	Butanol	√
	Carbon disulphide	√
	Ethyl benzene	
	Heptane	
	n-hexane	
	Perchloroethylene	
	Solvent mixtures and fuels	√
	Styrene	
	Toluene	
	Trichloroethylene	
	White spirit (stoddard solvent)	
	Xylene	√
Metals	Arsenic	
	Lead	
	Manganese	
	Mercury	√
	Organic tin	√
Others	Carbon monoxide	
	Hydrogen cyanide	√
	Organophosphates	√
	Paraquat	

Appendix 5 – Acoustic shock

Introduction

5.1 Acoustic shock is a term used to describe the physiological and psychological symptoms a person may experience after hearing a sudden, unexpected, loud sound (referred to as an acoustic incident), via a telephone headset or handset.

5.2 It is not the same as Acoustic trauma, which is caused by very high (greater than 140 dB(C)) peak noise levels. Acoustic shock does not usually result in hearing loss. It can be triggered by sounds with peak noise levels well below those in the National Standard or those currently required by telecommunications regulators.

5.3 Call/contact centre telephone operators are thought to be the type of workers most at risk.[22]

5.4 Though many acoustic incidents are reported from call centres throughout Australia, only a small proportion result in acoustic shock symptoms. Data from one telecommunications corporation indicates that only about 11% of those who reported an acoustic incident showed any symptoms and only 1.5% developed long-term symptoms.[23]

5.5 The effect on individuals can vary greatly for the same increase in sound level. Why this is so is not known with certainty and is still being researched. One theory (Patuzzi[24]) suggests that an acoustic incident induces a startle reflex in one of the middle ear muscles and that the sound threshold of this reflex is lowered when the person is under stress. So it is likely that acoustic shock is not due to one single factor, such as the level of sound experienced, but to a combination of physical and psychological stressors in the workplace.

Acoustic shock symptoms

5.6 A person may experience some or all of a number of symptoms that have been grouped into the following three categories:

(a) **Primary (immediate) symptoms** – include but are not limited to:

- a feeling of fullness in the ear
- burning sensations/sharp pain around/in the ear
- numbness/tingling/soreness down side of face/neck/shoulder
- nausea/vomiting
- dizziness
- tinnitus and other head noises such as ‘fluttering’
- hearing loss (in a very few cases), and
- falling to the floor (in extremely rare cases).

(b) **Secondary symptoms** – include but are not limited to:

- headaches
- fatigue, and
- anxiety.

[22] ITU-T Recommendation p.10 (12/98): Vocabulary of terms on telephone transmission quality and telephone sets, Geneva, 1998.

[23] *Patuzzi, R, Acute Trauma in users of Telephone Headsets and Handsets*, Proceedings of Risking Acoustic Shock Seminar, Fremantle, 2001

[24] *Patuzzi, R, Acute Trauma in users of Telephone Headsets and Handsets*, Proceedings of Risking Acoustic Shock Seminar, Fremantle, 2001

(c) **Tertiary symptoms** – include but are not limited to:

- sensitivity to previously tolerated sounds (hypersensitivity)
- hyper vigilance, and
- anxiety concerning return to telephone work.

People experiencing such symptoms will respond in different ways. As with other workplace injuries and ill health, some may experience further effects including anger, social isolation, depression and other psychological problems.

Sources of acoustic incidents

5.7 Sources that may cause acoustic incidents include:

- tones from misdirected facsimiles or modems
- transmission faults within the network
- faulty customer equipment
- faulty telephone or headset equipment
- feedback oscillation from some cordless phones
- mobile phones when flip cover is closed, and
- customers yelling, blowing whistles, slamming down phones etc.

Factors influencing likelihood of acoustic shock

5.8 The factors influencing the likelihood of an individual receiving an acoustic shock have been suggested by the Australian Communication Industry Forum[25] to include the following:

- number of calls made or received by a person in a working day – increases chance of receiving an acoustic incident
- background noise level – operators increase volume control in high background noise
- loudness of the received sound – severity may increase with increasing loudness
- suddenness of the increase in sound level – may induce startle
- duration of the increase in sound level – affects perceived loudness
- frequency of sound – 1 kHz to 4 kHz more likely to cause startle
- nature and unexpectedness of the sound – may affect perceived loudness
- operator's pre-existing health condition – e.g. middle ear inflammation or previous baro-trauma, from diving or flight depressurisation increases risk
- operator's tiredness, anxiety or stress – stress levels have been shown to have a significant influence
- number of previous acoustic incidents – more likely to react if experienced previous acoustic incidents
- severity of any previous acoustic shock – may increase the reaction to a new acoustic incident
- time since last acoustic incident – greater time less reaction, and
- whether a handset or headset is used – headset cannot be removed as quickly.

[25] Australian Communications Industry Forum, ACIF G616:2006, *Industry Guideline: Acoustic safety for telephone equipment*.

Reducing the risk and severity of acoustic shock

5.9 Possible risk control measures are:

- using acoustic shock protection devices

(Note: It is not possible to simply limit the volume of a telephone to a level that simultaneously provides complete protection from acoustic shock while maintaining high intelligibility in all listening situations.)

- reducing the background noise levels in the room by, for example:
  - reducing amount of external and building service noise entering the room
  - reducing reverberation (reflections) within the room by use of sound absorbing materials
  - placing acoustic barriers around/between workstations
  - locating photocopiers, printers and fax machines away from workstations
  - training operators to control voice levels
  - encouraging staff not to hold discussions near operators
- implementing a procedure for prompt repair of faulty telephone and network equipment
- preventing mobile phones from being used in or near call centre areas
- training operators in the proper fitting and use of headsets to reduce feedback
- improving the work environment and procedures to reduce stress
- developing and implementing procedures for managing acoustic incidents and acoustic shocks, and
- providing information and training to operators and supervisors so that they can understand and identify acoustic incidents and acoustic shock symptoms.

Managing acoustic incidents

5.10 A procedure for managing an acoustic incident should at least include the following:

(a) the operator should:
  (i) remove the headset immediately
  (ii) move to the 'timeout' area
  (iii) report the incident and any symptoms to management, and
  (iv) discuss with management the ability to continue work or, where appropriate, relocation to another workstation or referral for medical and/or audiological assessment.

(b) management should:
  (i) record and log the incident including possible source
  (ii) check headset and other equipment for faults
  (iii) discuss the incident, any symptoms and ability to continue working with the operator
  (iv) when symptoms persist or are severe, refer the operator for medical and/or audiological assessment and record this referral
  (v) review the adequacy of noise and stress control measures
  (vi) provide the operator with assistance in rehabilitation and return to work (i.e. an injury management program).