MANAGING NOISE AND PREVENTING HEARING LOSS AT WORK

LEARNING OUTCOME

Understand the legislative requirements relating to managing noise and preventing hearing loss at work.

ASSESSMENT CRITERIA

- Describe basic mechanisms of sound and the anatomy of hearing.
- Identify hazardous noise and describe its' effects on health and safety.
- Identify and describe the work, health and safety legislation applicable to management of noise hazards at work.
- Describe how noise hazards are assessed, evaluated and controlled.

REFERENCES

Work Health and Safety Act 2011:

- s19 Primary duty of care
- s28 Duties of workers
- s29 Duties of other persons at the workplace

Work Health and Safety Regulation 2011:

- Part 3.1 Managing risk to health and safety, sections 32 to 38
- Part 3.2 General workplace management
  - Division 1 Information, training and instruction, section 39
  - Division 5 Personal protective equipment, sections 44 to 47
- Part 4.1 Noise, sections 56 to 59

Managing Noise and Preventing Hearing Loss at Work Code of Practice 2011

ATTACHMENT

Managing Noise and Preventing Hearing Loss at Work Code of Practice 2011

ADDITIONAL RESOURCES

Noise Exposure Calculator

MANAGING NOISE AND PREVENTING HEARING LOSS AT WORK

Noise at the workplace that exceeds the exposure standard and is not controlled is a major cause of hearing loss to workers. A significant loss of hearing contributes to social isolation and reduced quality of life, career prospects, increased absenteeism, worker turnover and lowered work performance. It can also be a contributing factor to workplace injuries and accidents.

A person conducting a business or undertaking (PCBU) must ensure that workers are not exposed to noise that exceeds the exposure standard for noise. The exposure standard for noise is defined in the Work Health and Safety Regulation 2011 as $L_{Aeq,8h}$ of 85 dB(A) or an $L_{C,peak}$ of 140 dB(C).

There are requirements for designers, manufacturers, importers, and suppliers of plant to develop, provide and supply information about the noise emissions produced by a piece of plant.

WORK HEALTH AND SAFETY LEGISLATION

Work Health and Safety Regulation 2011 (WHS Regulation) includes a number of provisions applicable to the management of hazardous noise and prevention of hearing loss at work:

Part 3.1 Managing risk to health and safety, sections 32 to 38
Part 3.1 provides a requirement for PCBUs to manage all health and safety risks, so that the health and safety of workers and other people is not affected by an organisation's conduct. It includes requirements to identify hazards, manage risk through application of the hierarchy of control, maintain controls and periodically review controls.

A PCBU must review and as necessary revise noise control measures:

- when the control measure does not control the risk so far as is reasonably practicable
- before a change at the workplace that is likely to give rise to a new or different health and safety risk that the control measure may not effectively control
- if a new hazard or risk is identified
- if the results of consultation indicate that a review is necessary
- if a health and safety representative requests a review

A PCBU must also ensure that the control measures implemented remain effective. This includes checking that the control measures are suitable for the nature and duration of the work, are installed, maintained and used correctly.

Part 3.2 General workplace management
Division 1 Information, training and instruction, section 39
This division requires provision of readily understandable information, training and instruction to workers. It must be suitable and adequate given:

- the nature of the work carried out by the worker
- the nature of the associated risk, and
- control measures implemented

Division 5 Personal protective equipment (PPE), sections 44 to 47
This division provides requirements when PPE (for example hearing protectors) are used to minimise a risk to health and safety in relation to work at a workplace. The PCBU must ensure that the equipment is:

- selected to minimise risk to health and safety
- suitable for the nature of the work and any hazard associated with the work
- a suitable size and fit and reasonably comfortable for the person wearing it
- maintained, repaired or replaced so it continues to minimise the risk

- used or worn by the worker, so far as is reasonably practicable

A worker or person other than a worker must, so far as is reasonably practicable, wear the PPE in accordance with any information, training or reasonable instruction.

Part 4.1 Noise, sections 56 to 59
Section 56
Defines the exposure standards for noise as an LAeq,8h of 85 dB(A) or an LC,peak of 140 dB(C). There are two parts to the exposure standard for noise because noise can either cause gradual hearing loss over a period of time or be so loud that it causes immediate hearing loss.

$L_{Aeq,8h}$ means the eight hour equivalent continuous A-weighted sound pressure level in decibels, referenced to 20 micropascals, determined in accordance with AS/NZS 1269.1. This is related to the total amount of noise energy a person is exposed to in the course of their working day. It takes account of both the noise level and the length of time the person is exposed to it. An unacceptable risk of hearing loss occurs at LAeq,8h values above 85 dB(A).

$L_{C,peak}$ means the C-weighted peak sound pressure level in decibels, referenced to 20 micropascals, determined in accordance with AS/NZS 1269.1. It usually relates to loud, sudden noises such as a gunshot or hammering. LC,peak values above 140 dB(C) can cause immediate damage to hearing.

Section 57
Specifically requires a PCBU to manage risks to health and safety related to hearing loss associated with noise, using the criteria outlined in Part 3.1. It also requires a PCBU to ensure that the noise a worker is exposed to at a workplace does not exceed the exposure standard for noise.

Section 59
Requires a designer of plant to design the plant so that its' noise emission is as low as reasonably practicable.

BASIC MECHANISMS OF SOUND AND ANATOMY OF HEARING

Sound

The vibration of a sound source causes waves of pressure in nearby particles of air. Like ripples on water, these waves gradually spread away from the sound source and eventually fade away. Sound propagates in air at approximately 344 metres per second at 20^{o}C. In liquids and solids the propagation velocity is greater due to their increased density. For example, in water sound propagates at about 1500 m/s and in steel about 6000 m/s.

The unique characteristics of sound are provided by a combination of three features:
- Frequency
- Relative intensity
- Rate of onset and decay

The two properties of sound that are most often measured are frequency and relative intensity. These are explained in more details as follows:

Frequency & Hertz

Frequency expresses the number of waves per second in units of hertz (Hz). Sound exists over a very wide frequency range. Audible sound for a person with good hearing ranges

between 20 Hz and 20,000 Hz. At low frequencies, the air particles vibrate slowly producing base tones. At high frequencies the air particles vibrate quickly giving soprano tones.

Sound with frequencies under 20 Hz, which is normally inaudible, are called infrasound. Sounds over 20,000 Hz, which are normally inaudible, are called ultrasound.

Relative intensity & Decibel

Relative intensity is presented as a sound level using a logarithmic unit called a decibel (dB). As sound is a pressure wave, a sound level meter actually measures pressure. It then uses an algorithm to convert the pressure reading into a decibel.

The human ear is capable of discerning pressures from 20 micropascals up to 200 pascals. To put this huge range into something manageable, the decibel scale was creating, ranging from 0 to 140 dB.

As the decibel scale is logarithmic, we can't add decibels in the usual way:

- An increase of 3 decibels represents an approximate doubling of the sound pressure level; and
- An increase of 10 decibels represents an approximate ten-fold increase in sound pressure level.

DECIBEL WEIGHTING SCALES

The ear does not have an equal response across the whole frequency spectrum. It best responds in the middle frequencies. For this reason adjustments, called weightings, are made to reflect the range of the human ear:

The **A Weighting** of a sound level meter reduces the low frequency response to better represent the response on the human ear. It is used for assessing noise of all levels.

The **C-weighting** is an adjustment used to approximate the response of a human ear at high sound pressures/intensities. The C scale is typically used to measure peak sound pressure levels.

Noise

Noise is generally described as unwanted sound. This is a somewhat subjective concept, whether a sound is unwanted is dependent on the listener. For example, personal taste in music.

Hazardous Noise

Hazardous noise means noise that exceeds the exposure standards for noise in the workplace and has the potential to cause harm to workers and others.

ANATOMY OF HEARING

How the ear works

The human ear is a delicate organ that can detect a wide range of sounds. However, excessive noise can permanently damage its ability to work properly.

The ear is divided into three parts:

- Outer Ear
- Middle Ear
- Inner Ear

Outer Ear

The outer ear consists of the ear lobe and auditory canal. It collects and channels sound to the middle ear.

Middle Ear

The middle ear consists of the ear drum (tympanic membrane) and a series of small bones (Stirrup, hammer and anvil) that move as sound occurs. These bones transmit sound waves received at the ear drum and relay them to the inner ear.

Inner Ear

The inner ear has two parts. The semi-circular canals which control our balance and the fluid filled cochlear which allows us to hear. Inside the cochlear, movement of fluid and membranes reach a set of very sensitive hair-like cells called cilia. These cells change the sound vibrations to nerve impulses that are sent to the brain to give the individuals' perception of hearing. The auditory nerve cells react to both high and low tones and are adversely affected by excessive levels of noise. Continued loud noise will cause permanent damage by breaking or permanently tilting the cilia.

EFFECTS OF NOISE ON HEARING

People can lose their ability to hear through disease, birth defects, accidents, exposure to ototoxins (chemicals that may either alone, or when combined with noise, result in hearing loss) and more commonly through exposure to continuous loud noise. Exposure to noise in the work environment may cause a number of physiological and psychological responses.

Noise can:

- cause hearing loss
- annoy and interfere with speech
- interfere with concentration and thought processes
- disturb sleep
- cause fatigue and aggression
- reduce immune response
- lead to heart disease.

How the human body reacts

In response to excessive noise, the autonomic nervous system attempts to adjust body functions by increasing a person's heart rate, raising blood pressure and releasing the hormones adrenalin and cortisol.

However, prolonged high levels of adrenalin and cortisol under stressful working conditions may lead to more serious health effects, including:

- raised blood pressure
- accelerated heart rate
- stress, which can lead to irritability and headaches
- hypertension increasing the risk of strokes and heart attacks
- reduced white blood cell count and immune response
- gastric ulcers.

High Noise Levels

High levels of noise may initially cause dull hearing and ringing in the ears. Regular high level noise exposures will lead to loss of hearing and other adverse health effects.

Low Noise Levels

Low levels of noise can interfere with activities or concentration and causes similar stress and health effects as high level noise.

TYPES OF HEARING LOSS

Long-term hearing loss

Damage to hearing generally occurs gradually over a number of years and may remain unnoticed. Noise induced hearing loss is slow and painless, but permanent.

Exposure to excessive noise is cumulative. If you have already been exposed to excessive noise at work and also expose yourself to noise during leisure activities, your chances of sustaining noise induced hearing loss are substantially increased.

Immediate Hearing Loss

Your hearing can be damaged immediately by exposure to impulsive noise, including:

- explosive powered nail guns
- firearms
- stamping presses
- forges
- industrial machinery.

The hair cells in the inner ear can be desensitised or destroyed by loud noise. Once they are destroyed they do not grow back.

Tinnitus

Tinnitus can accompany noise induced hearing loss or exposure to sudden loud noise. It is characterised by the perception of noises that do not have an external source; such as ringing, clicking, cicadas or continuous tones.

Noise Induced Hearing Loss

As we get older our ability to hear high pitched sounds deteriorates naturally but with exposure to too much noise the ability to hear high pitched sounds is greatly decreased. People with noise induced hearing loss often say that they can hear someone talking but cannot understand them as they can no longer hear the high pitched letters like F, S, T, K, C.

Noise induced hearing loss leads to communication problems. Relationships with loved ones, family, friends and work colleagues may also suffer.

Noise induced hearing loss may result in not being able to hear warning sounds (such as alarms or car horns) or workplace noises such as supervisors giving directions and could result in increased absenteeism and lower productivity.

Indicators that a person's hearing may be at risk:

- needed to use a raised voice in a noisy workplace when talking to someone about one metre away
- experiencing a dulling of hearing at the end of a working shift
- ringing in the ears (tinnitus) during or after work.

AUDIOMETRIC TESTING

The hearing of workers exposed to noise can be assessed and monitored through regular audiometric tests. Testing is an important part of a hearing conservation program to manage risks from noise exposure in a 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.

Audiometric testing should also be provided to workers exposed to acoustic shock in call centres or to workplace ototoxins. Examples of ototoxins include lead, organophosphates and toluene.

Testing Scheme

All testing should be done by an appropriately trained and experienced person, using procedures and equipment that comply with Part 4: Auditory assessment of AS/NZS 1269: Occupational noise management.

Testing should include:

- an initial audiometric test carried out within three months of commencing work
- monitoring audiometric testing carried out within 24 months of the initial test for comparison of hearing abilities
- follow up monitoring audiometric testing every two years, if no threshold shift has been detected. High risk groups may require more frequent testing.

Threshold shifts in hearing

On exposure to noise above an intensity level of 75 dB(A), the ear's sensitivity level will decrease. This process is referred to as a shift in the threshold of hearing. The shift can be:

- temporary, called temporary threshold shift (TTS), and recovers gradually after the noise exposure
- permanent, called permanent threshold shift (PTS), and does not recover, resulting in permanent hearing loss.

Actions to be taken

If workers are found to have sufficient hearing loss to interfere with the safe performance of their jobs and their communication ability:

- all practicable steps should be taken to modify the work environment
- workers should be offered alternative work that does not put them at risk from excessive noise.

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

- review the worker's job to identify any changes that may have caused an increase in exposure to noise
- re-determine the worker's exposure to noise, if necessary
- check whether anything can be done to reduce the levels of noise to which the worker is exposed and the duration of exposure
- check the wearing conditions and rating of the worker's hearing protector to ensure it 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 they have any difficulty in using the hearing protector
- check the worker actually uses the hearing protector correctly
- deal with any problems revealed by the above procedures, calling in expert advice as necessary

- notify WHSQ of an incident (if a significant permanent threshold shift due to excessive exposure to noise is revealed).

RISK ASSESSMENT

A noise risk assessment should be carried out when workers and others may be exposed to excessive noise levels. To assess noise levels a sound level meter or noise dose meter should be used. These meters are designed to measure a frequency-weighted and time-weighted value of the sound pressure level.

Aims

The aims of noise risk assessments are to:

- identify whether the noise under investigation is excessive or not
- establish the noise characteristics and the daily duration of exposure
- identify all persons likely to be exposed to excessive noise
- identify all items of plant and equipment likely to cause excessive noise
- obtain information on work practices and associated noise sources
- identify what higher order controls can be put in place to reduce noise level exposure
- check the effectiveness of measures taken to reduce noise level exposure
- choose appropriate personal hearing protectors for those workers and other persons exposed to risks from excessive noise
- define designated hearing protection areas at work.

Noise assessments should be repeated at least every five years or whenever there is a change of plant, work processes, building structure or duration of work arrangements. Noise assessment records should be kept at the workplace and made available for inspection by workers.

SOUND LEVEL MEASUREMENT

A **noise dose meter** measures the amount of noise that a person is exposed to during a day. The noise meter will identify whether an individual has exceeded their daily noise dose and which areas within the workplace are most hazardous. Provided with this information, an action plan can be developed to reduce the risk of noise induced hearing loss to those individuals.

A **sound level meter** is designed to simulate the human hearing as closely as is possible and practical, while giving a repeatable and objective value. As the human ear responds not only to the level of a sound, but also to its frequency and to some extent, duration, these parameters must be built into the sound level meter.

The use of sound level applications on mobile phones or tablets is not recommended as their accuracy is not reliable.

More information

More detailed information on noise measurement and recording is available in part 1 of AS/NZS 1269: Occupational noise management. A person carrying out a noise assessment should meet the competency requirements set out in appendix A of part 1 of AS/NZS 1269.

DAILY NOISE EXPOSURE

The current Work Health and Safety Regulations refers to 85 dB(A) being the maximum level to which an unprotected person should be exposed over the eight-hour equivalent continuous A-weighted sound pressure level in decibels (dB(A)). This level of noise will provide the person with a daily noise dose of one. If the daily noise dose is greater than one, there is an increased risk of noise induced hearing loss. For example:

- 80 dB(A) for 8 hours will result in significant hearing loss to 5% of the work force;
- 85 dB(A) for 8 hours will result in significant hearing loss for approximately 10% of the work force;
- 90 dB(A) for 8 hours will result in significant hearing loss to 25% of the work force.

Extended work shifts

Shift durations of 10 hours or longer involve a degree of risk greater than that indicated by the 8 hour measurement $L_{Aeq,8h}$. This increase in risk arises because of the additional damaging effect of continuous exposure to noise after 10 hours. The risk may be further increased if there is reduced recovery time between successive shifts.

If workers work shifts of 10 hours or more, the adjustment factor for extended shifts as set out in AS/NZS 1269.1 (see Table 3) should be added to the measured $L_{Aeq,8h}$ before comparing it with the 85 dB(A) exposure standard for noise.

Table 1: Adjustments to $L_{Aeq,8h}$ for extended work shifts

Shift Length	Adjustment added to measured $L_{Aeq,8h}$ dB(A)
10 hours or more to less than 14 hours	+1
14 hours of more to less than 20 hour	+2
20 hours or more	+3

Noise control policy

An important step in managing noise in the workplace is the development of a noise control policy, which should cover:

- 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
- implementing a hearing conservation program

Hearing conservation program

A hearing conservation program sets out the ways the noise policy will be achieved. Elements of commitment to a hearing conservation program are as follows:

- nominating a person to be responsible for overseeing the program
- carrying out preliminary noise checks to assess if problems with noise exposure exists
- developing a program to choose new or replacement plant to reduce noise exposure

- choosing suitable noise control measures
- choosing, providing and maintaining personal hearing protectors
- identifying hearing protection areas
- giving induction and ongoing refresher training to workers
- providing audiometric testing at the beginning of employment to establish base level hearing and during employment to determine any hearing loss
- maintaining records in an easily understood form and available for inspection by certain persons
- check that noise control measures are maintained and operating effectively
- check noise levels to ensure that hidden defects in machinery which could cause excessive noise levels are identified.

Information and training for workers

Information and training should be provided to workers potentially exposed to excessive noise and those responsible for purchasing plant, noise control equipment and personal hearing protectors. It should include the following points:

- What noise is and how to assess it.
- Possible health effects due to noise.
- Social effects on the person's life, and that of family and friends, of noise induced hearing loss and tinnitus.
- Noise control policy and hearing conservation program.
- The noise exposures in the particular workplace and the control measures used to protect workers.
- Legal responsibilities for controlling excessive noise in the workplace.
- Control measures used in the workplace for the protection of exposed workers.
- Specific control measures necessary for each of the exposed worker positions and the correct use, operation and maintenance of noise control equipment.
- Correct use of personal hearing protectors.
- Arrangements for reporting defects likely to cause excessive noise.

Consultation should be undertaken between the person conducting a business or undertaking (PCBU) and workers in the planning stage about the introduction or purchase of potentially noisy plant or changes to existing plant at the workplace.

RISK CONTROL

Noise control measures are required to be implemented according to the hierarchy of control so far as reasonably practicable. Elimination and Engineering are preferred because they reduce a person’s exposure to noise and do not rely on the person to wear hearing protection. Although personal hearing protection will reduce the risk from exposure to excessive noise, they do not actually reduce the noise levels. The information below outlines how to reduce the effects of noise in the workplace.

Eliminating noise

New plant and workplaces - noise control measures can be included in the design of the installation area and the design and construction of a new workplace. Where a plant is designed for a particular workplace, designers should design the plant to eliminate or control noise emissions where there is a risk to a person's hearing.

AS/NZS 2107 Acoustics: Recommended design sound levels and reverberation times for building interiors gives information on acceptable design sound levels for various building interiors.

Engineering controls for existing plant and workplaces

The need for noise control should be considered when deciding production methods or processes and when the need to reduce noise exposure has been established.
Examples of engineering controls can include:

- reducing noisy machine operations by replacing rivets with welds
- redesigning machinery power sources to give quiet speed regulation, for example through the use of stepless electric motors
- avoiding metal-to-metal contact by using plastic bumpers
- repairing loose and rotating parts, replacing worn bearings and gears and regular maintenance
- adding noise barriers, noise enclosures, vibration isolation mountings, laggings, mufflers and silencers where appropriate to reduce noise at source
- absorbing acoustic shock by providing wear-resistant rubber or plastic coatings
- using conveyor belts rather than rollers
- stiffening and fixing damping materials to panels and other surfaces to reduce vibration and noise impact of items during processing
- using a sound-reducing enclosure that 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
- using acoustical silencers in intake and exhaust systems, for example, internal combustion exhaust systems or air conditioning systems.

Administrative controls

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

- organising schedules so that noisy work is done during a particular part of the shift or when as few people as possible are present
- notifying people in advance when noisy work is to be carried out so they can limit their exposure
- keeping people out of noisy areas if their job does not require them to be there
- sign-posting noisy areas and providing quiet areas for food and rest breaks
- limiting the time workers spend in noisy areas by moving them to quiet work areas before their daily noise exposure levels are exceeded
- maintaining machines and equipment in good condition to reduce noise, including the addition of noise mufflers, vibration isolators, or duct silencers
- job rotation (changing tasks carried out by workers to prevent exposure to excessive noise)
- purchasing new plant and equipment that produce less noise.

Personal Hearing Protection

A personal hearing protector can be worn to cover the ear and ear canal entrance, or inserted in the ears of a person to protect their hearing. When excessive noise cannot be reduced by other control measures, workers and others at the workplace should be:

- supplied with personal hearing protectors of correct rating and suitable for the work conditions
- instructed in their correct use and maintenance
- instructed to wear them when exposed to noise
- monitored to ensure they wear hearing protection.
-

Personal hearing protectors should not be used as a substitute for engineering or administrative noise control measures.

Personal hearing protectors should be selected and maintained in accordance with AS/NZS 1269.3 Occupational noise management – hearing protector program. Workers should be involved in the selection process and offered a reasonable choice from a range of types.

Suppliers of hearing protectors should provide the full information on the attenuation likely to be provided including the SLC80 ratings, class and octave band attenuation values. The attenuation values should be derived from attenuation measurements made in accordance with AS/NZS 1270 Acoustics – hearing protectors.

Selection

When selecting personal hearing protectors the following should be considered:

- the degree of attenuation required in the worker's environment (see Table 2). Do not provide protectors that overprotect by cutting out too much sound – this can cause difficulties hearing verbal instructions and other sounds needed to work safely
- the suitability for the type of working environment and the work tasks. For example, ear-plugs are difficult to use hygienically for work that requires them to be inserted with dirty hands and in these circumstances, ear-muffs are more appropriate, but ear-muffs can be uncomfortable to wear in hot environments and can make it difficult for the wearer to enter a confined space or to wear a helmet
- the comfort, weight and clamping force of the personal hearing protector

Individual fit of personal hearing protectors is critical for optimum protection. Wearing work equipment—such as hard hats, dust masks and eye protection—may affect the performance of the protector. The fit of hearing protectors should be checked while the user is wearing regular work equipment. Workers wearing spectacles should be fitted with hearing protectors while wearing the spectacles.

Table 2: Recommended Class of hearing protector	
Measured exposure LAeq,8h dB(A)	**Class**
Less than 90	1
90 to less than 95	2
95 to less than 100	3
100 to less than 105	4
105 to less than 110	5

Other tips

Areas where people may be exposed to excessive noise should be signposted as 'hearing protection areas' at every entry point to the areas. The boundaries of these areas should be clearly defined.

No person, including visitors, managers or supervisors, should enter a hearing protection area during normal operation unless they wear appropriate personal hearing protectors, however short the entry period.

Signs used to identify these areas should conform to AS1319: 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.