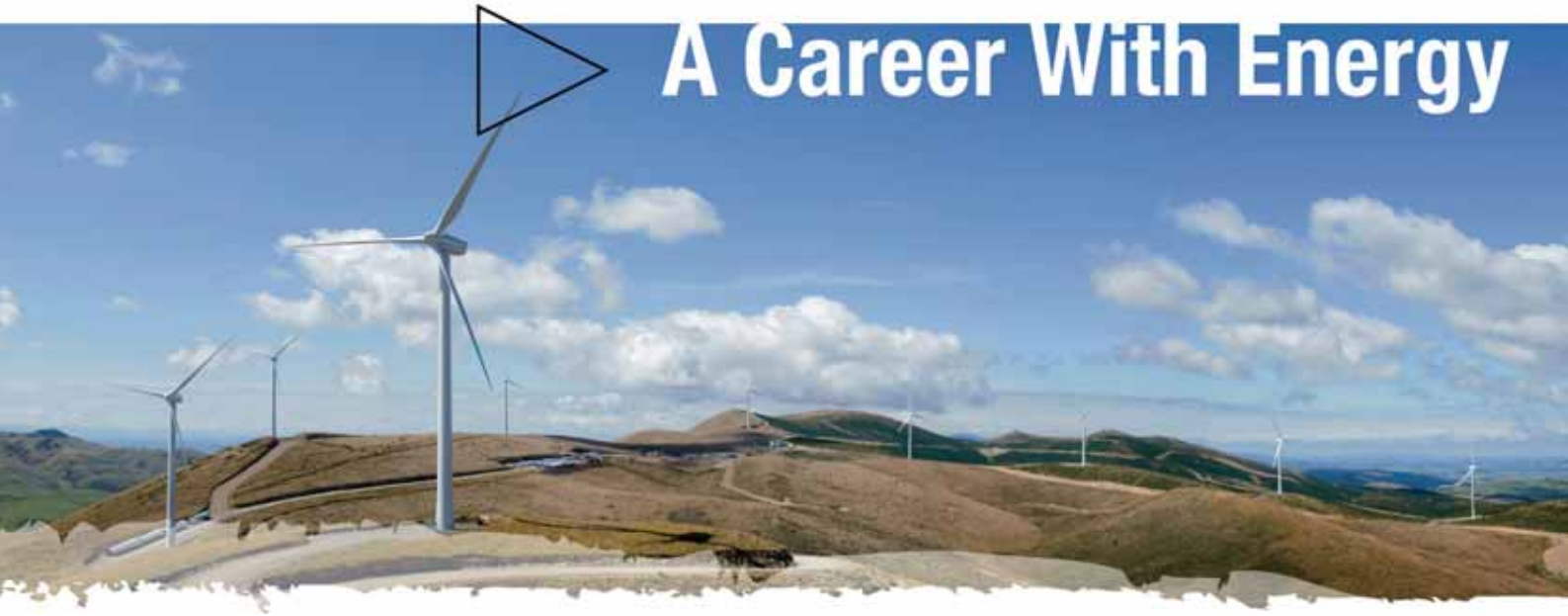


Demonstrate knowledge of hearing conservation in the workplace

US 17594 v3

Training and Assessment Resource

Level 3
Credits 3

Electricity Supply Industry Training Organisation www.esito.org.nz

Contents

Getting started on the ESITO Training & Assessment Resources

Activity: A written or spoken exercise or assignment.

Keypoint: Important information to remember.

Introduction to Training Assessment Resource

This Training Assessment Resource (TAR) contains the information that you need to complete the written assignment in the assessment pack for this unit standard.

Purpose

People who obtain credit for this unit standard are able to:

- Demonstrate knowledge of the mechanism of hearing, and the causes of hearing impairment.
- Demonstrate knowledge of how sound intensity is measured, the hearing comfort zone, and the effects of noise on the hearing mechanism.
- Demonstrate knowledge of types of hearing protection equipment, and the benefits of using them.
- Demonstrate knowledge of workplace hearing protection programme requirements.

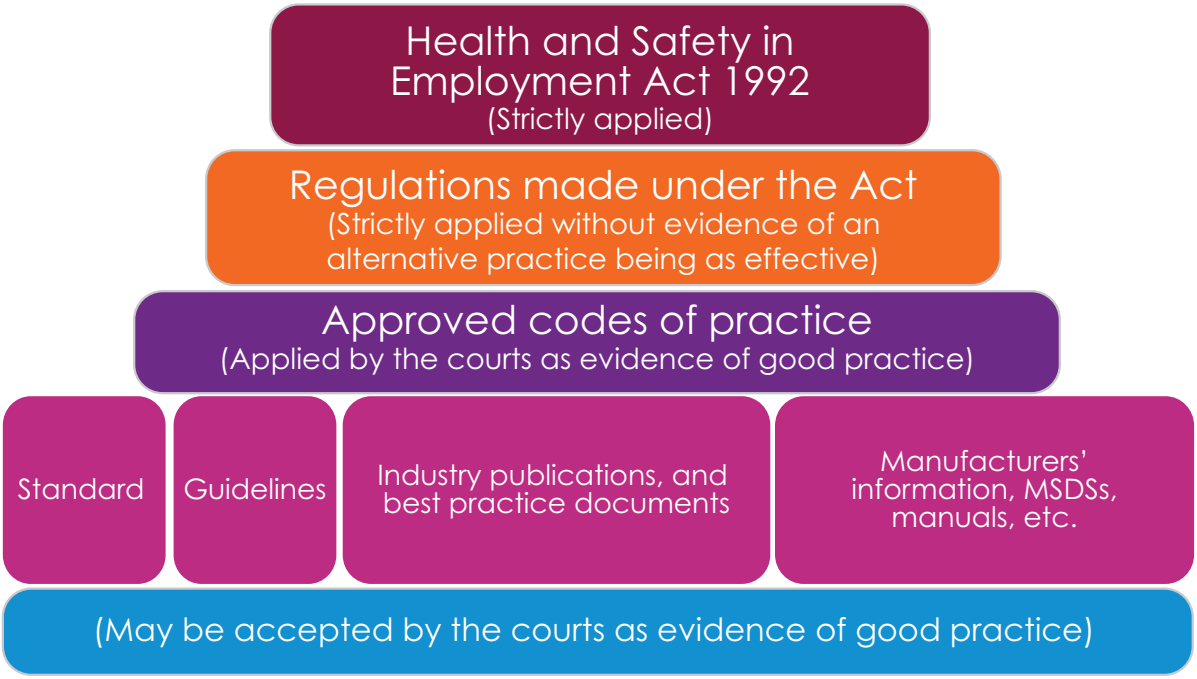
Glossary

When you see this word	It means
ACC.	Accident Compensation Corporation.
Acoustic.	The branch of physics that studies sound.
Acute.	Sudden onset of an illness or medical condition.
AS/NZS.	Australian Standards / New Zealand Standards.
Audiometric.	Testing hearing ability. Typically, audiometric tests determine a subject's hearing levels with the help of an audiometer.
Auditory canal.	The tube running from the outer ear to the middle ear, also known as the ear canal or external acoustic meatus.
Auricle.	The external portion of the ear.
Barotrauma.	Physical damage to ear tissues caused by high atmospheric pressure.
Canal caps.	A hearing protector that is a combination of earplugs and noise muffs. Canal caps may fit into the ear canal or they may just cap the outside of the ear canal.
Cranial nerves.	Nerves that emerge directly from the brain.
Cerumen.	Yellowish waxy substance secreted in the ear canal also known as ear wax.
Cochlea.	The auditory portion of the inner ear. Its core component is the Organ of Corti, the sensory organ of hearing.
COP.	Code of Practice.
Corti Organ.	Small structure inside the Cochlea that contains the sensory cilia.
dB.	Decibel – measures the loudness of sound.
Ear canal.	The tube that runs from the outer ear to the middle ear also known as the external acoustic meatus.
Eustachian tube.	Tube extending from the ear to the back of the throat.
External acoustic meatus.	The tube that runs from the outer ear to the middle ear also known as the ear canal or auditory canal.
Genetic abnormality.	An abnormality in the genes or chromosomes, that can lead to illness and medical conditions.
Helix.	Prominent ridge at the top of the external ear.
HSE.	Health and Safety in Employment.
Hypoxia.	A condition in which the body, or a region of the body, is deprived of adequate oxygen supply.
Incuis.	Anvil shaped small bone in the middle ear.

Malleus.	Hammer-shaped small inner ear bone.
Menieres disease.	A disorder of the inner ear that can affect hearing and balance to a varying degree. Sufferers have episodes of vertigo and tinnitus and progressive hearing loss, usually in one ear.
NIHL.	Noise Induced Hearing Loss.
NODS.	Notifiable Occupational Disease System.
OSH	Occupational Safety and Health Service.
Otitis media.	Fluid build-up in the middle air.
Otosclerosis.	A common age-related condition where the movable ear bones become fused.
Physiology.	The science of the functioning of living systems.
PPE.	Personal Protective Equipment.
Presbycusis.	The deafness of old age, due to the natural degeneration of the sensory cells in the Corti organ.
PTS.	Permanent Threshold Shift.
Rubella.	Commonly known as German measles, rubella is a disease caused by the rubella virus.
Sensory cilia.	Hair-like cells that bend and sway in response to vibrations caused by sound waves.
SOP.	Standard Operating Procedure.
Stapes.	Stirrup shaped small bone located in the middle ear.
Threshold shift.	As noise increases our ear's sensitivity level will decrease (we hear less) as a way of protecting our hearing. The threshold shift can be temporary or permanent .
Tinnitus.	A condition where the person hears sound (often a high pitched ringing or buzzing) in their ears when there is no external sound.
TTS.	Temporary Threshold Shift.
Tympanic membrane.	A thin membrane that separates the external ear from the middle ear. It transmits sound from the air to the middle ear.
Vestibular labyrinth.	The central cavity of our inner ear. It contributes to our balance and our sense of spatial orientation, and is the sensory system that provides the dominant input about movement.
Vibration.	Vibration refers to mechanical oscillations The study of sound and vibrations are closely related. Sound "pressure waves" are generated by vibrating structures - for example the vocal cords. These pressure waves can also induce the vibration of structures (e.g. ear drum). When trying to reduce noise it is often a problem in trying to reduce vibration.

1.0 Legislation, Standards, Specifications And Codes of Practice

This diagram is taken from the Department of Labour Occupational Safety and Health Service publication "A guide to the Health and Safety in Employment (HSE) Act 1992". It shows how the HSE Act fits with regulations and other documents.



Health and Safety in Employment (HSE) Act 1992 and subsequent amendments and regulations

The Health and Safety in Employment Act is the primary health and safety law. Regulations, codes of practice (COP), standard operating procedures (SOP), and other documents that give workplace safety guidance come under the HSE Act.

Approved Code of Practice for the Management of Noise in the Workplace (2002)

The principal objective of this code of practice is to reduce the incidence and severity of hearing loss resulting from excessive noise exposure in workplaces.

Joint Australian/New Zealand Standards (AS/NZ)

AS/NZS 1269-1998 Occupational noise management, Parts 0-4:
-Part 0: Introduction
-Part 1: Measurement and assessment of noise emission and exposure
-Part 2: Noise control management
-Part 3: Hearing protector program
-Part 4: Auditory assessment.

AS/NZS 1270:2002 Acoustics — Hearing protectors

What is the AS/NZS standard number that deals with hearing protectors?

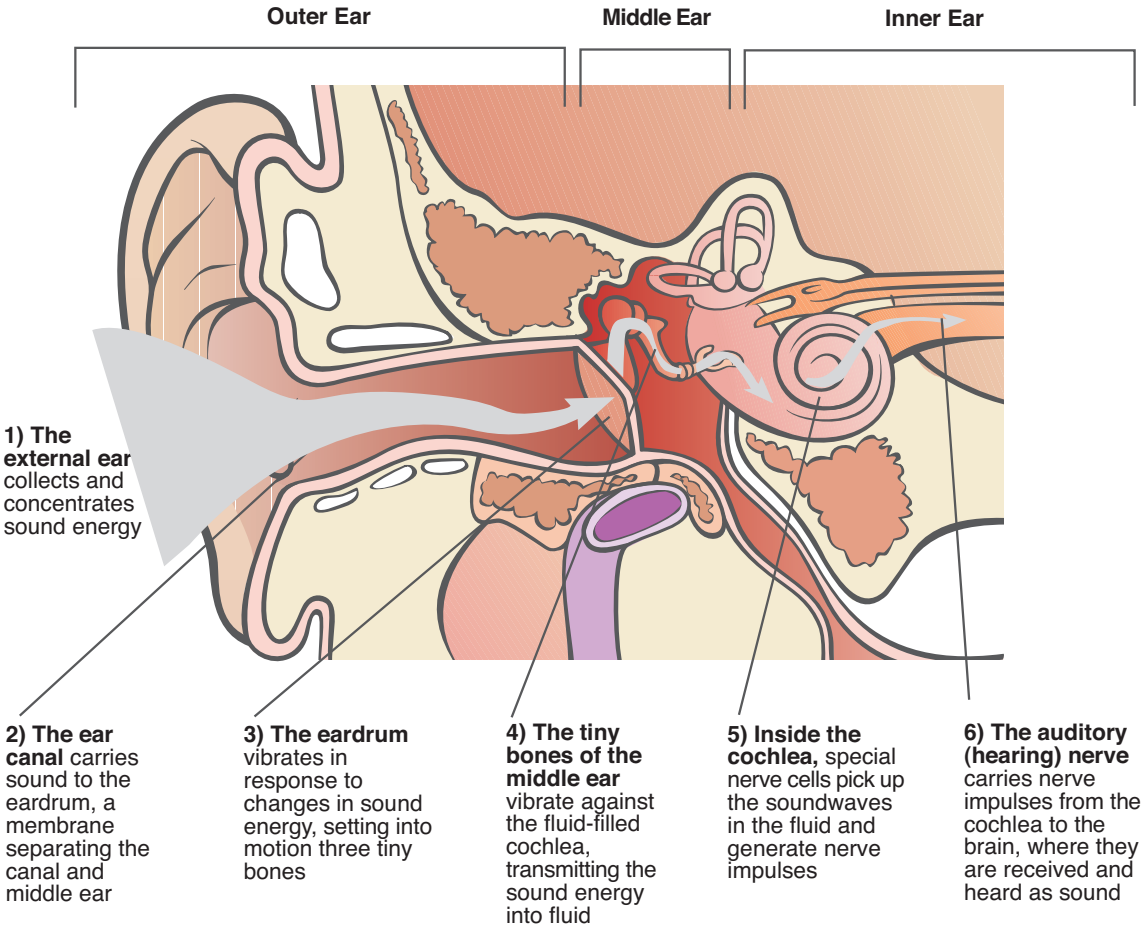
2.0 The Anatomy and Physiology of the Ear

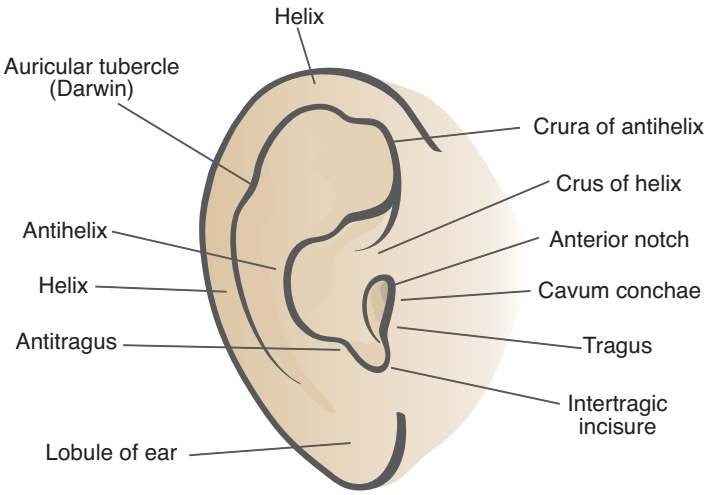
The ear is the organ we use to hear. It is attached to the auditory nerve. Sound waves cause vibrations in the air. These vibrations enter the ear canal and stimulate the nerve. The nerve stimulations pass along to our brain, and the brain integrates and coordinates the information into sound.

2.1 The structures of the ear

The ear has 3 distinct parts.

- The external ear (outer ear)
- The middle ear
- The internal ear (inner ear)



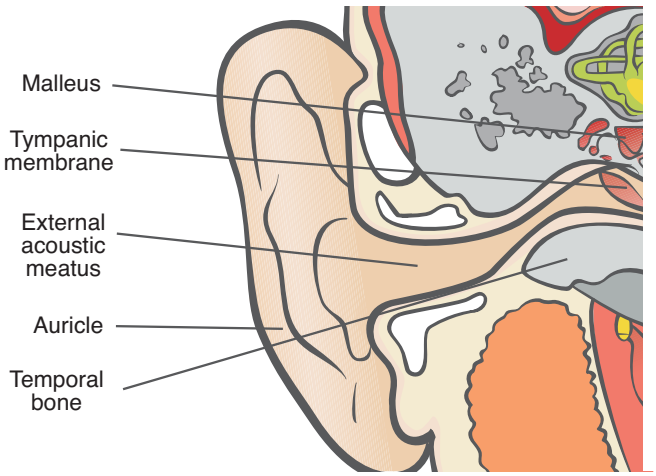


The **external ear** or outer ear consists of the *auricle (pinna)* and the *external acoustic meatus.*

The *auricle* is the part of the ear that we can see on the outside of the head. The auricle gathers sound waves. It is made up of cartilage covered with skin, and has deep grooves and ridges. The most prominent outer ridge is the *helix*. The *lobule* (ear lobe) is the soft pliable part at the bottom and is composed of mostly fatty tissue richly supplied with blood capillaries.

The *external acoustic meatus* (auditory canal) is a slightly 'S' shaped tube about 2.5cm long. It extends from the auricle to the *tympanic membrane (ear drum)*. The outside third is cartilage, while the inner two thirds are in the temporal bone of the skull.

The meatus is lined with hairy skin and glands that secrete a modified sweat called *cerumen* (ear wax). The hairy skin traps large dust particles and other foreign bodies. The hairs are also thought to play some part in picking up the movement of air or sound waves. The cerumen (ear wax) is a sticky substance which stops smaller dust particles, insects and microbes from reaching the ear drum. The wax moves out of the ear because of the movement of the jaw when we chew and talk. The wax pushes any dirt and old skin cells along with it cleaning the ear. So ear wax is not dirty - it's what the ear cleans itself with.

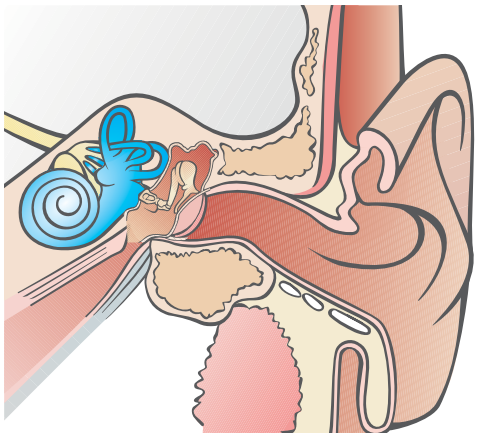


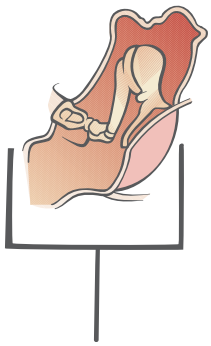
If we clean our ears using cotton buds or something similar, we push the wax back into the ear. This can build up a wall of wax in front of the ear drum that will reduce the quality of the sound you hear. Built-up ear wax can also trap microbes at the ear drum and these microbes could cause an ear infection.

The **middle ear** is an irregular shaped cavity within the temporal bone. Air coming from the *Eustachian tube* fills the cavity. The Eustachian tube extends from the back of the nasopharynx (back of the throat towards the nose). If there is equalised air pressure on both sides of the ear drum, the membrane can vibrate correctly when sound waves strike it. When there is unequal pressure (e.g. at high altitude) we can equalise it by yawning or swallowing.

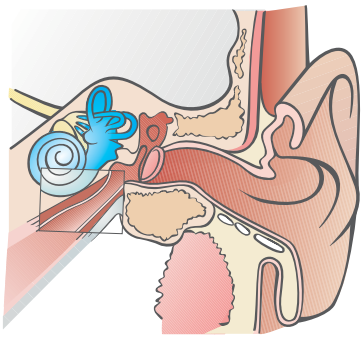
Behind the ear drum are three very small bones that extend across the cavity. They form a series of movable joints. They are the *malleus, incuis* and the *stapes*.

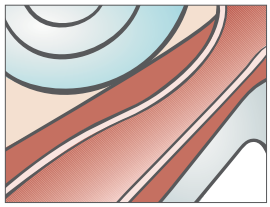
The *malleus* is a hammer-shaped bone. The handle of the hammer contacts the ear drum, and the head forms a joint with the incuis bone.



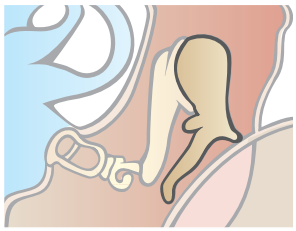


Middle ear

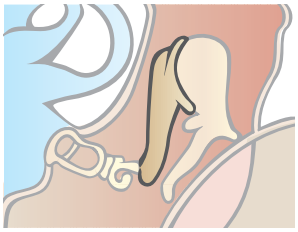




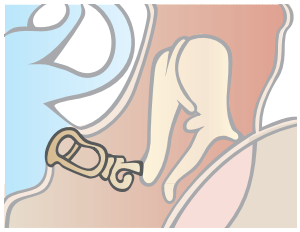
Middle Ear Bones



Malleus
(hammer)



Incuis
(anvil)



Stapes
(stirrup)

The *malleus* is a hammer-shaped bone. The handle of the hammer contacts the ear drum, and the head forms a joint with the incuis bone.

The *incuis* is an anvil-shaped bone that moves or hinges with the malleus and the stapes bones. It is stabilised by short ligaments that are attached to the ear wall.

The *stapes* is a stirrup-shaped bone. Its head moves with the incuis bone and its foot fits into one of the oval windows within the temporal bone.

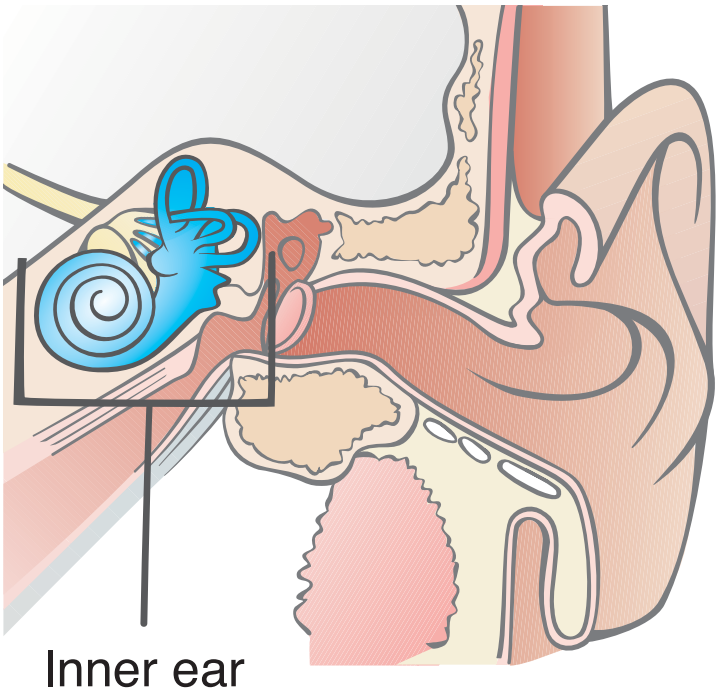
The **internal (inner) ear** contains the organs of hearing and of balance. The inner ear is a fluid-filled chamber divided into two parts.

- The *vestibular labyrinth* is the portion of the inner ear that functions as part of the body's balance mechanism.
- The *cochlea* contains the hearing-sensing nerve. It is to the cochlea that sound vibrations picked up by the middle ear are carried.

The cochlea is a hollow tube inside the inner ear that is coiled to resemble a snail's shell. It contains thin fluid and a highly specialized structure called the *organ of Corti*, which contains many millions of minute, *sensory cilia cells (hair cells).*

The cilia bend and sway in response to vibration caused by sound waves and as a result of this movement the hair cells send messages to the brain via the acoustic nerve to indicate that sounds are present.

The *acoustic nerve* (also called the eighth cranial or auditory nerve) leads from the inner ear to the brain, serving as the pathway for the nerve impulses that the brain will interpret as sound.



Inner ear

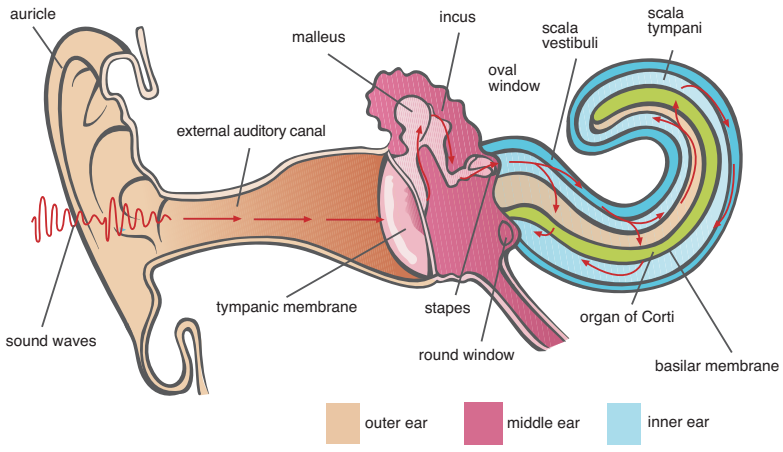
2.2 The physiology of hearing

Hearing involves a complex chain reaction within the ear:

- Sound creates vibrations in the air. The vibrations are a bit like the ripples created when a stone is thrown into a pond.
- The outer-ear "trumpet" collects these sound waves, and they are funnelled down the external ear canal to the eardrum.
- As the sound waves strike the eardrum, they cause it to vibrate.
- The vibrations are transmitted through the middle ear over the bony bridge formed by the malleus, incuis and the stapes (hammer, anvil, and stirrup).
- These vibrations, in turn, cause the membranes (ear drum) over the openings to the inner ear to vibrate, causing the fluid in the inner ear to be set in motion.
- The motion of the fluid in the inner ear excites the cilia or hair cells in the organ of Corti, producing electrochemical impulses that are transmitted to the brain along the acoustic nerve.
- As the impulses reach the brain, we experience the sensation of hearing.

Our hearing mechanism is amazingly sensitive. With the softest detectable sound, the eardrum only moves approximately one-millionth of an inch. Our ability to detect sounds from the softest to the loudest covers an intensity range of approximately 100,000,000 to 1.

So it's no surprise that such a remarkably complex system as your ear can be easily damaged.



Name the three parts of the structure of the ear.

1. _____
2. _____
3. _____

3.0 The Effects of Noise on Hearing

Hearing impairment or *deafness* is a decrease in our ability to detect or understand sounds. Deafness can be caused by a wide range of biological and environmental factors.

To measure hearing loss we need to know how many decibels (how loud) and hertz (what frequency) a sound must reach before an individual can hear it. Then we can work out the degree of the person's hearing loss. Hearing loss may be ranked as mild, moderate, severe or profound. It is quite common for someone to have more than one degree of hearing loss.

3.1 Common causes of hearing impairments

In young children:

- Genetic abnormality.
- Rubella in the mother during the first 3 months of pregnancy.
- Acute hypoxia (extreme lack of oxygen) at birth or soon after.

In older children and adults:

Conductive deafness – *impaired transmission of sound waves from the outer ear to the inner ear. So something is stopping the sound waves going through. This can be caused by:*

- Wax build-up in the auditory canal or foreign bodies in the ear.
- Infections, Otitis media (fluid build up in the middle air) which effects the movement of the ear drum.
- Middle and inner ear tumours.
- Otosclerosis (a common age related condition where the ear bones become fused).
- Traumatic rupture of the ear drum, due to high pressures in the ear canal (barotraumas) or something being placed in the ear that damages the ear drum
- Dislocation of the small ear bones.
- Severe blood loss in the ear due to a head injury.
- Damage to the auditory nerve.
- Excessive noise.

Sensorineural (perceptive) deafness – *damage to cochlea structures, the auditory nerve, or the hearing area of the brain caused by disease or trauma.*

- Presbycusis (the deafness of old age) due to the natural degeneration of the sensory cells in the Corti organ. Perception of high frequency sound is first impaired, and later low frequency sounds may also become affected.
- Meniere's disease, a progressive destruction of the Corti organ.
- Trauma caused by exposure to loud high pitched noise (machinery, music etc) for a prolonged period of time.
- Fractures of the temporal bone or the base of the skull.
- Blood flow changes, in which the blood supply to the inner ear is interrupted leading to death of the tissues.
- Severe inflammation of inner ear structures due to virus and infections.
- Brain damage (trauma, stroke, cancer etc) affecting the auditory centres and auditory pathways of the brain, injury to the auditory nerve.
- Side effects from certain drugs.

Hearing loss caused by disease or trauma can be temporary. With time and correct medical treatment hearing may improve.

3.2 Noise induced hearing loss

Noise induced hearing loss (NIHL) is a notifiable disease under the Notifiable Occupational Disease System (NODS). In 2007 according to ACC hearing loss cost New Zealand just over 61 million dollars in ongoing and newly diagnosed cases. So NIHL has been targeted as a priority by the Occupational Safety and Health Service (OSH).

Hearing loss can be a negative experience for the individual:

- It contributes to job related stress.
- It can create social isolation at work and at home.
- It complicates other hazards.
- It can reduce recreational enjoyment.
- It can make conversation more difficult.
- It can reduce the ability to differentiate between voices in public places.

Hearing loss is different for different people. Two people who have been exposed to the same level of noise and type of noise may present with different complaints. Each individual will have different symptoms and levels of NIHL.

Excess noise produces a number of effects on the hearing mechanism. NIHL is a result of excess noise over a period of time, and may be preceded by a number of warning signs. However the warning signs do not have to be present for NIHL to occur.

NIHL can be caused by a **one-time exposure to a loud sound** as well as by **repeated exposure to sounds over an extended period of time.** Damage happens to the microscopic hair cells (cilia) found inside the cochlea. These hair cells respond to mechanical sound vibrations by sending an electrical signal to the auditory nerve. Different groups of hair cells are responsible for different frequencies (rate of vibrations). The healthy human ear can hear frequencies ranging from 20Hz to 20,000 Hz. Over time, the hair cells may get damaged or broken. If enough of them are damaged, hearing loss results. The high frequency area of the cochlea is often damaged by loud sound.

3.3 NIHL warning signs

Temporary Threshold Shift (TTS) - Sometimes people find their threshold of detection of sound raises. The person notices a dullness or a difficulty in hearing over this period of time. The time taken for recovery to the normal hearing threshold depends on the intensity and duration of the noise and may exceed 48 hours.

A *Temporary Threshold Shift* (TTS) is the reason why audiometry (hearing tests) should be done after a suitable quiet period (16 hours). Often this is achieved by organising the tests at the beginning of a shift or working day.

The exact pathology of the effects of noise has not been fully established. TTS may include subtle changes in the sensory cells (hair cells) of the cochlea and swelling of the auditory nerve endings.

When a person does not have enough time to recover from TTS, and further excess noise levels are encountered, the temporary threshold shift can become permanent and is called a *Permanent Threshold Shift.*

Permanent Threshold Shift (PTS) – This is the extent of permanent hearing loss for a given set of conditions. PTS varies significantly from one person to another and is unpredictable. An exposed person does not have to have suffered a temporary shift to develop a permanent shift. If temporary threshold shifts are common, then a permanent threshold shift can develop and become NIHL *(occupational deafness)*.

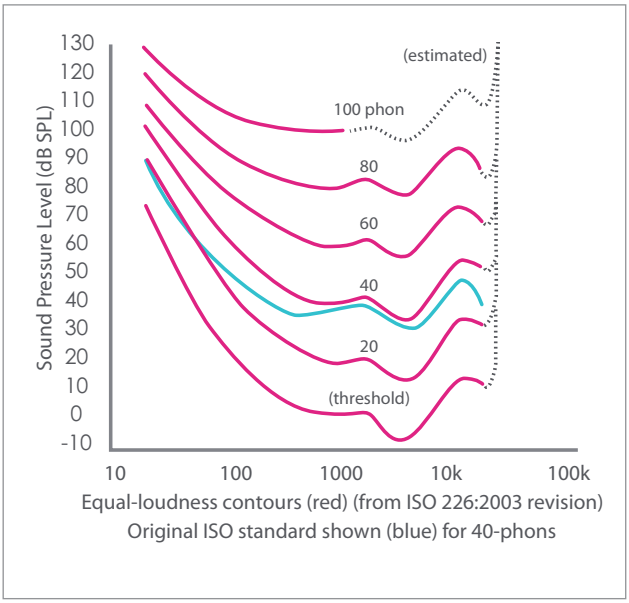
Tinnitus - sufferers hear noise in their ears or head when there isn't any real sound. There are various descriptions of tinnitus; most individuals define it as being an annoying sound that won't go away, it is described as a high-pitched ringing, hissing or whistling, or a low-pitched rushing or buzzing. Short periods of high-pitched whistling can be experienced before a temporary or permanent threshold shift is noticed. Tinnitus is one warning sign of impending hearing damage. However, NIHL can occur without the person ever having noticed tinnitus.

HEALTH WARNING!

Tinnitus

Tinnitus is an important warning sign. If you have tinnitus, tell your general practitioner to consider the possibility of impending NIHL. Tinnitus should never be dismissed lightly.

Recruitment – Is when the loudness of a sound increases beyond a threshold. The person with recruitment notices a sudden increase in their perception of the sound (it appears to get louder). Recruitment has many causes. Recruitment occurs when there is a high hearing threshold. Since the threshold is elevated, the effect is that the equal loudness contours are compressed upwards, in other words for them to hear these sound the pressure has increased. A consequence of recruitment is that the range between the threshold of hearing and the threshold of pain is reduced.



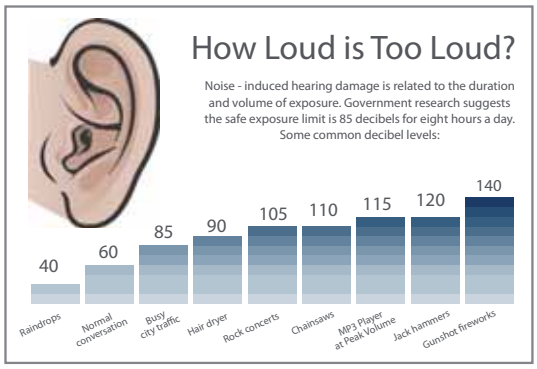
Masking - Masking occurs when the background sounds make it hard for a person to hear speech. Masking plays a major part in the inability of someone with NIHL to distinguish speech in a crowded room. In contrast, they are usually able to distinguish telephone speech more clearly.

NIHL and Presbycusis - NIHL starts gradually and is usually irreversible. The most common reason is that the hair cells degenerate. On top of this noise-induced damage is presbyacusis, the sensorineural hearing deterioration associated with age. Whether hearing loss is an inevitable consequence of aging is controversial. However, the consensus at the moment is that hearing deteriorates with age (presbycusis) and NIHL occurs in addition to this.

Noise Induced Hearing Loss (NIHL) is a notifiable disease.
True / False

4.0 Sound Measurements and the Hearing Comfort Zone

We hear sound waves provided by vibrations (movement) of air molecules. Sound waves or sound pressure travels at about 332 metres per second. The size and energy of these waves determine the loudness, which is measured in decibels (dB).



The number of vibrations or cycles per second makes up frequency - the more vibrations, the higher the pitch of the sound. Sound frequency is expressed in cycles per second, or hertz (Hz).

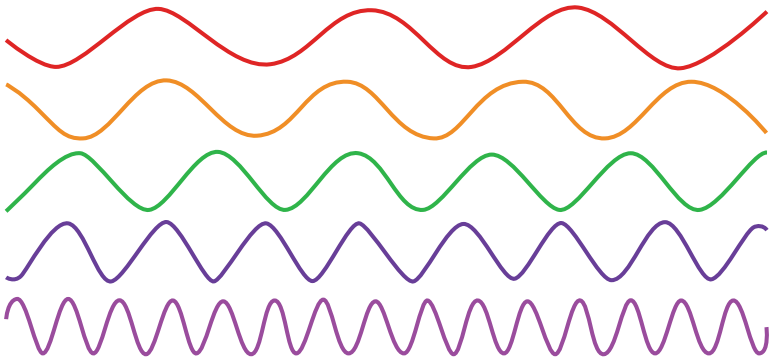
Many young, healthy humans (through teens and early twenties) can hear frequencies from about 20 Hz to 20,000 Hz, and can detect frequency differences as small as 0.2%. That is, we can tell the difference between a sound of 1000 Hz, and one of 1002 Hz.

Sound waves oscillate and can be transmitted through a solid, liquid, or gas, sound waves are composed of frequencies not all within the normal human range of hearing. Sound waves can be of a level sufficiently strong to be heard, or felt as a vibration in the body. The matter that supports the sound (that sound travels through) is called the medium. Sound cannot travel through a vacuum.

4.1 Sound wave properties and characteristics

Sound waves are characterised by the generic properties of waves, which are :

- frequency
- wavelength
- period
- amplitude
- intensity
- speed
- direction



4.2 Decibels

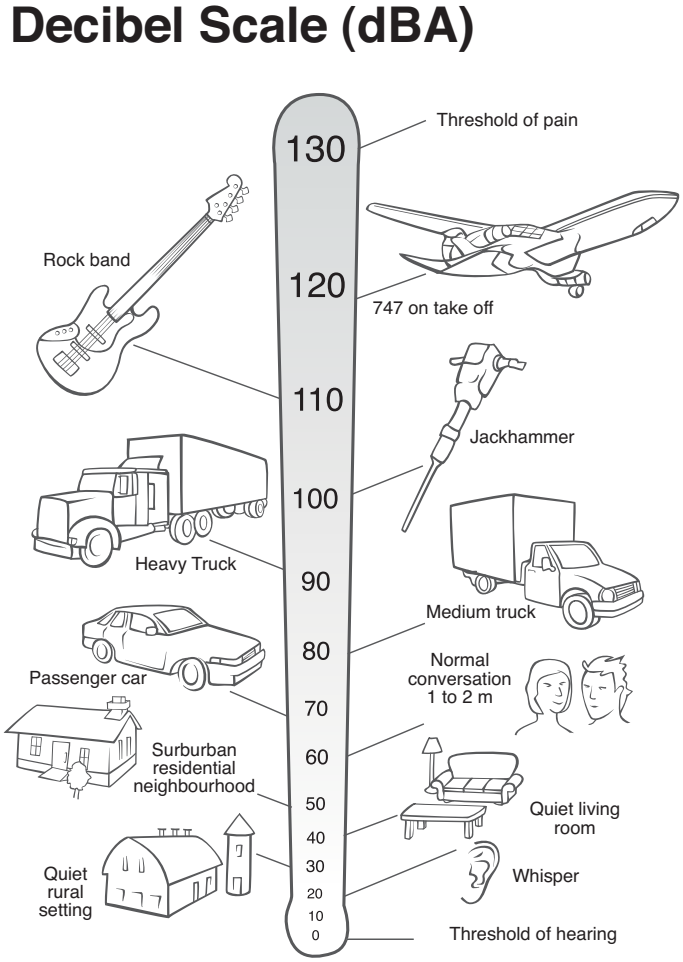
Sound pressures or intensity is measured in **decibels (dB)**. Like a thermometer, the decibel scale goes below zero. The average person can hear sounds down to about 10 dB, the level of rustling leaves. Some people with very good hearing can hear sounds down to -15 dB. If a sound reaches 85 dB or stronger, it can cause permanent damage to your hearing.

The decibel scale is a logarithmic scale. Logarithmic scales are used to help us organise large and varied values.

- On the **decibel scale**, the smallest audible sound (near total silence) is 0 dB.
- A sound 10 times more powerful is 10 dB.
- A sound 100 times more powerful than near totaL silence is 20 dB.
- A sound 1,000 times more powerful than near total silence is 30 dB

Noise levels of 85dB or lower are in the **hearing comfort zone**. If you are exposed to noise above the hearing comfort zone without hearing protection, you will damage your hearing. You can be exposed to these levels of noise at work, at home, or during your recreation.

The longer you listen to a sound, the more damage it can potentially cause. If the sound is very quiet, it will not cause damage even if you listen to it for a very long time. However, exposure to common noises that reach 85dB can cause permanent damage to the hair cells in the inner ear, and lead to hearing loss. Many common sounds may be louder than you think.

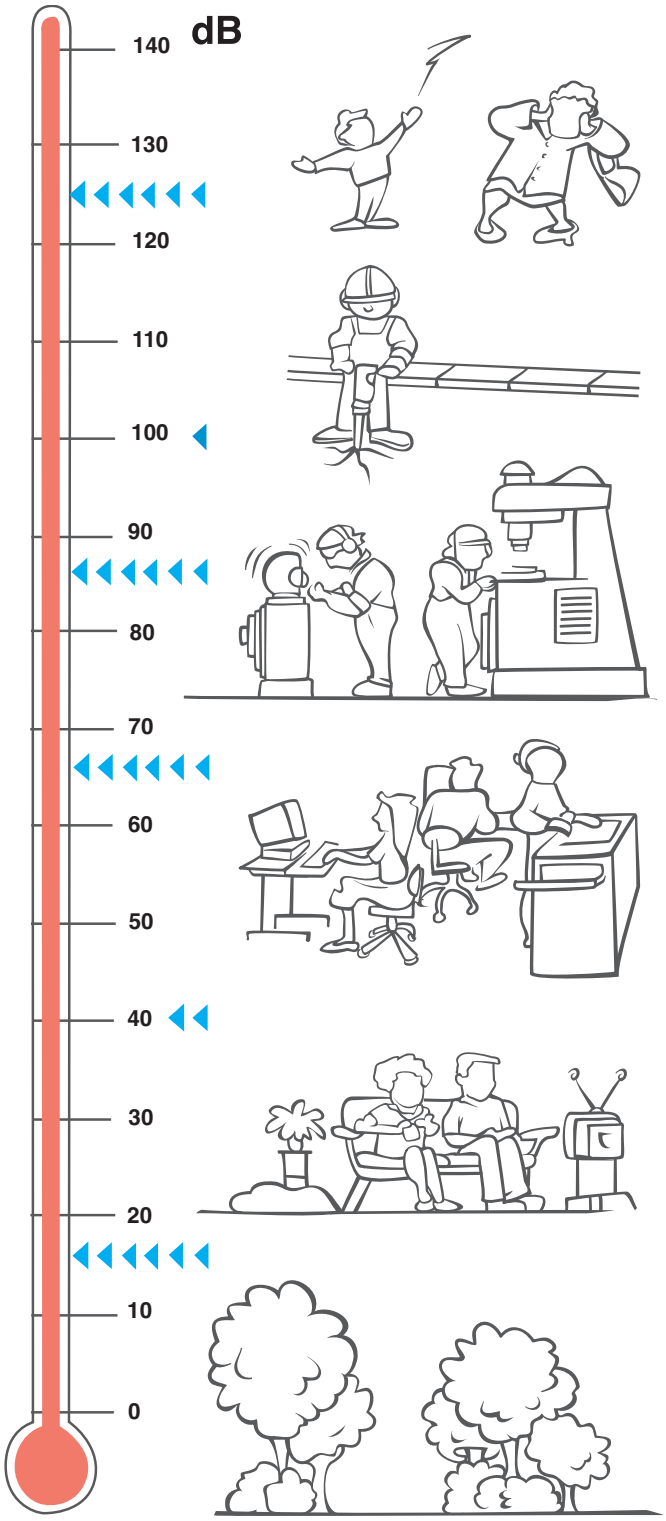


- When you listen to music on earphones at a standard volume level 5, the sound generated reaches a level of 100 dB. This is loud enough to cause permanent damage to your hearing after just 15 minutes per day!

Decibel scales show the decibel rates for common noises. The scale helps you understand what sounds make high levels of noise that could damage your hearing.

COMMON DECIBEL SCALE	
Source of sound	**Decibels (dB)**
theoretical limit for undistorted sound at 1 atmosphere environmental pressure	191
1883 Krakatoa eruption	≈ 180 at 80km
stun grenades	170 - 180
rocket launch equipment acoustic tests	≈ 165
a rifle shot (depending on weapon)	140 - 190
threshold of pain	134
hearing damage during short-term effect	≈ 120
a clap of thunder from a very close storm	120
jet engine, 100 m distant	110 - 140
jackhammer, 1 m distant, disco, listening to music on earphones at a volume level 5	≈ 100
hearing damage from long-term exposure	≈ 85
traffic noise on major road, 10 m distant	80 - 90
a bulldozer/digger etc, idling only not working	85
moving car, 10 m distant	60 - 80
TV set – typical home level, 1 m distant	≈ 60
normal talking, 1 m distant	40 - 60
very calm room	20 - 30
quiet rustling leaves, calm human breathing	10
auditory threshold at 2 kHz – undamaged human ears	0

Other decibel scales



4.3 Time exposure to noise levels amd exposure time

You are exposed to *workplace noise* throughout your day at work. When you are exposed to noise for a long time there is a cumulative (or growing) effect on your hearing. So the longer you are exposed to a loud noise, the more likely it is that you will have hearing loss.

Industrial *noise exposure standards* are set for an average 8-hour working day. This table shows noise levels in decibels, and how long you can work in that level of noise.

The extent of damage to hearing depends on the total amount of noise energy that the ear is exposed to over a period of an 8 hour day. In New Zealand, the exposure standard is set at 85dB (A) Leq (8hrs). For every 3dBA increase in measured sound levels (a doubling of the sound power) the acceptable time of exposure must be halved.

DECIBEL SCALE	
Constant Noise Levels	**Maximum Exposure Time**
85dBA	8 hrs
88	4 hrs
91	2 hrs
94	1 hrs
97	30 mins
100	15 mins
103	8 mins
106	4 mins

What you do in your own time outside of work also affects you. For example, noise levels of music at dance clubs can be as much as 97dB. A person who completes their 8 hour working day in an "acceptable" noise level, and then spends 4 hours listening to loud music at a club will exceed their daily dose, despite having had an "acceptable" exposure during work.

To define an acceptable level of continuous noise, the term "Leq" is normally used. Noise Level Leq is short for Equivalent Continuous Noise Level. It is an imaginary constant noise level which contains the same amount of sound energy as the fluctuating noise that an individual would actually be exposed to over a stated time period.

What decibel level is the maximum for the hearing comfort zone?

5.0 Hearing Protection

Our ears do not recover from Noise Induced Hearing Loss (NIHL).
If people have confirmed NIHL, workplace health and safety management programmes must include actions to prevent further hearing loss. Staff must be informed of the hazards of further excessive noise exposure. Both their work and recreational activities should be explored to identify noise hazards and appropriate advice given to the person and their employer.

From 1 April 1993, the Health and Safety in Employment Act has required employers to identify and control hazards such as noise. NIHL is defined as "Serious Harm" in the Act. An employer who knowingly causes "serious harm" is liable to fines of up to $100,000 and/or 12 months' imprisonment.

Cost-benefit studies of different ways of controlling excessive noise show that using hearing protection can be a *more expensive option* than isolating noise sources and using engineering controls. If there are ways to control noise at the source, we should do this. However it is not always possible to control noise. So if the workplace has excess noise, a **hearing protector programme** must be put in place.

As part of a hearing protector programme, employers need to consider:

- The need for hearing protectors.
- Defining hearing protector areas.
- Selection of hearing protectors.
- The issuing of hearing protectors to individuals.
- Cleaning and maintenance of hearing protectors.
- Training and education for people wearing hearing protectors.

5.1 Hearing protection in New Zealand

In New Zealand, hearing protection equipment is graded according to its ability to reduce noise exposure to a level no higher than the Leq of 85 dBA. We need to know what noise levels people will be working in to decide the best type of hearing protection to use.

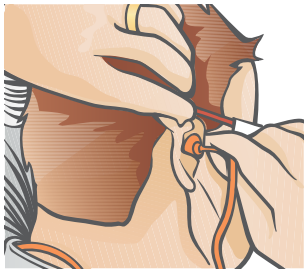
Like any personal protective equipment you use, there can be some problems with using hearing protection.

Problems include:

- People don't use the protection for small jobs.
- People find ear muffs hot and sweaty and uncomfortable to wear.
- People have to wear other protective equipment (e.g. respirator masks, helmets) and this makes it difficult to wear ear protection.

Hearing protection equipment has some design limitations. Low frequency sounds are not well-excluded. Also, most ear muffs are designed for northern European males' average head size. This means that Asians, Polynesians and women often have difficulty in getting equipment that fits correctly.

Using hearing protection correctly



People must be trained in how to use hearing protection correctly.
You will either need enough sets of ear muffs so they can be cleaned and maintained, or you will need ear muff covers. Personal protection only works if it is the right sort of equipment for the job, and is worn or inserted correctly.

- Ear plugs must be firmly placed in and occlude the external auditory meatus (fill the space in your ear canal).
- Ear muff pads must seal around the ear. The tension band must clamp the muffs onto the head at the designed pressure to ensure an effective seal.

Types of approved hearing protection in New Zealand			
Grade	**Leq (8hr) dBA**	**Types**	
1	Less than 90	Earmuffs, Earplugs and Canal Caps	
2	90 - 95		
3	95 - 100	Earmuffs only	
4	100 – 105		
5	105 - 110		

Ear plugs are inserted to block the ear canal. They may be premolded (preformed) or mouldable (foam ear plugs). Ear plugs are sold as disposable products or reusable plugs. Custom moulded ear plugs are also available.

Canal caps or Semi-insert ear plugs which consist of two ear plugs held over the ends of the ear canal by a rigid headband.

Ear muffs have sound-reducing material and soft ear cushions that fit around the ear, and hard outer cups. They are held together by a head band.

The Workplace Exposure Standard is:

- Leq (8hrs) 85 dB(A)
- Maximum Level 115 dB(A)
- Peak Level 140 dB

If you are not sure which grade of hearing protection you should use, it is better to go to the next higher grade of protection.

All hearing protection has to be labelled either on the device itself (ear muffs) or its packaging (ear plugs) and this label must show the appropriate grade. There have been some imports of substandard equipment which have not been graded and do not offer any practical protection.

Ear muffs do not work well if they do not fit properly. They are also less effective if they are only worn part of the time during periods of noise exposure. Ear muffs should not be modified – this makes them less effective. Remember, radio headsets are not substitutes for hearing protectors and should not be worn where hearing protectors are required to protect against exposure to noise.

5.2 General hearing protection information

How do I pick my hearing protectors?

The choice of hearing protectors is a very personal one. It depends on a number of things including level of noise, comfort, and the suitability of the hearing protector for both the worker and the environment. However, the most important thing is to provide the desired noise reduction.

Ear muffs are easier to use when loud noise comes in bursts

(is intermittent) because they are easier to take off and put on.

It may be inconvenient to remove and reinsert earplugs.

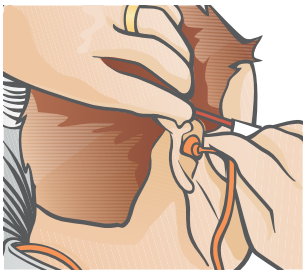
Comparison of Hearing Protection		
Ear Plugs	**Ear Muffs**	**Canal Caps**
Advantages • small and easy to carry • convenient to use with other personal protection equipment (can be worn with ear muffs) • more comfortable for long-term wear in hot, humid work areas • convenient for use in confined work areas • stops foreign matter entering the ear	**Advantages** • less noise reduction variability • designed so that one size fits most head sizes • easily seen at a distance to assist in the monitoring of their use • not easily misplaced or lost • may be worn with minor ear infections • stops foreign matter entering the ear	**Advantages** • relatively easy to fit • medical fit is not required (Individuals should be instructed on the proper fit and wear of ear canal caps) • one size fits most • can rest around neck when not worn
Disadvantages • requires more time to fit • more difficult to insert and remove • require good hygiene practices • may irritate the ear canal • easily misplaced • more difficult to see and monitor usage	**Disadvantages** • less portable and heavier • more inconvenient for use with other personal protective equipment • more uncomfortable in hot, humid work areas • more inconvenient for use in confined work areas • may interfere with the wearing of safety or prescription glasses - wearing glasses breaks the seal between the ear muff and the skin and results in decreased hearing protection	**Disadvantages** • cannot be used when noise levels are in excess of 95 dB(A) • more expensive than earplugs • can become uncomfortable when worn for long periods of time

Why is user preference so important?

The only useful kind of hearing protection is the one that is actually worn. Every human being is different, and the anatomy of the ear and ear canal can vary significantly from person to person. What is comfortable for one person may not work for another person.

It is a good idea for your employer to provide a number of different types of hearing protection for you to choose from. However, there may be safety or hygiene reasons for not using a particular kind of protector. Some protectors should not be used if noise levels are too high. Others might be inadequate from a hygienic point of view. For example, if ear plugs have to be inserted and removed a lot throughout the day, people may reinsert them with dirty fingers and introduce dirt and bacteria into the ears. This can cause ear infections.

What should I know about the fit of my hearing protectors?



Follow the manufacturers' instructions to fit your hearing protection.

- With **ear plugs**, the ear should be pulled outward and upward with the opposite hand to enlarge and straighten the ear canal. You should insert the plug with clean hands.
- Ensure the **ear muffs** tightly seal around the outside of your ear or against the side of the head. Your hair and clothing should not be in the way.
- Place the caps of the **canal caps** either into the ear canal or just over the ear canal. Allow the head band to rest over the head, behind the head, or under the chin. Adjust head band tension for comfort, if available.

What happens to the protection level when hearing protectors are removed for short periods of time?

In order to get full benefit, hearing protectors must be worn all the time during noisy work. If hearing protectors are removed only for a short duration, the protection is substantially reduced. Ear protectors must be used **ALL THE TIME** to get the full benefit.

How should I care for my hearing protection device?

- Follow the manufacturer's instructions.
- Check hearing protection regularly for wear and tear.
- Replace ear cushions or plugs that are no longer pliable.
- Replace a unit when head bands are so stretched that they do not keep ear cushions snugly against the head.
- Disassemble ear muffs to clean.
- Wash ear muffs with a mild liquid detergent in warm water, and then rinse in clear warm water. Ensure that sound-reducing material inside the ear cushions does not get wet.
- Use a soft brush to remove skin, oil, and dirt that can harden ear cushions.
- Squeeze excess moisture from the plugs or cushions and then place them on a clean surface to air dry.

Note: Check the manufacturer's recommendations first to find out if the ear plugs are washable.

Is this statement true or false?
"Under the health and safety in employment act NIHL is defined as minor harm."
True / False

6.0 Workplace Hearing Protection Programmes

Section 6 of the HSE Act requires employers to take all practicable steps to ensure the safety of employees at work, and to provide a safe working environment. *Regulation 11 of the Health and Safety in Employment Regulations 1992* states the levels of noise exposure that should not be exceeded. The regulation also states that hearing protection is only a valid means of control when all practicable steps have been taken to reduce noise to below the stated levels.

6.1 Audiometric testing

We do audiometric testing of a person's hearing of a person to determine if they have any hearing loss. In New Zealand, the method of audiometric testing used is known as PURE Tone Audiometry

Audiometric tests only give an estimate of hearing loss. Where hearing loss is due to noise exposure, it may take months or even years of repeated noise exposure before permanent hearing loss becomes measurable.

If audiometric tests indicate that hearing loss due to noise exposure has occurred, then employers need to make changes that will ensure no further hearing loss.
OSH has criteria for when hearing loss is considered to be serious harm. If audiometric testing reveals serious harm, OSH must be notified.

6.2 Employer duties

Employers have to:

- Provide audiometric testing for employees when a noise assessment shows noise levels are above the exposure limits, or for any reason it is assumed the noise level exceeds the exposure limits.
- Gain the informed consent of employees exposed to noise that exceeds the exposure limits before carrying out any audiometric tests.
- Arrange for those audiometric tests to be carried out.
- Establish baseline reference tests.
- Have a notification system when the threshold shift exceeds 10 decibels.
- Have a system for annual testing.
- Provide audiometric testing records to current and former staff when requested.

This is required by *Section 10 of the Health and Safety in Employment Act 1992.*

Reminder: Threshold Shift - As noise increases our ears' sensitivity level will decrease (we hear less) as a way of protecting our hearing. So a person with a threshold shift of 10dB can now only hear sound that is 10dB louder than the sound that they used to be able to hear.

6.3 When should audiometric tests be done?

The *Approved Code of Practice for the Management of Noise in the Workplace (2002)* requires audiometric testing to be carried out, as follows:

- reference audiometry as soon as possible after the noise hazard is identified
- reference audiometry at the commencement of employment of any new employee who will be exposed to noise that exceeds the exposure limits, preferably before they are exposed to any noise in the workplace
- reference or monitoring audiometry at no greater than 12 month intervals.

The code also recommends reference or monitoring audiometry be carried out for new employees 3 months after the commencement of employment.

6.4 Informed Consent

Under the *Health and Safety in Employment Act 1992*, the employer is required to take all practicable steps to gain the informed consent of employees to carry out audiometric tests. This is often done by the person who carries out the audiometric tests.

Audiometric testing reveals personal information about the health status of an individual. This means the information is subject to privacy laws and should not be passed to a third party. Employers need the information to help them to better manage noise hazards and employees' exposure to them. These things need to happen:

- Employees need to give their consent for the employer to use the results of audiometric tests.
- Employers should treat this information as confidential, and ensure no other party has access to it.
- All employees should be given the results of their personal audiometric tests.

6.5 Other action to take following audiometric tests

If the audiometric tests show these things, an employer should take action to review noise control and hearing protector programmes:

- Monitoring audiometry reveals a temporary hearing loss (temporary threshold shift or TTS).
- Reference audiometry reveals serious harm as defined in Section 7.6 of *Approved Code of Practice for the Management of Noise in the Workplace (2002).*
- Reference audiometry reveals further deterioration in the hearing of a person already diagnosed with noise-induced hearing loss.

Actions could include:

- Checking to see if there has been any change in the employee's work that would change his or her noise exposure.
- Checking to ensure that noise control solutions are still being used and are effective.
- Re-evaluating the employee's noise exposure if necessary, re-evaluating the suitability and fit of any hearing protector.
- Evaluating whether the hearing protector is being worn correctly and consistently.

6.6 Advising people when they must wear hearing protectors

Every person in a designated hearing protector area must wear hearing protectors. This includes people working full or part time in those areas, and people passing through or spending very short amounts of time there.

A "designated hearing protector area" is any environment where the noise levels exceed, or are likely to exceed, the exposure limits stated in the Regulations. The areas or machinery concerned must be clearly labelled and the boundaries where the noise hazard exists must be clearly defined. Signs identifying the hearing protector area may be necessary.

The signs used to identify these areas and machines should conform to the specifications in *NZS/AS 1319.* The construction, location, maintenance and use of signs should conform to *Section 4 of NZS/AS 1319.*

The requirements for hearing protector areas are detailed in *Clause 10 Hearing protector areas of AS/NZS 1269.3.* The meaning of signs must be explained to employees as a part of training.

If it isn't practical to put signs up, you can make other arrangements to make sure people know when they should use hearing protectors. Any arrangements should be made in consultation with employees.

Examples of things you can do include:

- Attach prominent warning notices to tools and equipment to say that hearing protectors must be worn when operating them.
- Provide written and oral instructions on how to recognise circumstances in which hearing protectors are needed.
- Effective supervision of the specified high-noise areas.

Employees should be able to see copies of any guidelines and company policy on noise exposure levels and equipment if they need to.

6.7 Hearing protection training

It's easy to become complacent about workplace noise because it is a hazard that is often present. So it is important to make sure everyone gets health and safety training that covers workplace noise and hearing loss hazards.

Who should get training:

- Employees who are likely to be, or are actually, exposed to excessive noise at work.
- Managers and supervisors of these employees.
- Employees responsible for purchasing plant, and for the designing, scheduling, organisation and layout of work.
- Employees responsible for buying and looking after hearing protectors.

Staff responsible for visitors and contractors who are likely to be in a designated hearing protector area are another group who may need training.

The needs of each group are different, and the content and methods of training must be tailored to meet the specific needs of each of these groups.

What training should include

Before hearing protectors are issued, the need for their use must be fully explained. Employees should be trained in how to select, fit, use, care for and maintain their hearing protectors. This instruction must be repeated at regular intervals.

It is extremely important to point out the effect of removing hearing protectors when exposed to excessive noise. Managers and supervisors should encourage the use of hearing protectors by explanation and personal example.

Training programme outline

The format and content of an appropriate training programme is given in *Appendix D of AS/NZS 1269.3 Hearing protector programme.*

Topics to cover in a training programme aimed at prevention of noise-induced hearing loss include:

1.	A brief overview of noise, dB, the hearing mechanism and the hearing protector programme/s
2.	The threshold for wearing hearing protection and the reasons for wearing hearing protectors
3.	The selection of suitable hearing protectors with regards dB risks
4.	The use and proper fitting of hearing protectors
5.	Upper noise levels and the hearing comfit zone
6.	Time weighted average exposure over an 8 hr average
7.	The importance of wear time and consequences of hearing protector removal
8.	The maintenance and storage of protectors; and a summary of the session emphasising the most important factors.

Supervisor training
Before a person first becomes a supervisor, that person must be trained to understand:

- The control measures implemented to reduce noise exposure
- Where, when and what types of hearing protectors employees should wear
- How hearing protectors will be selected, fitted, used, cleaned, maintained and replaced.

Training on hearing protector maintenance
If a person is responsible for maintaining hearing protectors, they must be trained in:

- how to clean and maintain hearing protectors
- how to undertake visual examination of hearing protectors for defects.

Training persons responsible for purchasing hearing protectors
Before a person is first responsible for purchasing hearing protectors, that person must be trained to understand the HSE Act and regulations and AS/NZS 1269.3, and how to interpret both the attenuation data provided by manufacturers and the field measurements of attenuation required to provide adequate protection.

Training workers of non-English-speaking backgrounds
The employer must ensure that the content of the training is clearly understood by all employees. The employer must take into account the specific needs of workers with a non-English-speaking background.

Complete the sentence below

If the workplace has excess noise then a .... must be put in place.

What are the employer's duties concerning audiometric testing?

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Answers to Activities

Activity (Section 1 - page 8)
What is the AS/NZS standard number that deals with hearing protectors?
AS/NZS 1270:2002 Acoustics — Hearing protectors.

Activity (Section 2 - page 13)
Name the three parts of the structure of the ear

i) The external ear (outer ear)

ii) The middle ear

iii) The internal ear (inner ear)

Activity (Section 3 - page 18)
Noise Induced Hearing Loss (NIHL) is a notifiable disease.
True

Activity (Section 4 – page 23)
What decibel level is the maximum for the hearing comfort zone?
85dB

Activity (Section 5 – page 29)
Under the health and safety in employment act NIHL is defined as minor harm
False – it is defined as "serious harm"

Activity (Section 6 – page 34)
Complete the sentence below
If the workplace has excess noise then a **hearing protector programme** must be put in place.

Activity (Section 6 – page 34)
What are the employer's duties concerning audiometric testing?

1. Provide audiometric testing for employees when a detailed noise assessment shows noise levels are above the exposure limits, or for any reason it is assumed the noise level exceeds the exposure limits.
2. Gain the informed consent of employees exposed to noise that exceeds the exposure limits before carrying out any audiometric tests.
3. Arrange for those audiometric tests to be carried out.
4. Establish baseline reference tests.
5. Have a notification system when the threshold shift exceeds 10 decibels.
6. Have a system for annual testing.
7. Provide audiometric testing records to current and former staff when requested.