NOISE & PROTECTION

Hellberg®

Since 1962

INTRODUCTION

Noise induced hearing loss is the most common reported occupational disease. About 1 billion people around the world are affected by hearing loss - about 16% of the world's population.

The financial cost of hearing loss has been estimated to be 78 billion euro per year in Europe, between 90 and 135 billion euro in the United States and 6.7 billion euro in Australia.

Over 30% of all workers are exposed to hazardous noise levels and one in four manufacturing workers exposed to loud noise does not use hearing protectors.

We seldom think about what a fantastic sensory organ our ear actually is. It allows us to hear people talk, music play, birds sing and children laughing. It is our link to the environment and is vital for how you communicate with others.

As well as helping us communicate, our hearing helps to keep us safe. A fire alarm ringing and a car honking its horn are examples of sounds that we need to hear. We rely on our hearing in so many ways, which is why we should protect it.

Unfortunately, for a significant part of the population, this ability is partially or entirely lost, because of exposure to loud noise. Hearing loss can never be restored, but avoiding damage to your hearing is in most cases a matter of selecting and wearing the proper protection.

This guide provides you with insight how your hearing works and tactics to select appropriate protection.

SOURCES: NOISE SECTION OF THE EUROPEAN AGENCY FOR SAFETY AND HEALTH AT WORK (EU-OSHA)
THE NATIONAL INSTUTUTE FOR OCCUPATIONAL SAFETY AND HEALTH
HELLBERG SAFETY AB

CONTENT

HOW HEARING WORKS

Sound waves are around us. When a telephone rings or someone speaks sound waves are sent through the air in different directions.

When our ears capture sound waves, they convert them into messages our brains can understand.

The reason why we have two ears is because it is easier to determine the direction of the sound, especially in noisy situations.

Our hearing organ consists of three parts which work together so we can hear sound.

outer ear - the part of the ear that people can see. The main job of the outer ear is to collect sound waves and direct them into the middle ear.

middle ear – the area where sound waves are translated into mechanical energy that are then transferred to the fluids of the inner ear. Three tiny bones (the hammer, the anvil and the stirrup) and the eardrum make up the middle ear. They work together to amplify sound waves. The ear's hammer, anvil and stirrup are the smallest bones in the human body. All three together could fit together on a coin.

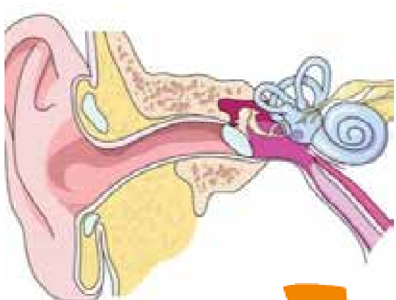
inner ear (cochlea) - Each ear has a small, fluid-filled structure called the cochlea that contains about 20,000 hair cells. These tiny hair cells are responsible for translating sound vibrations into electrical impulses.

HOW DOES IT WORK?

1. Sound waves enter the ear canal, strike the eardrum which starts to vibrate making three tiny bones, the hammer, anvil and stirrup move.

2. This movement makes fluids in the cochlea (spiral shaped inner ear) flow causing the tiny hair cells in the cochlea to move. The hair cells detect the movement and change it into the chemical signals for the hearing nerve.

3. The hearing nerve then sends the information to the brain with electrical impulses, where they are interpreted as sound.



Hearing is our fastest reacting sense. It only takes 8-10 milliseconds for our brain to recognise a sound compared to 20-40 milliseconds to recognise an image

DEFINITION OF SOUND

Machines, music instruments and the human voice box cause vibrations/sound waves in the air that we perceive as sounds.

The number of sound waves per second is called frequency and is measured in Hertz (Hz). The most common sounds, like that of human speech (800-4000Hz), are found in the High and Middle frequency range.

Middle to High frequency noise is the most damaging to your hearing, and should therefore be your primary concern.

Low frequency sounds (below 500Hz) are usually generated by large engines, ventilation systems, etc. Low frequency noise is usually less damaging, but can be dangerous because it masks human speech, alarm signals and it can cause symptoms like dizziness and nausea. Some low frequencies are difficult to block out even with proper hearing protection because it can transmit directly into the inner ear through your scull.

Decibel (dB) is the unit used to measure the sound pressure level (strength). The lowest level distinguishable by the human ear is 0dB. Anything above 120dB is likely to cause pain and is about one million times stronger than 0dB. Every increase of 3 dB represents a doubling of sound intensity and around 8-10dB is perceived to be twice as loud. High frequencies are perceived louder than low frequencies.

INFRA- AND ULTRA SOUND

Infrasound is low frequency sound <22Hz. Even if it is too low for us to hear it can still affect us. Infra sound can cause sleep disturbances, changes in blood pressure, feelings of fatigue, depression, loss of concentration etc.

Ultrasound is high frequency sound >18,000Hz and is too high for us to hear but can still cause unpleasant sensations such as aural fullness or pressure, headaches and possibly nausea and fatigue.

The speed of sound is around 6000m/s in steel, 1500m/s in water and 340 m/s in air.

DEFINITION OF NOISE

What we call "noise", is usually described as sounds we experience as unpleasant or disturbing. High level of noise is hazardous to your hearing. Noise can also lead to stress symptoms, discomfort and pain. Harmful noise is everywhere. Loud music, a rock concert, motorsports, target practice or hunting, even mowing the lawn – it could all damage your hearing.

Noise can be continuous, intermittent, impulsive or variable depending on how the noise changes over time or how a person moves in a noisy environment.

CONTINUOUS NOISE

Steady continuous noise does not vary over time. In the industrial environment, the sound of a rotating electric motor (a fan, pump etc.) can be classified as steady continuous noise. Fluctuating continuous noise change level or/and frequency over time. Most manufacturing noise is fluctuating.

INTERMITTENT NOISE

Noise is intermittent if it stops and starts at intervals. One example of intermittent noise is a compressor.

IMPULSE NOISE

Impulse noise is characterized as a short pulse (<1sec) with very fast rise time and a level of at least 20dB above the continuous noise level.

Impulse noises are very dangerous to hearing. The brain needs at least 0,3 sec to identify a sound at the right level. The hearing organ reacts a lot faster. We do not realize that these noises are harmful to our hearing and we often disregard the need for protection. Examples of sound sources giving impulse noise are gunfire and hammer blows.

Standing in front of the speakers at a rock concert can expose you to 120 decibels, which will begin to damage hearing in only 7 1/2 minutes.

HEARING LOSS

Hazardous noise affects the functioning of the hair cells in the inner ear leading to impaired hearing ability. Hearing may be restored after a period of time away from noise but with further exposure the hair cells will gradually die and the hearing loss will become permanent.

Permanent hearing loss can also occur suddenly. Exposure to one single impulse noise is enough to destroy the inner ear of an unprotected hearing organ.

Damage hair cells cannot be replaced or repaired by any known medical treatments or technology.

Different groups of hair cells are responsible for different frequencies. Hazardous noise first affects the ability to hear high-frequency (high-pitched) sounds. Humans are most sensitive to sounds near 4000Hz (the frequency band for speech) and this is the area where most hearing loss occurs.

Noise induced hearing loss often leads to tinnitus or hyperacusis. Tinnitus is commonly described as a ringing in the ears and it may be soft or loud, high pitched or low pitched. Hyperacusis is characterized by over-sensitivity to certain frequencies.

Other dangers with hazardous noise are high blood pressure, stress, negative social effects, headache, depressions and irritation.

Exposure to certain ototoxic chemicals can also affect hearing. Many sectors with high exposures to noise also have high exposures to dangerous substances.

Some people are more sensitive to noise than others. High temperatures, exposure to vibrations or having a cold increase the risk of hearing damage.

How quickly hearing loss takes place depends on the intensity of the noise, its duration, and how often the exposure occurs

SELECTION PRINCIPLES

When selecting hearing protection it is of great importance to choose the most suitable one. The choice depends on factors such as;

SOUND ATTENUATION

Most importantly, the hearing protector should provide the desired noise reduction.

When selecting hearing protection you need information on the character of the noise; sound pressure level (dB), duration and frequency content (Hz).The level of the disturbing noise and its frequency distribution is of great importance. High levels of low frequency noise have the inconvenience of degrading the ability of perceiving speech (below 500Hz).

WORK ENVIRONMENT

Different factors such as temperature, dust, substances at work, moving machinery parts, localization of the noise source etc. should affect the selection of the hearing protector. Where communication is necessary the ability to communicate must be balanced with adequate protection from the hazardous noise. The type of noise such as continuous noise, intermittent noise or impulse noise is another factor to consider.

WEARER COMFORT

The wearer's comfort when selecting an earmuff is of importance to enhance full wear time. Parameters such as cushion pressure, headband force, weight and adjustability may be relevant but the user should be given the opportunity to make a personal choice of hearing protector.

COMPATIBILITY WITH OTHER PPE

When combining hearing protection with other protective equipment it is important that the hearing protection attenuation is not impaired due to the combination. For example the side arms of spectacles should be of a low profile type to minimise the reduction of performance.

If you are uncertain if your other equipment will affect the attenuation it may be wise to choose a ear muff with a slightly higher protection level than what the analyse method is stating.

Depending on the thickness of the side arms of spectacles the attenuation will be reduced by between 3-8dB. This principle will apply to other personal protective equipment that is breaking the seal between the ear and the ear muff.

MEDICAL FACTORS

An existing hearing impairment may result in additional difficulties in hearing by the use of hearing protectors. In such cases appropriate specialist advice should be sought.

The real world sound attenuation of hearing protectors may differ from that obtained in laboratory testing due to incorrect fitting, selection, misuse and maintenance.

Attenuation performance can be affected negatively by factors such as long hair, heavy stubble or beard, glasses or incorrect fitting over the ears.

Therefore the calculated level under the hearing protector (at the ear) should be between 70-80dB (A) based on a legalised level of max. 85dB (A).

In most cases it is not desirable with levels below 70dB (A) under the hearing protection as it may cause difficulties with communication and hearing warning signals. Over protection will cause the users to feel isolated and to remove the hearing protector to increase perception of sounds in certain situations and therefore risk damage to their hearing.

If the noise exposure exceeds 105dBA to 110dBA the worker should consider wearing a combination of ear plugs and ear muffs. The attenuation of the combination is not equal to the sum of the attenuation of the individual protectors. The extra attenuation is max 6dB over that provided by the better of the individual protectors. The increase is mainly at frequencies below 1000Hz. At higher frequencies the bone sound conduction may limit the total sound attenuation.

Hearing protectors must be worn all the time in noisy environments. A hearing protection with an attenuation of 30dB will only give you a protective effect of 12dB if removed 30 minutes during an 8 hour working day. If only worn for 4 hours out of an 8 hour day, the effective protection provided by any hearing protector is not more than 3dB.

Remember that it is as important to protect yourself from noise during your spare time as it is during your work day.

STANDARDS

Legislations and regulations require you to wear hearing protection in a noisy environment and place limits on sound exposure. The level of noise entering our ears must be reduced to below the legal limits. Most industrialised nations have some form of noise exposure legislation.

Before a hearing protection product can be placed on the market it must be tested and certified. There are three main standards to ensure that the product fulfil the requirements in the legislations.

The testing scheme differs for each type of hearing protector but they all must undergo physical tests such as cold drop test, water immersion, dry heat and clamping force measurements as well as attenuation measurements. Human subjects are always used when testing the performance of a hearing protector.

EUROPEAN STANDARD

For a hearing protector to be categorised as Personal Protective Equipment (PPE) in the EU it must meet the relevant European Standard EN 352. The EN 352 today consists of eight parts. Part one to three sets out the general requirements of earmuffs and earplugs. The final five parts relate to electronic devices.

NORTH AMERICAN STANDARD

In North America hearing protectors must meet the requirements of ANSI S3. 19-1974. The CSA Class rating is a method of rating hearing protectors that are used in Canada. CSA recommends that a:

Class C device may be used for noise levels of <90dBA
Class B device may be used for noise levels of <95dB
Class A device may be used for noise levels of <105dBA

AUSTRALIA/NEW ZEALAND

For Australia and New Zealand products must meet the requirements in the Australian Standard 1270:2002. Depending on the SLC rating, a Class is assigned:

A Class 1 protector may be used up to 90dB
A Class 2 protector to 95dB
A Class 3 protector to 100dB
A Class 4 protector to 105dB
A Class 5 protector to 110dB

DAMEN

ATTENUATION RATING

The attenuation rating of hearing protectors are specified by a single number rating which is a simplified description of the amount of protection offered by a hearing protector.

All three standards are using different test methods and generate different attenuation ratings. SNR (Single Number Rating) is the attenuation rating used in Europe, the NRR (Noise Reduction Rating) in North America and the SLC80 (Sound Level Conversion) in Australia and New Zealand.

Since the procedures for measuring NRRs, SNRs and SLC80s are different, the rating for an individual hearing protector is different. The single number rating is lower than the average attenuation across all frequencies because it contains corrections to make it applicable to a broader population.

The NRR is an estimate of the amount of protection achievable by 98% of users in a laboratory setting when hearing protectors are properly fitted. The SLC80 estimates the amount of attenuation provided to at least 80% of users and the SNR 84% of the users.

The SNR also rates protectors in terms of the particular noise environments in which they will be used – H for high-frequency noise environments, M for mid-frequency and L for low-frequency.

The images on the next page shows two attenuation data charts (North American and European) with explanations of the different terms. The hearing protector's attenuation data chart should follow each product, either on the packaging or the user manual.

Subtracting one extra standard deviation from the mean attenuation will protect a larger number of the population

ATTENUATION DATA CHARTS

SECURE 3 Headband ANSI S-3. 19-1974										
Frequency Hz	125	250	500	1000	2000	3150	4000	6300	8000	NRR
Mean Attenuation	18,1	24,8	33,5	42,8	37,3	36,2	38,0	39,0	38,9	28
Standard deviation	2,3	2,3	2,8	2,8	2,8	2,1	3,3	1,8	2,4	

The earmuff's average attenuation at a given frequency

Difference/deviation in attenuation between different test individuals

Frequencies (octave bands) where the earmuff´s attenuation have been measured

NRR - Noise reduction rating
SNR - Single number rating
A simplified description of the earmuff's attenuation.
A value calculated from the earmuff's octave band values

SECURE 3 Headband EN 352											
Frequency Hz	63	125	250	500	1000	2000	4000	8000	H	M	L	SNR
Mean Attenuation	20,5	17,5	24,8	32,7	43,8	36,4	35,9	38,1				
Standard deviation	5,4	3,0	2,4	2,6	3,7	3,5	3,1	4,1	34	31	22	33
APV	15,1	14,5	22,4	30,1	40,1	32,9	32,8	34,0				

Assumed protection value
Assumed attenuation at a given frequency. Mean attenuation minus standard deviation

Average attenuation in a frequency area
H - Noise dominated by high frequency sounds
M- Noise dominated by medium frequency sounds
L- Noise dominated by low frequency sounds

NOISE SOURCES

Below are some examples that can contain dominating Mid-High frequency noise

- Centrifuges
- Hydraulic pumps
- Gas cutting
- Wood working machines
- Hydralic pumps
- Impact tools
- Grinding machines

Below are some examples that can contain dominating Low frequency noise

- Engine generators
- Electric furnaces
- Diesel generators
- Melting furnaces
- Ground vibrating machinery
- Blasting machines
- Compressor units

DIFFERENT TYPES OF PROTECTION

All hearing protectors have the characteristics of reducing noise. Devices with only this function are called passive hearing protectors.

Passive ear muffs are available in different protection levels and different versions; helmet mounted, headband and neckband Hearing protectors with neckbands permit the simultaneous wearing of a safety helmet or bump caps.

Hearing protectors with level dependent function are designed to provide different attenuation as the sound level changes. Their main purpose is to protect against impulsive or intermittent hazardous noise whilst allowing situational awareness.

They are recommended if impulse and intermittent noise at the workplace exists. The unit allows the wearer to engage in face to face communication and hear warning signals and other important sounds without removal of the hearing protector.

Hearing protectors with 3.5 mm audio input allow connection to external devices such as communication radios or MP3 players.

Hearing protectors with a built in radio receiver is suitable particularly for workplaces with monotonous and stationary tasks in noisy areas. Employees that wear these devices are more productive and motivated on the job.

For the built in radio receiver the EN standards impose a limitation on the reproduced sound pressure level at the ear.

Hearing protectors with integrated radio receivers may be combined with level dependent function.

Other hearing protectors are earmuffs with built in communication radios and hearing protection with Bluetooth for wireless connection to Bluetooth enabled devices.

GLOSSARY

Frequency - The number of sound waves per second is called frequency and is measured in Hertz (Hz).

Decibel (dB) - The unit used to measure the sound pressure level (strength). The lowest level distinguishable by the human ear is 0dB.

Continuous noise - Steady continuous noise does not vary over time. Fluctuaing continuous noise change level or/and frequency over time.

Intermittent noise - Noise that stops and starts at intervals

Impulse noise - Impulse noise is characterized as a short pulse (<1sec) with very fast rise time and a level of at least 20dB above the continuous noise level.

Infrasound - low frequency sound <22Hz and too low for us too hear

Ultrasound- high frequency sound >18,000Hz and too high for us to hear

Real world sound attenuation - The sound attenuation of hearing protectors in the field (real world) is often smaller than determined from laboratory testing.

Over protection - Too high attenuation. It is not desirable with levels below 70dB (A) since it may cause difficulties with communication and hearing warning signals. It will cause the user to feel isolated and to remove the hearing protector.

SNR - (Single Number Rating) A simplified description of the amount of protection offered by a hearing protector used in Europe.

NRR - (Noise Reduction Rating) A simplified description of the amount of protection offered by a hearing protector used in North America .

SLC80 - (Sound Level Conversion valid for 80% of the wearers) A simplified description of the amount of protection offered by a hearing protector used in Australia and New Zealand.

Mean attenuation - The earmuff's average attenuation at a given frequency.

Standard deviation - Difference/deviation in attenuation between different test individuals.

Assumed protection value - Assumed attenuation at a given frequency. Mean attenuation minus standard deviation.

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When hearing matters!

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