Module 1
Occupational Audiometry Testing
Hearing Conservation
Chapter 5

Chapter 5

Hearing Conservation

Chapter Outline

Hearing conservation programme (HCP)	The Hierarchy of Controls
Hearing protective devices (HPD)	Preventing Noise-Induced Hearing Loss

Educational Aims

After studying this chapter, you should be able to:

- ✓ Explain the main features of a hearing conservation programme (HCP) as they relate to the current NIHL Regulation and / or Mines Code of Practice
- ✓ Advice on how the hierarchy of control measures need to be applied in an HCP to prevent noise induced hearing loss (NIHL)
- ✓ Explain what content would need to be addressed and recorded for an induction program related to the noise hazard training requirements listed in the NIHL Regulation
- ✓ Provide health education on the use of HPD
- ✓ Explain the selection, use, care, and maintenance of hearing protective devices to prevent hearing loss as related to the NIHL Regulations and respective SANS standard/s.
- ✓ Prevent hearing loss

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Introduction

As we have explored in Chapter 4, as per legislation, all employers and self-employed people must assess for potential noise exposure, then monitor the exposure and perform medical surveillance on all employeess exposed to noise. In addition to these legal requirements, the employer or self-employed person must identify and demarcate noise zones, limit exposure in these noise zones and control noise exposure, these actions are all detailed in the Noise-Induced Hearing Loss Regulations (NIHL)[1]. For this reason, it is imperative that audiometrists understand what is meant by the terms and what role they play where applicable.

Hearing Conservation Programme

A Hearing Conservation Programme (HCP) becomes mandatory when any in the workplace is exposed to elevated noise levels. Excessive noise is defined as an equivalent sound pressure level of 85 decibels (averaged) (dB(A)) or more over an 8-h workday[2]. Hearing conservation is defined by SANS 10083:2021 as the control of exposure to noise to prevent noise induced hearing loss. HCP is the process to prevent hearing impairment[2]. The objectives of an HCP are to protect exposed employees from the adverse effects of noise and to minimise the risks associated with workplace noise exposure, thereby preventing occupational NIHL. Where employees are exposed to noise levels of 130 dB(A) or higher, additional advice from an expert should be incorporated into the hearing conservation programme. Occupational noise-induced hearing loss is a work-related medical condition characterised by a permanent sensorineural hearing loss because of excessive exposure to high levels of noise in the workplace.

In terms of hearing conservation, both the OHSA[3] and the MHSA[4] require that:

- ✓ No person shall be required / permitted to be exposed to noise above or at the 85dB(A) noise-rating limit
- ✓ Noise exposure should be prevented or adequately controlled
- ✓ Noise monitoring and a noise measurement programme should be in place
- ✓ Potential noise exposure should be monitored in at intervals not exceeding two-years
- ✓ Noise zones need to be demarcated
- ✓ Hearing protective equipment, capable of keeping noise exposure below the noise-rating limits must be provided by the employer, free of charge

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SANS 10083:2021 defines a hearing conservation programme as to consist of:

- ✓ New installations and changes to existing installations: adjudicate layout plans and proposed equipment complement to predict by calculation the 8 h rating level in the proposed work environment
- ✓ Assessment and prediction of noise exposure in all workplaces which may be accessed by any person
- ✓ Obligatory introduction to alternative engineering or administrative procedures and layouts of the workplace to limit noise exposure of employees
- ✓ Demarcation of noise zones where improvement to limit the 8 h rating level to below 85 dB(A) is not possible
- ✓ Issue certified personal hearing protectors to the employees in the noise zones, free of charge
- ✓ Training and information to employees regarding the proper use and maintenance of personal hearing protectors
- ✓ Introduction of audiometric assessments as part of the occupational health surveillance programme
- ✓ The introduction of a follow-up assessment programme

The HCP must be conducted within 6 months of the commencement of operations and then reviewed:

- ✓ At intervals not exceeding two years
- ✓ If there are reasons to believe that the previous risk assessment is no longer valid
- ✓ If there are reasons to believe that the control measures are no longer effective
- ✓ If technological or scientific advances allow for more efficient control methods
- ✓ If there has been a significant change in:
  - Work methods
  - Type of work carried out
  - Type of equipment used to control exposure
  - Type of machinery, plant and equipment used

The employer should:

- ✓ Ensure assessments is done by person(s) authorized by the relevant national body
- ✓ Before anyone is exposed or may be exposed to noise at or above the noise rating limit for hearing conservation, after consultation with the health and safety committee established for that section of the workplace where relevant, ensure that the employees are adequately and comprehensively trained on both the practical aspects and the applicable theoretical knowledge pertaining to the noise exposure
- ✓ Provide adequate information and training to any mandatory body and any other person, other than employees, that may be affected by noise exposure at the workplace

- ✓ Provide refresher training on the above aspects at intervals of two years or at intervals as recommended by the health and safety committee
- ✓ Instruct any person(s) who may be exposed to noise at or above the noise rating limit for hearing conservation of the duties and obligations of such:
  - Use of measures adopted for hearing conservation
  - Immediate reporting of defective, damaged, or lost noise control equipment
  - The use of personal hearing protectors issued to such a person
  - Prohibition to enter or remain in an area where personal hearing protection is required unless such a person is wearing the required personal hearing protectors
  - The co-operation with the employer to determine the noise exposure of such a person
  - The reporting of medical surveillance
  - The information and training received

Information and training (health education)[1,2]:

All employees and others who are not employees, who work or will be exposed to a noise zone should be adequately and comprehensively informed and trained. Training should be conducted prior to placement of the employees and others in the noise zone and refresher training should be done annually or as recommended by the health and safety committee. Training and attendance records shall be kept for 40 years. The following aspects shall be covered in the training:

- ✓ Content and scope of the hearing conservation programme and the NIHL regulation
- ✓ Potential sources of exposure to noise
- ✓ Potential risks to health and safety caused by exposure to noise
  - Assessment of exposure, purpose of noise monitoring, the necessity for medical surveillance and the long-term benefits and limitations of undergoing such surveillance
  - Noise rating limit for hearing conservation and its meaning
  - Procedures for reporting correcting and replacing the defective personal hearing protectors and engineering noise control measures
  - The duties of persons who may be exposed to noise above the noise rating limit for hearing conservation
- ✓ Measures to be taken by the employer to protect employees against risk of exposure to noise
- ✓ Precautions to be taken by an employee to protect himself or herself against the health risk associated with exposure to noise, including the wearing and use of personal hearing protectors

- ✓ The necessity, correct use, maintenance and potential limitations of personal hearing protectors, facilities and engineering control measures provided
- ✓ The necessity of audiometric testing and medical surveillance to monitor possible hearing impairment, together with appropriate explanation of results to the employee

MHSA hearing conservation programme includes the following aspects[4,5]:

According to the DMR Mandatory code of practice for an occupational health programme for noise, a hearing conservation programme should be designed. Aspects that need to be included are:

- ✓ Occupational hygiene
- ✓ Medical surveillance
- ✓ Recording and reporting

Hazard Identification and Risk Assessment (HIRA)

A hazard identification and risk assessment are an inspection of the work environment, equipment, and systems to determine potential hazards and implement safety systems to prevent injury. Through a HIRA, hazards and risks will be identified, who might be at risk, and where control measures are needed to prevent illness and injury. The main purpose of a HIRA is to focus on providing employees with a safe, healthy environment, improving safety and mitigating compensation claims. A HIRA followed by a hygiene survey is an important part of the occupational health and safety management plan.

Job Category	Hazards					
	Noise above OEL	Vibration	UV radiation	Cold stress	Heat stress	Dust
Jackhammer operator	Y	Y	Y	Y	Y	Y
Grinder operator	Y	Y	N	N	N	Y
Blaster operator	Y	Y	Y	Y	Y	Y

Table 5.1 An example of a HIRA by Job Category per Hazard

Figure 5.1 Jackhammer Operator

Figure 5.2 Grinder Operator

Figure 5.3 Blast Operator

Hygiene Survey

An occupational hygiene survey reports on anticipating, identifying, evaluating and controlling health hazards in the workplace to formulate controls that match the severity of the exposure and risk[6]. The main purpose of an occupational hygiene survey is to communicate measures for the control of an exposure/s that could cause harm or adversely affect health, to provide legitimacy to the control measures recommended, be based on scientific evidence to support the conclusion that a health risk is of sufficient severity to warrant the extent/ magnitude of controls recommended.

An occupational hygienist is involved with a hygiene survey which assesses, measures and controls physical, chemical, biological, ergonomical or environmental hazards in the workplace which could cause injury or disease. Physical hazards include noise, thermal stress, illumination extremes, ionizing or non-ionizing radiation.

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Although there are many aspects to occupational hygiene the most known and sought after is in determining or estimating potential or actual exposures to hazards such as noise, lighting, and chemical measurement. Several methods can be applied in assessing the workplace or environment for noise as a physical hazard.

The Path to Prevention

When an employer is fully committed towards preventing hearing loss, employees are far more likely to follow this lead and be proactive in terms of protecting their own hearing.

Noise Surveys[12,13,14]

- ✓ This should be done by an approved noise inspection authority (AIA)
- ✓ It must be done within 6 months of the establishment of a workplace that may generate noise **and**
  - Should be repeated at intervals not exceeding 2 years **or**
  - When new machinery or work processes are implemented
- ✓ The results must be recorded and stored for forty (40) years
- ✓ Hearing conservation programmes should be implemented in all areas where the noise levels are equal to or greater than 85dB(A)

Often after a hygiene survey for noise, hygienists will provide the company with noise maps, and a list of homogenous exposure groups (HEG's) which are lists of job types per department where noise exposure is prevalent (see examples in Figure 5.4 and Tables 5.1 and 5.2).

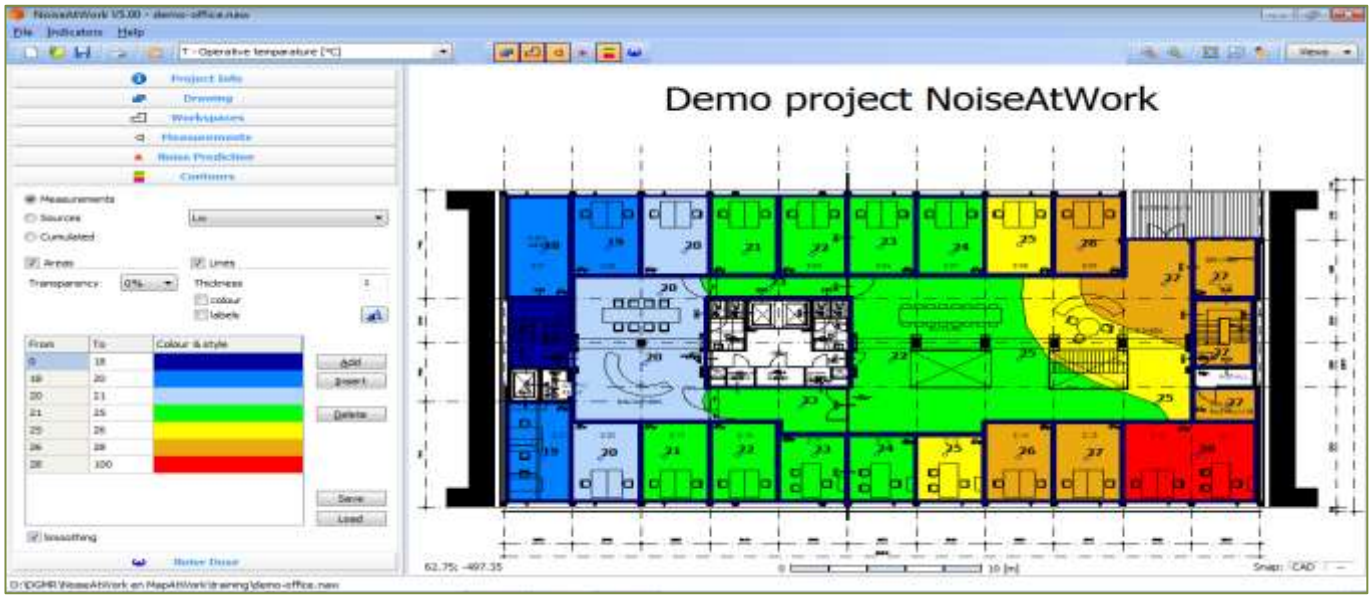

Figure 5.4: An example of a noise map[7]

Table 5.2 An example of a Matrix which indicates the Hygiene Noise measurements per Job Type

Risk Matrix								
Hazards	Hygiene Data	OEL	Consequence	Likelihood	Risk Rating	PPE Requirements	Comments
Physical							
Noise	Installing props – 93.1 dB(A) Hammering – 100.3 dB(A) Shutter installation while hammering – 93.2-97.5 dB(A) Skill saw operator – 107 dB(A) Hilti drill – 90 dB(A)	85dB(A)	3	C	H	Hearing protective devices – plugs, muffs, custom made devices. When selecting devices, consideration should be given to noise levels, type of work, practicality of wearing bulky devices e.g., muffs and the attenuation factor of the device.	Noise is ubiquitous on construction sites. Noise is generated by a variety of processes and / or equipment / tools: ✓ Generators, jack hammers ✓ Coring drilling / cutting ✓ Construction vehicles Employees are constantly moving around the site. Therefore, there is a high probability of all employees being exposed to high levels of noise. Records confirm that most employees work shifts in excess of 8hrs. This will increase exposures. The TWA 8-hour exposure levels would not be applicable in such cases.

The Hierarchy of Control

Upon the completion of a HIRA and Hygiene Survey, the employer gains insight into the location, nature, and personnel exposed to noise. In cases where noise exposure is assessed as high risk, it should be treated as a top priority. Subsequently, planning should be undertaken to prevent, control, and manage noise exposure, including educating employees about the associated risks and consequences of noise.

Where noise has an occupational exposure limit of equal to or greater than 85dB(A) employers have the added responsibility to reduce the risk of health effects due to exposure by implementing a hierarchy of controls[8]. The hierarchy of control are defined as a system for controlling risks in the workplace. It is a step-by-step approach to eliminating or reducing risks. The system ranks risk controls from the highest level of protection and reliability down to the lowest and least reliable protection method.

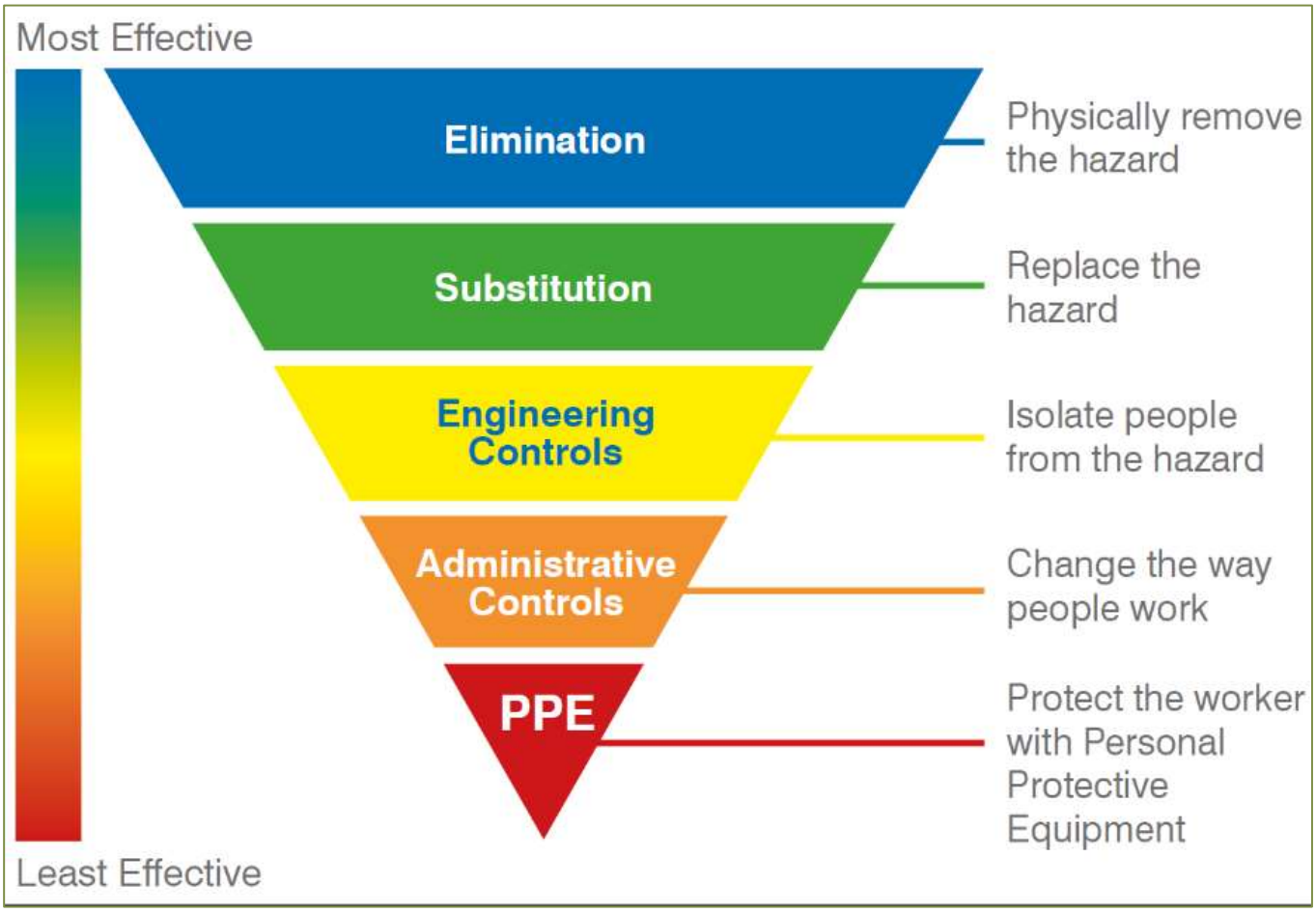

Figure 5.5 The Hierarchy of Control Measures[9]

The Hierarchy of Control includes elimination, substitution, engineering controls, administrative controls, and personal protective equipment[10].

- ✓ Elimination – Physically remove the hazard

  The elimination of a source of noise is the most effective way to prevent risks to employees and should always be considered when new work equipment or workplaces are planned. A 'no noise or low noise' procurement policy is usually the most cost-effective way to prevent or control noise.

- ✓ Substitution – Replace the hazard

  Replacement or alteration of hazards (machines) — including belt drives as opposed to noisier gears, or electrical rather than pneumatic tools. Decreasing alarm sounds to below the noise rating limit but still audible to the employee.

Figure 5.6 The above picture shows how a noisy machine has been encased to reduce the noise[11]

- ✓ Engineering controls – reduce / prevent hazards from coming into contact with employees. It includes modifying equipment, workspace, use of protective barriers, ventilation, etc. The most effective engineering controls are part of the original equipment design
- ✓ Administrative controls – Change the way people work

  Where noise cannot be adequately controlled at the source, further steps should be taken to reduce the exposure of employees to noise. Limiting the time of exposure, reducing shifts, signage, demarcating noise zones, ensuring adequate rest breaks, training, occupational health surveillance as well as task rotating for employees are all examples of administrative controls

- ✓ Personal protective equipment– Minimize exposure to hazards and protecting the PPE for hearing protection consists of earplugs and earmuffs. Employees who are regularly exposed to noise levels must be provided with hearing protection by their employers, free of charge[1].

Administrative controls and PPE are frequently used with existing processes where hazards are not particularly well controlled. Administrative controls and PPE programs may be relatively inexpensive to establish but, over the long term, can be very costly to sustain. These methods for protecting employees have also proven to be less effective than other measures, requiring significant effort by the affected employees.

Hearing Protective Devices (HPD)

A hearing protection device, also known as HPD, is an ear protection device worn in or over the ears by employees exposed to hazardous noise to help prevent noise-induced hearing loss. HPDs reduce (not eliminate) the level of the noise entering the ear. There are many different types of HPDs available for use, including earmuffs, earplugs, electronic hearing protection devices, and semi-insert devices. In terms of the SANS guideline 50458:2008[12] HPD:

- ✓ Must be supplied free of charge by the employer
- ✓ Must be able to attenuate the noise effectively
- ✓ Must be worn in all areas where the noise level is equal to or greater than 85dB(A)
- ✓ Training regarding the use of HPD should be given to all
- ✓ Wearing of HPD must be enforced by the employer

Add to the "To Do" list

Get examples of all the HPD's offered at the company you work for and have them available in the audiometry room to use when you do health education

Figure 5.7 Hearing protection examples[13]

Noise Attenuation of Hearing Protective Devices[14] [15]

There are 3 types of ratings used to determine the reduction rate of hearing protective devices.

- ✓ The single noise rating used in Europe
- ✓ The noise reduction rating used in the USA
- ✓ The octave band methods
  - OBM—octave-band method
  - OBsm—octave-band with a safety margin
  - HML—high, medium, low

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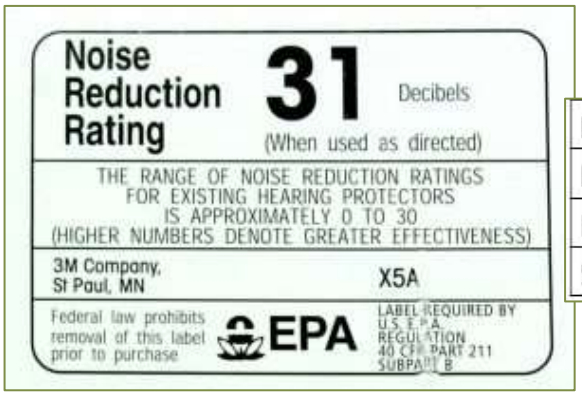
All earplugs, earmuffs, earbuds, and HPD's have a "Noise Reduction Rating" (NRR) or a "Single Number Rating" (SNR) on the label together with a number, depending on whether the HPD comes from Europe or America. In Figure 5.8 below, the F4 Series earplug with an NRR of 27 and Figure 5.9 indicates the 3M's Peltor X5A earmuffs which have an NRR of 31. Every hearing protector sold in the Republic of South Africa (RSA) must have an NRR / SNR on the label as per the SANS guidelines 1451 (3 parts)[16]. The label provides purchasers and users of hearing protection a guideline on the level of noise protection they can expect from their earplugs or earmuffs when properly fitted. In addition to the NRR, earplugs and earmuffs are accompanied by an attenuation table detailing how much they reduce noise at different frequencies. This table comprises actual test results and is the basis for the calculation of the NRR. And – it can give you a good picture of the strengths and weaknesses of the hearing protection you are considering.

F4 Series™

ATTENUATION CHART (ANSI S3.19-1974)

Frequency (Hz)	125	250	500	1000	2000	3150	4000	6300	8000	NRR
Mean Attenuation (dB)	39.4	35.4	38.4	39.3	37.4	40.6	37.7	40.7	42.9	27
Standard Deviation (dB)	4.5	5.2	5.1	4.3	4.6	4.6	4.6	4.5	5.3	

Figure 5.8: The picture below shows the attenuation chart and NRR for the F4 Series earplug[17]



Peltor X5A, NRR 31									
Frequency (Hz)	125	250	500	1000	2000	3150	4000	6300	8000
Mean attenuation (dB)	23.9	30.5	41.1	43	38	43.1	44	41.1	40.3
Standard deviation	4.1	2.2	2.8	2.9	2.7	2.9	2.4	2.6	2.2

Figure 5.9: The picture below shows the attenuation chart and NRR for the 3M Peltor Earmuff [18]

A few notes on HPD[19]

- ✓ There is no such thing as one size fits all when it comes to HPD's
- ✓ A variety of HPD's must be available to match size, comfort, and job requirements
- ✓ An ear plug that is not inserted properly can just as well not be used
- ✓ HPD's needs to be worn all the time. If it is taken out – even for 5 or 10 minutes – exposure to noise can cause damage

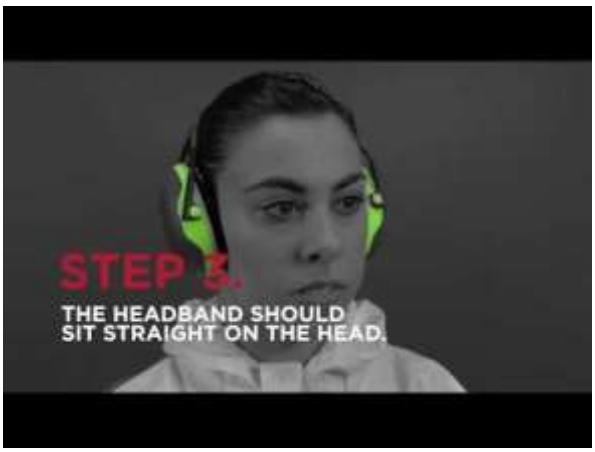
The correct use of HPD

Hearing protection devices (HPD) should be chosen based on the job requirements, the potential exposures, and individual employee needs. Employees should receive guidance on the proper insertion and maintenance of the specific HPD they will be using. This responsibility is an integral part of the duties of each audiometrist.

Figure 5.10 How to insert earplugs correctly[20]

Figure 5.11 How to use earmuffs correctly[21]

Video 5.1: How to insert ear plugs[22]
https://www.youtube.com/watch?v=xF1CjCugD_M



Video 5.2: How to use earmuffs correct[23]
https://www.youtube.com/embed/JimCQT5NzxY

The correct care for ear plugs[24]

Prior to fitting, inspect earplugs or ear tips for dirt, damage, or hardness. Discard and replace immediately if compromised. For proper hygiene discard disposable earplugs after use.

- ✓ With proper maintenance, reusable earplugs should be replaced every 2-4 weeks
- ✓ Push-in foam earplugs should be replaced every 5 days
- ✓ Wash with mild soap / water, pat dry or air dry, and store in a case when not in use
- ✓ Clean regularly and replace ear tip pods every 2-4 weeks on banded earplugs
- ✓ Do not store in temperatures above 55ºC (130ºF), e.g., behind a windshield

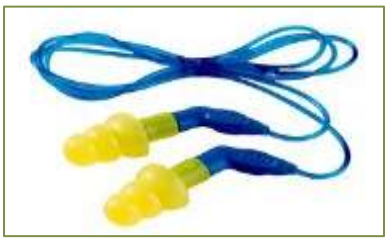
- ✓ Do not clean with solvents such as isopropyl alcohol (IPA), alcohol, acetone, or with waterless hand cleaners or products containing lanolin

Roll-down foam earplugs

After each use, it's essential to clean earplugs by gently wiping away any dirt and debris using a clean cloth. Additionally, make sure the earplugs remain fully intact. Regularly inspect them to see if they regain their original uncompressed shape and softness between uses. When earplugs no longer return to their original form or become excessively soiled or contaminated, they should be replaced as they are no longer hygienic.

Push-to-fit earplugs

Wipe dirt and debris from earplugs with a clean cloth between uses. Assess if the foam tip is damaged, detached from the stem, or is not soft and pliable. Replace if the earplug is damaged or is excessively soiled or contaminated (no longer hygienic).



Pre-moulded / reusable earplugs

As necessary, earplugs should be cleansed with gentle soap and warm water. During this process, carefully examine all three flanges for any signs of tears or cracks. If the flanges show damage, detachment from the stem, or a lack of softness and pliability, it's crucial to replace the earplugs.

Banded hearing protectors

Bands and reusable tips can be washed. However, foam tips should not be washed. If bands become damaged or lose their ability to securely hold tips in place, they should be replaced. Similarly, tips should be replaced when they exhibit damage or are no longer soft and pliable.

Electronic earplug

If the earplugs are composed of a reusable material, the earplug tip should be removed and washed according to the manufacturer's instructions. If the earplugs are composed of foam, wipe off any debris with a dry, clean cloth. Do not immerse the electronic earplug in water or any solution. Inspect as outlined in the manufacturer's instructions. For cleaning the earplug tip follow the instructions above depending on the style; foam, push-to-fit or reusable. Replace the tip when it is damaged, no longer hygienic or if a foam tip does not return to its original uncompressed state. Replace the entire unit if damaged.

Earmuffs

Cup shell and headband. Headband and outside of cups are washable. Foam inserts inside cups are not washable. Replace bands when damaged or they no longer have enough tension to hold cups tightly over ears. Do not immerse in water. Wipe the outside regularly with mild soap and lukewarm water. Check regularly for cracked or worn parts. Replace cushions at least twice a year from the hygiene kit or sooner if damaged. Cushion: Wipe with mild soap and water. Determine if the cushion is soiled or cracked. Replace if the cushion is soiled and replace with a new cushion from the hygiene kit. Foam inserts: Never wet or dampen foam inserts. Determine if the foam insert is soiled or damaged. Replace if the foam insert is soiled and replace it with a new foam insert from the hygiene kit.

Windsocks (For microphones on electronic HPDs)

Replace when they become dirty. Conduct regular inspections and replace as needed. When changing batteries, it's essential to manually turn off electronic earmuffs to safeguard them from potential damage.

Demarcating the noise zones

The noise regulations provide precise guidelines for marking noise zones, which are designated areas where the noise level equals or surpasses 85dB(A).

Noise zone[1]

An employer or self-employed person shall ensure that—

(a) In any workplace or part of such workplace under his or her control, where the noise exposure is at or above the noise-rating limit, that workplace or part thereof is zoned as a noise zone

(b) A noise zone is clearly demarcated and identified by a notice indicating that the relevant area is a noise zone and that hearing protective equipment as contemplated in regulation 12 must be worn

(c) No person enters or remains in a noise zone unless he or she wears the required hearing protective equipment

(d) The reason why noise exposure is at or above the noise-rating limit is identified and that action is taken, as soon as is reasonably practicable, by means other than the use of hearing protective equipment, to lower the noise level so that it is not at or above the noise-rating limit

Figure 5.12 Mandatory hearing protection signage[25]