NYCOSH Factsheet

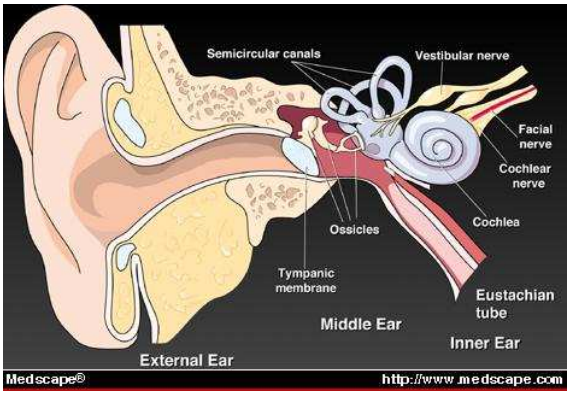
Noise – An Overview

What is sound? What is Noise?

Sound is a form of physical energy, perceived by the ear and resulting from fluctuations in the pressure of the air. These air pressure fluctuations are usually initiated by a vibrating surface or object, or by air flow.

Noise can be defined as excessive levels of sound. The effects of noise exposure can be annoying or stressful, can damage our hearing and may also affect other bodily functions.

How do we hear?



The ear has three main parts: outer, middle and inner ear.

- The outer ear collects sound waves and directs them into the external auditory canal.
- Sound waves strike the eardrum, causing it to vibrate.
- Vibrations pass into small bones of the middle ear, which transmit them to sensory cells (hair cells) in the cochlea, the main sensory organ for hearing.
- The vibrations become nerve impulses and go directly to brain, which interprets the impulses as sound.
- When noise is too loud, it begins to kill nerve endings in the inner ear. With greater exposure to loud noise, more nerve endings are destroyed. As the number of nerve endings decreases, so does hearing. The damage is permanent – there is no way to restore life to dead nerve endings.

Factors affecting sound

Three factors affect our perception of sound:

- *Amplitude* of the sound wave, which corresponds to its sound pressure level, which we perceive as loudness.
- *Frequency* of a sound refers to its number of cycles per second and is measured in *Hertz (Hz).* We perceive the frequency of a sound as its pitch.

  Humans with normal hearing can hear frequencies in the range of about 20 Hz. to 20,000 Hz. (20 Kilohertz).

  Typical human speech ranges from 300 Hz. to 4,000 Hz. (4 Kilohertz).
- *Duration* of a sound is broadly classified as ***continuous type*** or ***impulsive.***
  - All *non-impulsive noise* (i.e. continuous, varying or intermittent) is referred to as ***continuous type noise.***
  - *Impact and impulse* noises are referred to as ***impulsive noise.***
  - *Impulsive noise* is distinguished from continuous type noise by a steep rise in the sound level to a high peak followed by a rapid decay.
  - *Workplace exposures* are often a mixture of continuous type and impulsive sounds.

Measuring sound levels

Sound levels are measured in a unit called the *decibel (dB).*

It is important to know that the dB scale is **not linear.** Rather, it is a *logarithmic scale,* where:

- An increase of 3 dB means that the sound pressure level is doubled. Likewise:
- A 10 dB increase = 10 times increase.
- A 20 dB increase = 100 times increase.
- A 30 dB increase = 1,000 times increase.

Sound Intensity (Pressure)	Sound Level in dB
100, 000, 000, 000, 000	140
10, 000, 000, 000, 000	130
1, 000, 000, 000, 000	120
100, 000, 000, 000	110
10, 000, 000, 000	100
1, 000, 000, 000	90
100, 000, 000	80
10, 000, 000	70
1, 000, 000	60
100, 000	50
10, 000	40
1, 000	30
100	20
10	10
1	0

Hearing loss

Conductive hearing loss

- Occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and the tiny bones, or ossicles, of the middle ear.
- Usually involves a reduction in sound level, or the ability to hear faint sounds.
- Often can be medically or surgically corrected.
- Conditions that may cause conductive hearing loss include:
  - fluid in middle ear from colds, allergies (serous otitis media), poor eustachian tube function, ear infection (otitis media), perforated eardrum, benign tumors
  - impacted earwax (cerumen)
  - infection in ear canal (external otitis)
  - presence of a foreign body
  - absence or malformation of outer ear, ear canal, or middle ear
- *Work-related conductive hearing loss* is not common, but may occur as a result of accidents involving:
  - An eardrum rupture or a break in the ossicular chain by a head blow
  - Explosions
  - A rapid pressure change in a decompression chamber
  - Penetration of the eardrum by a sharp object or fragment

Sensorineural hearing loss

- Occurs when there is damage to inner ear or to nerve pathways from the inner ear to the brain.
- Cannot be medically or surgically corrected. It is a permanent loss.
- Involves not only a reduction in sound level and ability to hear faint sounds, but also affects speech understanding and ability to hear clearly.

- Can be caused by diseases, birth injury, drugs that are toxic to the auditory system and genetic syndromes.
- May also occur as a result of **noise exposure**, viruses, head trauma, aging (presbycusis) and tumors.

Noise-induced hearing loss

- Begins to occur at 75 – 80 dB.
- OSHA / PESH noise *Permissible Exposure Limit (PEL)* = 90 dB for 8-hour time weighted average (TWA).
- OSHA / PESH *hearing conservation requirements* are triggered at 85 dB.

Other effects of noise

- Noise levels in the range of 55-116 dB can also contribute to *hypertension* (high blood pressure).

	DECIBEL - dB(A)	EQUIPMENT
Double protection recommended above 105 dB(A)	112	Pile driver
	110	Air arcing gouging
	108	Impact wrench
	107	Bulldozer - no muffle
	102-104	Air grinder
	102	Crane - uninsulated cab
	101-103	Bulldozer - no cab
	97	Chipping concrete
	96	Circular saw and hammering
	96	Jack hammer
	96	Quick-cut saw
	95	Masonry saw
	94	Compactor - no cab
Hearing protection recommended above 85 dB(A)	90	Crane - insulated cab
	87	Loader/backhoe - insulated cab
	86	Grinder
	85-90	Welding machine
	85	Bulldozer - insulated cab
	60-70	Speaking voice

Table 1: Some typical noise levels found on construction sites

Audiometric testing

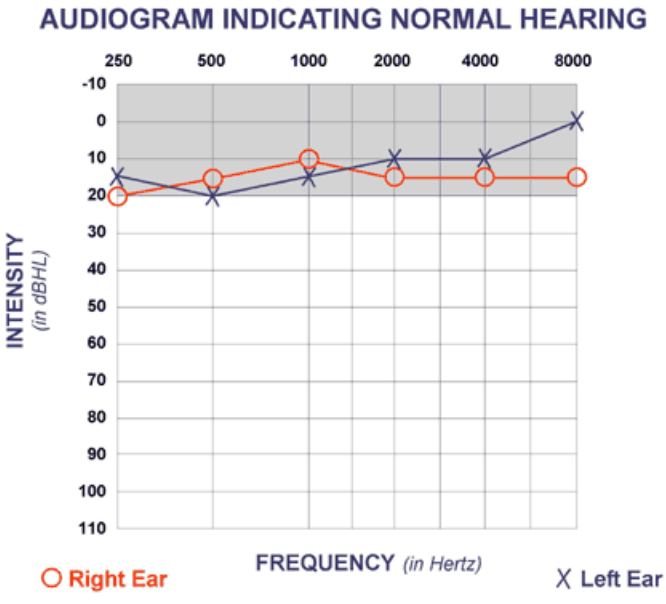
Hearing tests are the only way to tell for sure whether a hearing conservation program is working. Consider the following:

- Occupational hearing loss occurs gradually, so we often do not notice a change in hearing ability until a relatively large loss has occurred.
- By comparing annual hearing tests, we can tell early on if workers are developing mild hearing losses. We can then do something to prevent further losses.
- For example, we can evaluate and improve engineering controls, refit hearing protective devices, or retrain workers, so that no one suffers additional hearing loss.

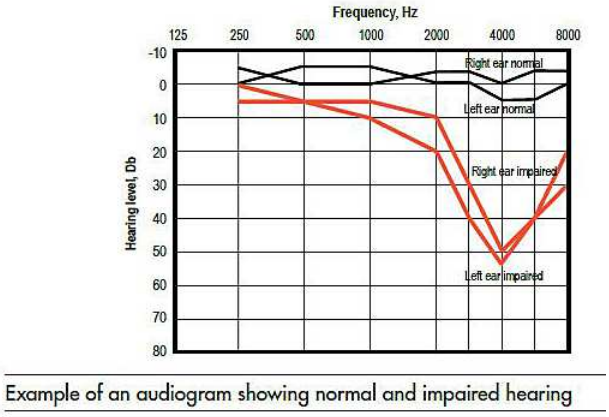
Audiograms are used to detect hearing loss. The initial audiogram provides a "baseline" look at your hearing. Later, subsequent audiograms are compared against your baseline results.

A change in your ability to hear at a specific frequency is known as a *threshold shift.* An audiometric technician will look for a *Standard Threshold Shift* (10 dB or greater change at 2000, 3000 or 4000 Hz in either ear) when compared to your baseline audiogram.

Here is a normal audiogram:



This audiogram shows age-related hearing loss or noise-induced hearing loss:



Example of an audiogram showing normal and impaired hearing

Frequently shows a notch at 4000 Hz with better hearing at 8000 Hz.

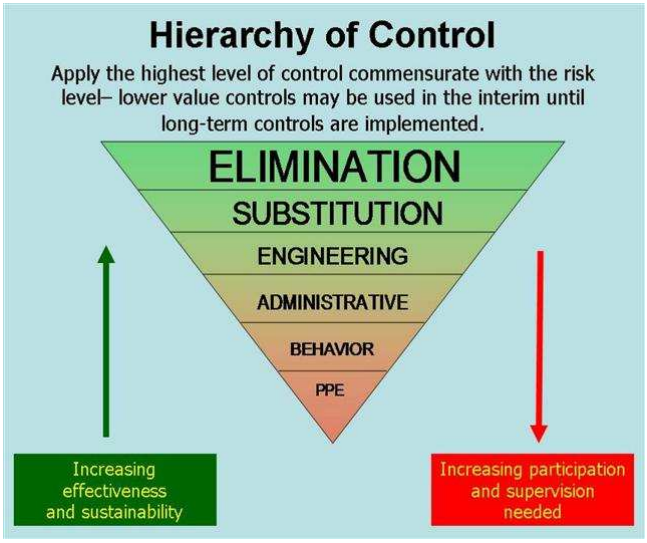
A change in your ability to hear at a specific frequency is known as a *threshold shift.* An audiometric technician will look for a *Standard Threshold Shift* (10 dB or greater change at 2000, 3000 or 4000 Hz in either ear) when compared to your baseline audiogram.

Some noise exposures will initially produce a *Temporary Threshold Shift (TTS).* After a period of "recovery" away from noise exposure, a follow-up audiogram will show that your hearing has returned to its normal level.

However, failure to take steps to prevent future hearing loss can ultimately produce a *Permanent Threshold Shift (PTS).* At this point your hearing cannot recover to its undamaged state.

Controlling noise exposures

There is a *hierarchy of controls* for controlling exposures to occupational hazards. This is as true for controlling noise exposures as it is for any other work-related hazard.



Credit: Innovative Occupational Hygiene Solutions

Applying the hierarchy of controls

A solution is likely to be safer & more effective when you:

- understand what is causing the noise
- determine how the noise is reaching the worker
- identify where to control the noise:
  - at the source
  - along the sound path
  - at the worker.

Examples of the hierarchy at work:

Substitution: Design and manufacture of equipment to produce lower noise output.

Engineering controls:

- Acoustical enclosures and barriers
- Sound-absorbing material
- Vibration mounts for equipment
- Proper lubrication
- Increase distance: doubling the distance from the source reduces the noise level four times (inverse square principle).

Administrative controls:

- Reduce time in noisy environments, rotate workers.
- Shut down noisy equipment when not needed.
- Implement work practice controls.
- Properly maintain equipment.

Personal Protective Equipment (PPE): Hearing Protective Devices

All HPDs are designed to reduce the intensity of noise that reaches the sensitive nerves in the inner ear.

There are three types of hearing protectors:

- Ear muffs
- Ear plugs
- Ear caps

Ear muffs and ear plugs offer about equal protection, ear caps are less protective.

HPD noise reduction ratings (NRR)

Every HPD is assigned a NRR in dB, but...

- The NRR reflects testing done under ideal laboratory conditions.
- The NRR does not reflect real world performance & over-rates the amount of protection that an HPD can provide.
- There are a variety of methods for "de-rating" an assigned NRR in order to better reflect real world performance of an HPD.

One method for de-rating the NRR

NIOSH recommends de-rating the NRR by a multiplicative factor of:

- 75% for earmuffs
- 50% for slow-recovery foam earplugs & custom earplugs, and
- 30% for all other earplugs

OSHA/PESH Hearing Conservation Program 29 CFR 1910.95 (c) – (o)

Major elements of the OSHA/PESH standard are:

- Written program
- Noise monitoring, with employee observation
- Employee notification
- Audiometric testing
- Hearing protectors
- Training
- Access to information
- Recordkeeping

Review of OSHA/PESH triggers under the standard:

- OSHA/PESH noise *Permissible Exposure Limit (PEL)* = 90 db for 8-hour time weighted average (TWA).
- OSHA / PESH *hearing conservation requirements* are triggered at 85 dB.
- OSHA also has limits on *Permissible Noise Levels*, shown in the following chart:

Duration per day, hours	Sound Levels in dB
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
½	110
¼ or less	115