Hearing Protection

Training Guide

Kinds of Noise

Wide Band Noise: Noise that covers a wide range of frequencies. If you are employed in a manufacturing workplace or if you drive a truck as part of your work, you are exposed to this kind of noise.

Narrow Band Noise: Noise limited to a narrow range of frequencies. Power tools, fans, and some saws make noise in this range.

Impulse Noise: Noise that pulsates in on-and-off patterns. A jackhammer creates impulse noise.

Effects of Noise

Physical Effects: Higher blood pressure – Headaches – Sleeping problems

Mental Effects: Nervousness – Lack of concentration – Anger

Permissible Noise Exposures

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

What are the warning signs that your workplace may be too noisy?

Noise may be a problem in your workplace if:

- You hear ringing or humming in your ears when you leave work
- You have to shout to be heard by a coworker an arm's length away
- You experience temporary hearing loss when leaving work

What can be done to reduce the hazard from noise?

Engineering controls that reduce sound exposure levels are available and technologically feasible for most noise sources.

- Choose low-noise tools and machinery
- Maintain and lubricate machinery and equipment
- Place a barrier between the noise source and employee
- Enclose or isolate the noise source

Administrative controls are changes in the workplace that reduce or eliminate the worker exposure to noise.

- Operating noisy machines during shifts when fewer people are exposed
- Limiting the amount of time a person spends at a noise source
- Providing quiet areas where workers can gain relief from hazardous noise sources
- Restricting worker presence to a suitable distance away from noisy equipment

Hearing Protection is for everyone!

Everyone is exposed to loud noise at some time in their lives. The decibel is a unit used to express sound level, and "loud noise" means sounds that are more than 85 decibels. Loud noise can be very hazardous to your health and particularly to your hearing. Over time, exposure to loud sounds on a regular basic can result in permanent hearing loss. You often don't know you have the hearing problem until it is too late to do anything about it. Sudden, very loud noises, like explosions, can cause instant hearing loss.

Hearing Protection Devices

The OSHA Hearing Protection Program states that hearing protection devices must be made available if 8-hour noise exposure can't be reduced below 85 dB. There are three basic kinds of hearing protection.

Earplugs: (inserts) are inserted into the ear canal. Some kinds of earplugs are disposable while others are reusable.
Disposable earplugs are usually made of waxed cotton or acoustical fibers. They are used once then thrown away.
Semi-disposable plugs are made of foam material. They can be used for about a week.
Reusable plugs may be two kinds;
Premolded plugs are usually made of silicone, rubber, or plastic.
Custom-molded plugs are usually made of silicone rubber or plastic compound. They are made to the exact fit of the ear.

Canal Caps: (semi-inserts) Earplugs on a band, worn under your chin. Canal caps are soft, flexible pads on the ends of a lightweight headband. Canal caps must fit snugly so they seal the entrance to the ear canal instead of going into it like earplugs do.

Earmuffs: (circumaural) Earmuffs help protect you against moderate to high level noise. In some high noise area, you may have to wear earmuffs and earplugs together.
There are special earmuffs;
Dielectric earmuffs have no metal parts. These are used by employees who work with electricity, such as live electrical lines.
Electronic earmuffs reduce dangerous noise, but they magnify other needed sounds, such as voices.
Folding earmuffs can used by workers who need quick, but not full time protection.

Hearing Protection Devices Selection

Attenuation – The amount of noise that is absorbed or repelled by a hearing protector.
Decibel (dB) – A unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale.
Frequency – Represents the number of cycles of vibration that occur in one second. The number of cycles is designated in Hertz (Hz).
A-weighting – This scale corresponds to the way the human ear hears across the common frequencies (reported in dBA). The emphasis is on the human ear (real ear).
C-weighting – Provides a flat frequency response with slight attenuation of the very high and very low frequencies (reported in dBC), also called an octave band analysis. The emphasis is on machinery frequency analysis.

All Hearing Protection Devices are rated in the A-weighting scale i.e. dBA

Methods of selecting HPDs are based on the measurement and statistical treatment of octave band sound attenuation data for test subjects. Until 1997, the standard for testing was ANSI standard S3.19-1974 which tested subjects under "Laboratory conditions." ANSI standard S12.6-1997, Method B, test sound attenuation under "real world" conditions, where the protection provided is much less than under the laboratory conditions previously used. However much of the sound attenuation data in use today is still ANSI standard S3.19-1974 data, including the NRRs that manufacturers print on their packages of HPDs. Consequently, NIOSH recommends derating NRRs by a multiplicative factor of 75% for earmuffs, 50% for foam earplugs and custom plugs, and 30% for all other ear plugs.
i.e. NRR subtract 25% for earmuffs
NRR subtract 50% for foam plugs and custom plugs
NRR subtract 70% for other earplugs

When selecting Hearing Protection Devices, it is often incorrectly assumed that the NRR on the package accurately predicts the dBA reduction that the device will provide. This is untrue for two reasons.
First, the NRR is designed for use with C-weighted sound measurements. So if only A-weighted data are available there must be an adjustment to account for the difference between A-weighting and C-weighting.
Second, the data used to determine the NRR for a device are normally obtained under laboratory conditions, so devices must be "derated" to account for the significantly reduced protection provided under "real world" conditions.

Earplugs worn underneath earmuffs

The NRR will be calculated by adding 5dB of whichever protector has the higher NRR.
Keep in mind that this is after the necessary reduction factor of 7dB (if using the A - weighted scale) has been calculated. For example, if you were using an earplug with an NRR of 32dB with an earmuff with 27dB NRR, your noise reduction calculations would be:

32dB[A] (earplug) - 7db (OSHA Safety Factor) = 25dB
25dB + 5dB (for using earmuff and earplug together) = 30dB
Total corrected NRR = 30dB

NRRs may be revised

The same hearing protection standards have been in place since 1974, but now the Environmental Protection Agency (EPA) has proposed new regulations that could shed new light on noise reduction ratings (NRR). Two new or pending standards are behind the changes in the NRR:

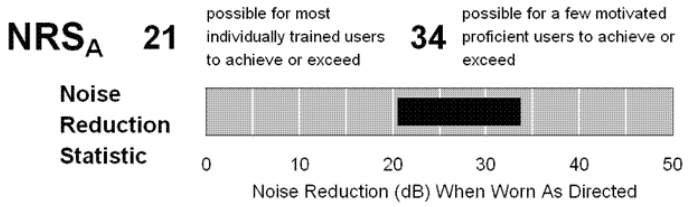
- ANSI S12.6-2008: Methods for measuring the real-ear attenuation of hearing protectors (would replace ANSI S3.19-1997)
- ANSI S12.68-2007: Methods of estimating effective A-weighted sound pressure levels when hearing protectors are worn

Since the existing protocol (S3.19-1997) is a single-number NRR rating calculated by the hearing protection device (HPD) manufacturer, it is not representative of real-world applications. ANSI S12.6-2008 highlights two new test protocols for determining NRR in laboratory analysis: Method A and Method B. The new protocols will incorporate more real-world testing and ratings will be presented as a two-number range, which allows users to see the full range of performance and not focus on a single number; this range is more representative of the group of people being tested (20th-80th percentile or a normal curve).

More key features of the new NRR include:

- It can be applied directly to dBA noise measurements without having to use the 7dB correction factor.
- No de-rating is required.
- Requires periodic retesting of HPDs.

The new proposed regulation (S12.6-2008) will address for the first time the ratings of nonstandard hearing devices, such as electronic earmuffs, impact muffs and any active noise-reducing devices. Under the old method, these devices were rated with very low NRR because there was no testing done at higher noise levels where these types of devices are most effective. A typical label may look like this:



Why is it changing?

Many different studies over the last 25 years have shown that the NRR overestimates the amount of protection that most wearers obtain under normal wearing conditions. In response to these studies, OSHA, NIOSH, and even the hearing protector manufacturers themselves have recommended that the NRR be routinely reduced by a factor of 50% or more in order to better predict the effective protection provided by the device. This process, known as "de-rating," has caused confusion along with an OSHA requirement that employers subtract 7 dB from the NRR when it is used with noise exposure readings measured on the A-weighting scale. Finally, experts have expressed concern that a single number rating such as the NRR does a poor job of informing users that the actual performance of hearing protectors varies widely from one person to the next due to differences in the training, fitting ability, and motivation of the wearer. As a result, the Environmental Protection Agency (EPA) has undertaken a process to revise hearing protector testing and NRR labeling.

How will the new numbers compare to the existing NRR?

Early indications are that the current NRR will likely fall below the new upper value, closer to the new lower value, but it will vary by product. Until data are reported from hearing protector performance tests done using the most up-to-date test methods specified by the EPA

Quick reference guide to the proposed changes

ISSUE	OLD RULE	PROPOSED RULE
Testing protocols	ANSI S3.19-1974	ANSI/ASA S12.6-2008
		ANSI S12.42-1995(R2002)
		ANSI/ASA S12.68-2007
		IEC 60711
Fit testing	Subjects fit with product by lab personnel	Subjects self-fit product without assistance
Number of test subjects	10, regardless of product type	10 for earmuffs
		20 for earplugs and ear bands
Retesting requirement	Once in product life cycle	All devices to be retested every five years
NRR	Single number	High/low numberic range
Attenuation	Passive only	Passive, active and impulse attenuation testing
Device position testing	No reference	Testing results for each wearing position
Description of rating	Estimates 98th percentile of protection obtained by users when properly fitted	Estimates 80th and 20th percentile of protection obtained by users

NOTE: *children less than 12 years of age should not wear earplugs, except where prescribed by a doctor or certified audiologist. Earmuffs or banded plugs that do not go into the canal are ok.*

European Standardisation

In Europe, CEN/TC 159 (European Committee for Standardization, Technical Committee 159, Hearing Protectors) is responsible for the standardization but the acoustical test methods are set out by ISO/TC 43/SC1 (International Organization for Standardization, Technical Committee 43, Acoustics, Sub-Committee 1, Noise).

- EN 352-1:2002, Hearing protectors - General requirements - Part 1: Ear-muffs
- EN 352-2:2002, Hearing protectors - General requirements - Part 2: Ear-plugs
- EN 352-3:2002, Hearing protectors - General requirements - Part 3: Ear-muffs attached to an industrial safety helmet
- EN 352-4:2001, Hearing protectors - Safety requirements and testing - Part 4: Leveldependent ear-muffs
- EN 352-5:2002, Hearing protectors - Safety requirements and testing - Part 5: Active noise reduction ear-muffs
- EN 352-6:2002, Hearing protectors - Safety requirements and testing - Part 6: Ear-muffs with electrical audio input
- EN 352-7:2002, Hearing protectors - Safety requirements and testing - Part 7: Leveldependent ear-plugs

The following new work items are still under development:

- prEN 352-8, Hearing protectors - Safety requirements and testing - Part 8: Ear-muffs with entertainment audio input
- prEN 352-9, Hearing protectors - Safety requirements and testing - Part 9: Ear-plugs with electrical audio input
- prEN 352-10, Hearing protectors - Safety requirements and testing - Part 10: Ear-plugs with entertainment audio input

NRR – Noise Reduction Rating

A rating system set up by the Environmental Protection Agency (EPA) as a guideline that indicates the amount of potential protection a hearing protection device will give in a noisy environment. All testing is performed in a controlled environment.
Consequently, posted NRR ratings are a qualified example of how the individual products compare with other similar hearing protection products in an uncontrolled noise environment. Test results do not evaluate the product reusability, comfort, adaptability or quality.

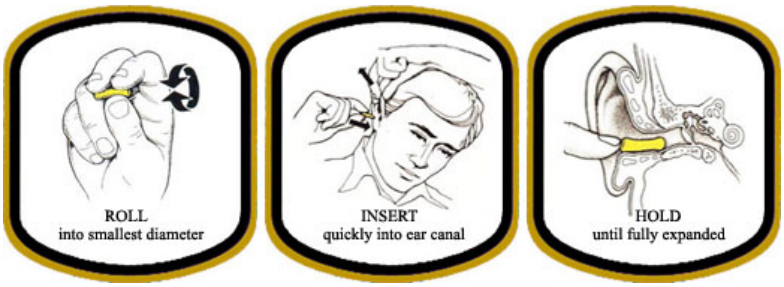
SNR – Single Number Rating

A rating system set up by the European Union (EU). Tests are conducted by independent testing laboratories with no direct participation by manufacturers. The independent testing laboratories meet all of the regulatory requirements as set out by the EU. The test results serve as a guideline to indicate the amount of potential protection a hearing protection device will give in a noisy environment.

NRR vs SNR Definitions

There is no direct conversion but a reasonably accurate guide is ***NRR + 2 or 3 = SNR*** *Example NRR 22 = ±SNR 25*

How to use earplugs



Formable Plugs:

- ROLL into smallest diameter
- INSERT quickly into ear canal
- HOLD until fully expanded

Premolded Plugs:
While pulling the ear outward and upward, insert the plug until the ear feels sealed. Adjust for greatest noise reduction.

How to use canal caps

- Hold large ends of pads
- Swivel them to place tips into ear canal openings
- Push and wiggle pads into canals until they seal snugly

How to use earmuffs

- Adjust headband so cushions press equally against both ears
- Pull hair back and away from beneath cushions
- Don't place any thing under the cushions

For proper fit, earmuffs must

- have a headband that's neither too tight nor too loose
- have cups that fit comfortably
- be lightweight so you can wear them many hours

How to care for Hearing Protection

Earplugs: Formable Plugs; Wash in mild detergent and warm water - Squeeze out excess water - Let dry in air
Premolded Plugs; Wash in warm, soapy water - Rinse well – Dry well with cloth and store in carrying case

Canal Caps: Clean them the same way as premolded earplugs - Don't bend or try to change headband

Earmuffs: Clean cushions with warm, soapy water - Rinse - Replace cushions about twice a year-sooner if they become stiff, cracked or don't seal - Don't stretch headband

How long do they last

Foam earplugs will last for about 10 wearings, other earplugs will last about 1 year. Earmuffs will last about 4-5 years, but you must replace the cuff (the part that sits right on your skin) every year. The oils and sweat from your skin will make the plastic of the cuff deteriorate.

Protection from water

Some earplugs are primarily designed to keep water out of the ear canal, especially during swimming and water sports. This type of earplug may be made of wax or moldable silicone which is custom-fitted to the ear canal by the wearer.

Musicians' or 'Hi-Fi' earplugs

Musicians who perform music styles noted for their loud nature, especially rock music, often wear earplugs to prevent their own performances from damaging their hearing. Musicians' earplugs are designed to attenuate sounds evenly across the audio band and thus minimise their effect on the user's perception of bass and treble levels. These are commonly used by musicians and technicians, both in the studio and in concert, to avoid overexposure to high volume levels. Alternately, musicians may use in-ear monitors, which are essentially headphones that also serve as earplugs.

Electronic earplugs

The noise reduction of passive earplugs varies with frequency but is independent of value (soft noises are reduced as much as loud noises). As a result, while loud noises are softened, protecting hearing, it is difficult to hear soft noises. Active electronic earplugs exist, where loud noises are reduced more than soft noises, and soft sounds may even be amplified, providing dynamic range compression. This is done by having a standard passive earplug, together with a microphone/speaker pair (microphone on outside, speaker on inside; formally a pair of transducers), so sound can be transmitted without being attenuated by the earplug. This protects hearing, but allows one to hear normally when sounds are in safe ranges – for example, have a normal conversation when there are no noises, but be protected from sudden loud noises, or hear soft passages in music but be protected from sudden sounds like cymbal crashes.

Flight ear protection

Earplugs are available which help to protect ears from the pain caused by airplane cabin pressure changes. Some products contain a porous ceramic insert which reportedly aids equalization of air pressure between the middle and outer ear thereby preventing pain during landings and take-offs. Some airlines distribute regular foam earplugs as part of their amenity kits for passengers to aid their comfort during landings and takeoffs as well as to reduce exposure to the aircraft's noise during the flight. These can help passengers get to sleep during the flight if desired.

Sleep

Earplugs for sleeping are made to be as comfortable as possible while blocking external sounds that may prevent or disrupt sleep. Specialized earplugs for such noises as a partner's snoring may have sound-dampening enhancements that enable the user to still hear other noises, such as an alarm clock.

To determine the comfort of earplugs used for sleeping, it is important to try them on while actually lying down. The pressure on the ear between the head and pillow may cause significant discomfort. Furthermore, just tilting the head back or to the side causes significant anatomical changes in the ear canal, mostly a reduction of the ear canal diameter, which may reduce comfort if the earplug is too large.

References:

Occupational Safety and Health Administration https://www.osha.gov

The National Institute for Occupational Safety and Health https://www.cdc.gov/niosh

American National Standards Institute https://www.ansi.org

International Safety Equipment Association https://safetyequipment.org

European Committee for Standardization https://www.cen.eu

The European Union https://europa.eu

The British Standards Institution https://www.bsigroup.com