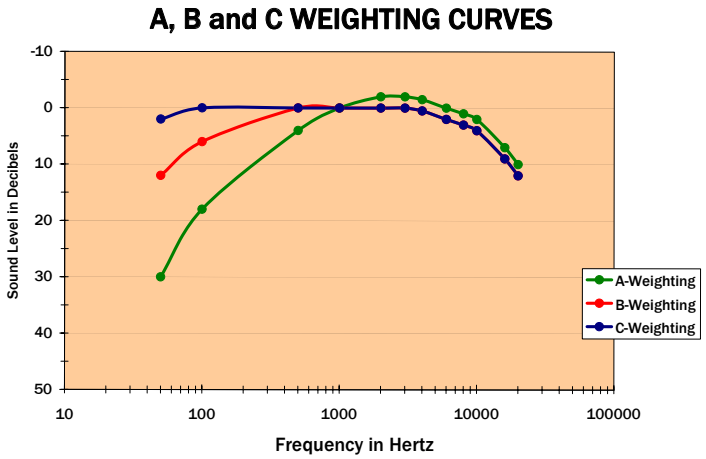
Hearing Safety Glossary

A-Weighting

A filter applied to noise measurements, intended to replicate the frequency sensitivity of the human ear. The A-weighting is the most commonly-used weighting scale in hearing conservation programs, as it predicts quite well the damage risk of the ear. Sound level meters set to the A-weighting scale will filter out much of the low-frequency noise they measure, similar to the response of the human ear. Noise measurements made with the A-weighting scale are designated dBA. If A-weighted measurements are used to determine adequacy of hearing protection, OSHA instructions stipulate that a correction factor of 7 dB should be subtracted from the NRR of the hearing protector [as an error cushion for C-minus-A differences], then subtract the resulting lower NRR from the dBA noise measure to determine the protected noise level for the worker. [see also C-Weighting]



Action Level

The noise exposure level at which precautionary actions are required to prevent hearing loss. OSHA defines the Action Level as an 8-hour time-weighted average noise exposure of 85 dBA [or equivalently, a dose of 50%]. According to OSHA regulations, noise exposures at or above this Action Level require follow-up measures that include noise monitoring, annual audiometric testing for exposed employees, hearing protection, training and recordkeeping. While OSHA's *Action Level* is at 85 dBA TWA, the *Permissible Exposure Limit* is at 90 dBA TWA. Another way to describe these is to consider 85 dBA the required *prevention* level, and 90 dBA the required *protection* level. [see also Permissible Exposure Limit]

Administrative Controls

OSHA regulations state that when noise exposures exceed mandated levels, engineering and administrative controls are to be the first line of defense in reducing exposures to acceptable levels. Administrative controls include such actions as giving noise-exposed workers breaks in quiet areas, or rotating employees into noisy jobs for short durations so that no single employee is overexposed. If such controls are not feasible or practical, personal protective equipment [earplugs and earmuffs] should be implemented. [see also Engineering Controls]

Bacou-Dalloz Hearing Safety Group
7828 Waterville Road, San Diego, CA 92154
Tech Support ph. 800/977-9177 • fax 619/661-8131
Cust Service ph. 800/430-5490 • fax 401/232-3110
www.hearingportal.com

HOWARD LEIGHT®

Bilsom®

Hearing Safety Glossary

Age Corrections

When a shift in hearing occurs, it is not immediately known whether that shift is due to noise exposure, normal age-related hearing loss, disease or even wax blockage. In many ways, age-related hearing loss mimics noise-induced hearing loss: it is painless, gradual in progression and affects high frequencies. To help differentiate the effects of aging from noise, OSHA published age correction tables within its Hearing Conservation Amendment. These age correction tables [one for males, one for females] show relative age correction values between two ages. Use of age corrections is optional for Hearing Conservation Program managers, but their use definitely helps differentiate the contributions of aging from noise in a hearing loss.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9741

American National Standards Institute [ANSI]

The agency that promulgates consensus standards used in regulations. In the OSHA Hearing Conservation Amendment, ANSI standards are cited for calibrating audiometers used in annual testing, and for sound level meters used in noise monitoring. www.ansi.org

Area Monitoring

One of the two methods recommended by OSHA to measure noise exposures [compare with *Personal Monitoring*]. In area monitoring, a sound level meter is used to measure instantaneous noise levels in a given area. This method of noise monitoring is only valid when noise levels are fairly constant in a given area, and where workers remain fairly stationary throughout their work shift; in areas of high worker mobility, or where noise levels fluctuate, personal monitoring is the preferred method.

Attenuation

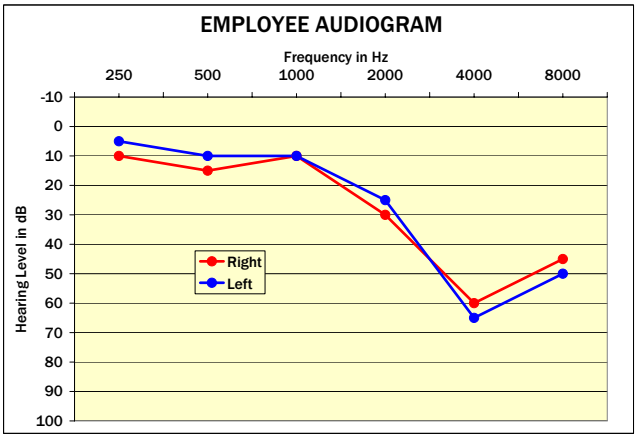
A reduction in noise level. Hearing protectors are rated for their attenuation; protectors with higher attenuation reduce more noise. A chart showing the attenuation levels [obtained at each frequency band during laboratory testing] is printed on every bulk package of hearing protectors sold in the U.S., Europe and Australia.

Audiogram / Audiometric Test

A standardized hearing test. According to OSHA regulations, workers who are routinely exposed to 85 dBA average noise exposure must take an audiometric test at least annually. This annual hearing test is compared to the worker's baseline audiogram to determine if a significant decline in hearing [a Standard Threshold Shift] has occurred.

Baseline Audiogram

The hearing test to which all successive hearing tests are compared. A worker's first hearing test is usually his baseline audiogram. But in some cases, the audiologist or physician reviewing the audiograms may revise the baseline, by designating a later hearing test to be more indicative of stable hearing levels. A baseline audiogram might be revised due to improved thresholds [if the employee undergoes corrective surgery, for example, for a physical disorder in the ear] or due to worse thresholds. OSHA regulations specify a process for revising baselines for workers who demonstrate a persistent shift in hearing, thus avoiding informing a worker repeatedly year after year of the same shift in his hearing.



Hearing Safety Glossary

C-Weighting

A filter applied to noise measurements. In contrast to the A-weighting, the C-weighting is a "flatter" filter, and allows more low frequencies to be measured. The C-weighting was originally conceived to be the best predictor of the ear's sensitivity to tones at high noise levels. But the ear's risk to damage from noise has since been found to be predicted much better by the A-weighting scale. Noise measurements made with the C-weighting scale are designated dBC. If C-weighted measurements are used to determine adequacy of hearing protection, OSHA instructions state that the NRR of the hearing protector should be subtracted directly from the dBC noise measure to determine the protected noise level for the worker. [see also A-Weighting]

Criterion Level

The noise level that defines a 100% dose if workers are exposed to it continuously for 8-hours [or equivalent]. Also called the *Permissible Exposure Limit*. In current OSHA regulations, the *Criterion Level* is 90 dBA of noise exposure over an 8-hour time-weighted average. Exposures over the *Criterion Level* warrant protective actions. [see also Permissible Exposure Limit]

Decibel [dB]

Unit of measurement used for sound levels. The decibel scale is a logarithmic, not a linear scale. Since the physical measurement of acoustic energy typically spans an enormous range [from zero into the trillions], a logarithmic scale based on exponents is handier for day-to-day measurement of noise. This means that small changes in decibel levels represent enormous changes in sound level. It also means that decibels cannot simply be added mathematically: 80 dB plus 80 dB equals 83 dB [not 160 dB].

De-Rating

When hearing protectors are not properly fitted or inserted, the attenuation obtained in the workplace can be significantly lower than the laboratory ratings on the required labeling. Studies show that in a typical workplace, there is wide variation in the amount of attenuation obtained in the field – many workers will achieve the labeled NRR, while others fall far short. In an attempt to bridge this wide variation, OSHA instructed its inspectors through an enforcement guideline to de-rate the labeled NRR of hearing protectors by 50%. This means that a 26 NRR hearing protector would only get credit for 13 dB of attenuation when applied to dBC noise levels. This 50% de-rating is not a regulation, but has become standard enforcement procedure by federal OSHA [state OSHA programs may have differing policies]. It is widely believed to contribute to an overemphasis on higher NRRs, and overprotection of noise-exposed workers.

Detectable

An optional feature of some earplugs, designed to avoid contamination in food and other process industries. In a metal-detectable earplug, a metal component is added to the earplug and/or cord during production which can be recognized by contamination sensors in the processing line. In a visually-detectable earplug, colorant is used to produce an earplug that is easily detected in contaminant inspections.

Dielectric

Any material that is electrically non-conductive. The term is used to describe the non-conductive feature of some earmuff cups and bands – a safety feature that is particularly useful for industrial wearers who work around live electrical components.

Dose

A measured percent of allowable noise exposure. For example, a noise dose of 75% indicates a worker was exposed to noise equivalent to 75% of the criterion level for an 8-hour work shift. A 200% noise dose indicates the worker was exposed to the equivalent of twice the allowable criterion noise level for an 8-hour work shift. The dose calculation takes two factors into consideration: the criterion level, and the exchange rate. Under current OSHA regulations, a 100% dose is equivalent to a 90 dBA time-weighted average noise exposure.

Photo courtesy of Quest Technologies

Dosimeter

A noise monitoring device that integrates exposures over time. When worn by a noise-exposed worker, a dosimeter measures all continuous as well as intermittent noise exposures, and provides a readout of the worker's average exposure at the end of the monitoring period [usually a few hours, or an entire work shift]. Since noise monitoring with a dosimeter is specific to the wearer, dosimetry is also referred to as *personal monitoring*. Noise dosimeters used for regulatory compliance must meet specifications in ANSI Standard S1.25-1978, "Specifications for Personal Noise Dosimeters."

Hearing Safety Glossary

Engineering Controls

According to OSHA regulations, when noise exposures exceed mandated levels, engineering and administrative controls are to be the first line of defense in reducing exposures to acceptable levels. If such controls are not feasible or practical, personal protective equipment [earplugs and earmuffs] should be implemented. Engineering controls include such actions as installing acoustic enclosures, barriers, mufflers, dampers, vibration isolators, or acoustic treatment of walls and ceilings. Varying the feed pressure or drive speed of production machinery can also reduce noise levels. [see also Administrative Controls]

Exchange Rate

The increase [or decrease] in noise level in decibels which warrants a doubling [or halving] of the noise dose. For example, an increase in noise level from 90 to 95 dB warrants a decrease in allowable exposure time from 8 to 4 hours, according to the 5 dB exchange rate accepted by OSHA. Exchange rates are somewhat arbitrary: different regulatory bodies choose different exchange rates. The most common exchange rates in use are 5 dB [used by OSHA] and 3 dB [recommended by NIOSH, and used in European regulations, as well as US Army and Air Force measurements].

Frequency

The physical measurement of the oscillations in a sound wave [measured in units called Hertz]. Subjectively, we hear frequency as "pitch" of a sound. The frequency range that can be perceived by human hearing generally extends from 20 – 20,000 Hertz, but the sounds that are most useful to us [in the speech and conversation range] are in the narrower range from 300 – 3,000 Hertz. Audiometric tests administered in industry generally test hearing at six or seven different standardized frequencies: 500, 1000, 2000, 3000, 4000, 6000 and sometimes 8000 Hertz. In noise monitoring and audiometric testing, frequency is often measured in thousands of Hertz, or *kilohertz* [kHz].

Hearing Conservation Amendment [CFR1910.95]

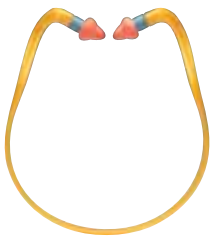
The 1983 amendment to OSHA's basic noise regulation, defining the components of an effective hearing conservation program. The Hearing Conservation Amendment is the regulation that details noise monitoring, annual audiometric testing, provision and evaluation of hearing protectors, employee training and recordkeeping. Because it is a "General Industry" standard, its provisions apply to most US industries [construction, mining, and transportation are covered by other OSHA standards, and are therefore precluded from this amendment].
CFR 1910.95 link: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9735&p_table=STANDARDS

Hearing Protection Device [HPD]

A generic term for earplugs, earmuffs, and banded protectors.

Howard Leight® Max®
Single-Use Earplug

Bilsom® Leightning® L3 Earmuff



Howard Leight® QB2 HYG®
Banded Earplug

Hertz [Hz]

Unit of measurement for frequency, equal to the number of oscillations [or cycles] per second of a sound wave. For example, the lowest note on a piano has a frequency of about 27 Hz [the thick wire-wound piano strings oscillate 27 times per second], while the highest note on a piano has a frequency of about 4,186 Hz [these thinnest strings oscillate over 4,000 times per second]. In noise monitoring and audiometric testing, frequency is often measured in thousands of Hertz, or *kilohertz* [kHz].

Hearing Safety Glossary

Impulse Noise

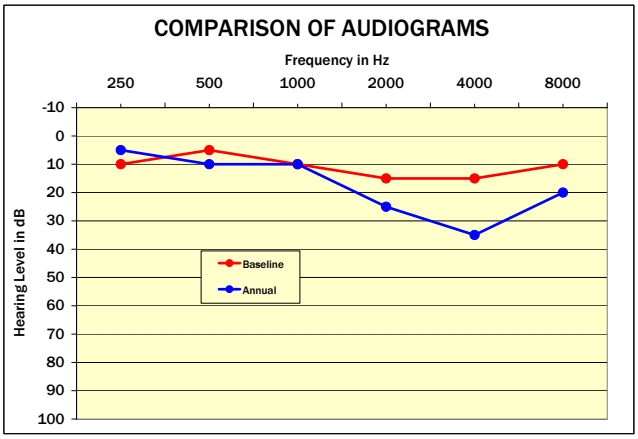
Defined as noise bursts with peaks more than one second apart [as opposed to continuous noise with peaks less than one second apart]. If the noise bursts occur very rapidly [noise from a running jackhammer, for example], the noise would not be considered impulse noise. Most industrial noise is steady and continuous, but much of it is impulse noise – a hammer or punch press, for example. When monitoring noise for OSHA compliance, all noise sources [both continuous and impulsive] are figured into the measurements. This is most easily accomplished by using a noise dosimeter.

National Institute for Occupational Safety & Health [NIOSH]

NIOSH is a U.S. government agency, charged with providing research and recommendations in support of U.S. health and safety policies and regulations. In one of its roles, NIOSH is the research arm of OSHA. NIOSH has no authority to make regulations, only recommendations.
NIOSH www.cdc.gov/niosh
NIOSH Noise and Hearing Loss Prevention www.cdc.gov/niosh/topics/noise/

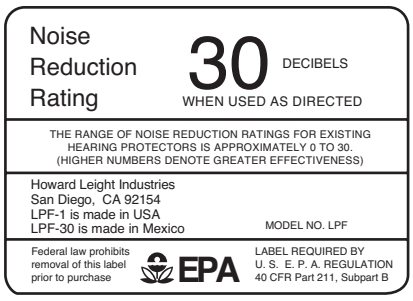
Noise-Induced Hearing Loss [NIHL]

Permanent loss of hearing due to overexposure to noise. NIHL is marked by a decline in high-frequency hearing sensitivity [often beginning around 3000-4000 Hz] regardless of the noise source, usually bilateral [affecting both ears], and usually slow in progression – NIHL often takes years to develop, not days or weeks. NIHL is often accompanied by tinnitus [ringing in the ears], but is not typically accompanied by other symptoms such as pain, fullness, or drainage from the ears. NIHL is permanent, painless, progressive, but also very preventable when hearing protectors are properly used 100% of the exposure time.



Noise Reduction Rating [NRR]

The hearing protector rating method used in the U.S. The current range of NRRs available in the U.S. market extends from 0 to 33 decibels. The NRR is derived from an involved calculation that begins with attenuation test results from at least ten laboratory subjects across a range of frequencies. Two standard deviations are factored in to account for individual user variation, and several corrections and cushions are included to make the NRR applicable to a broader population, and a wide variety of noise sources. While it is not a perfect real-world measure of attenuation, the NRR is the most standardized method currently in use for describing a hearing protector's attenuation in a single number. The NRR estimates the amount of protection achievable by 98% of users in a laboratory setting when hearing protectors are properly fitted.



Hearing Safety Glossary

Occlusion Effect

The amplification of body-borne sounds caused when you occlude [close off] the ear canal. This can be demonstrated by singing the vowel sound 'ee' while you lightly push your tragus closed [the tragus is that little flap at your ear canal]. Most people hear the 'ee' become much louder with their ear occluded. The Occlusion Effect contributes to a variety of complaints among hearing protector users: *"My voice sounds like I'm in a barrel,"* or *"My own footsteps are too loud."* It is more noticeable in banded hearing protectors and shallow-insertion earplugs. With hearing protectors, the Occlusion Effect is reduced by inserting the earplug deeper into the ear canal, or by stiffening the soft portion of the ear canal by using an earplug with more surface contact in the ear canal.

Occupational Safety & Health Administration [OSHA]

The U.S. government agency, organized in 1970 as part of the Department of Labor, charged with overseeing safety and health issues in the workplace. OSHA is a regulatory body, with the authority to enact standards and rules. The most significant OSHA standard affecting workplace noise exposures is its Hearing Conservation Amendment CFR 1910.95, enacted in 1983. OSHA is a federal agency, however individual states may implement their own safety and health standards, as long as they "meet or beat" the minimum standards of federal OSHA. Currently, more than half of the U.S. states have their own safety and health regulatory agencies, supplanting federal OSHA. Employers must determine which regulations apply in their particular locations.
OSHA www.osha.gov

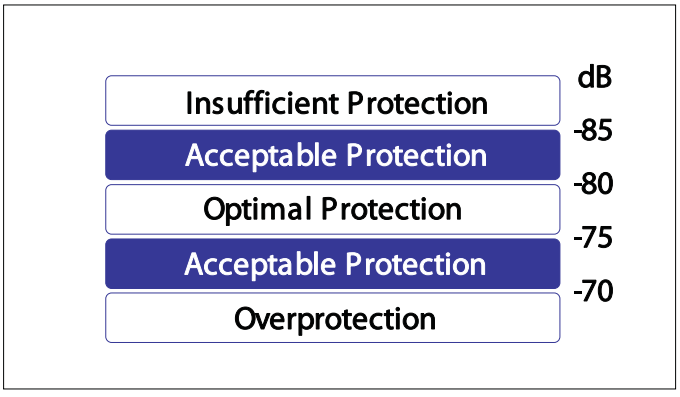
Octave Band Analysis

An analysis of noise levels broken down by component bands one octave apart in center frequency [e.g. 125, 250, 500, 1000, 2000, 4000, 8000 Hz]. Such noise measurements offer more precise information about the spectrum of the noise, but are more time-consuming. Octave band analysis is also used to match appropriate hearing protection to specific noise environments, by comparing the published attenuation values [found on boxes or bulk packages of hearing protectors] with noise levels at each octave band of noise. In Appendix B of OSHA's Hearing Conservation Amendment, this octave band analysis is referenced as *NIOSH Method #1* for estimating the adequacy of hearing protector attenuation. Other methods [such as using the NRR] are simpler but less accurate.

SmartFit®	NRR 25	Canada A (L)							
Frequency in Hz	125	250	500	1000	2000	3150	4000	6300	8000
Mean Attn.	29.5	28	30.5	31.6	33.5	40.5	40.0	41.8	42.1
Std. Dev.	3.5	4.1	3.6	3.2	3.5	3.3	4.2	5.3	4.7

Overprotection

Even in noisy environments, there are sounds we want to hear clearly – warning signals and alarms, voices of co-workers, even maintenance sounds from machinery. Just as hearing protectors may not provide enough attenuation, there are many instances where they provide too much attenuation. NIOSH estimates that 90% of noise-exposed workers in the U.S. are exposed to less than 95 dB TWA [meaning they only need about 10 dB of effective attenuation]. Workers who are overprotected say they feel isolated and cut off from their work environment – and not as safe. While there are no U.S. standards defining overprotection, a comparable European guidance document [EN 458] recommends that attenuated noise levels [under hearing protectors] should be no lower than 70-84 dB for ideal communication in noise.



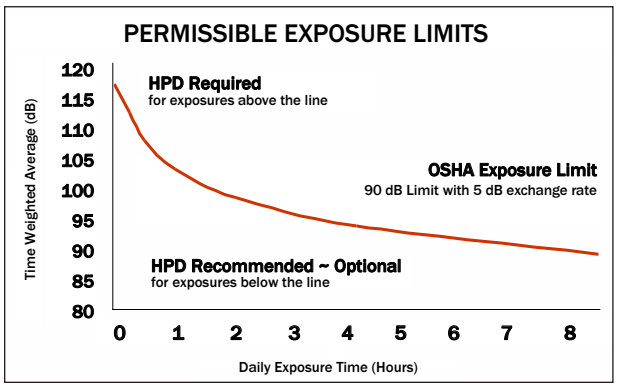
Hearing Safety Glossary

Permanent Threshold Shift [PTS]

A permanent decline in hearing following overexposure to noise. PTS usually occurs after repeated exposures to loud noise, but can also occur after only one traumatic exposure to noise. Most workers experience a *Temporary Threshold Shift* in hearing prior to a *Permanent Threshold Shift*. But because of individual variations in tolerance to noise, there is no way to predict when a shift in hearing will become permanent. Therefore, hearing protection is critical for all loud noise exposures.

Permissible Exposure Limit [PEL]

The maximum noise level allowed, beyond which protective measures are mandated. Also called the *Criterion Level*. In current OSHA regulations, the *Permissible Exposure Limit* is 90 dBA of noise exposure over an 8-hour time-weighted average. Workers exposed continuously at this level throughout a work shift will have a dose of 100%. Exposures over this PEL warrant protective actions – administrative or engineering controls, or mandatory use of hearing protection.



Personal Monitoring

One of the two methods recommended by OSHA to measure noise exposures [the other being Area Monitoring]. In personal monitoring, a noise dosimeter is used to average exposures over time. When worn by a noise-exposed worker, a dosimeter measures all continuous as well as intermittent noise exposures, and provides a readout of the worker's average exposure at the end of the monitoring period. In contrast to area monitoring, personal monitoring is the required measurement method when there is significant fluctuation in noise levels, or high worker mobility, during the course of an employee's work shift.

Recordable Hearing Loss

The amount of decline in hearing that triggers required reporting on OSHA health and safety records. Current criteria for recordability on OSHA's Log of Work-Related Injuries and Illnesses [OSHA Form 300] define a hearing loss as recordable when any work-related Standard Threshold Shift occurs, and when the resulting average hearing thresholds are 25 dB HL or higher at the STS frequencies in that ear [2000, 3000 and 4000 Hz on the audiogram]. This means a hearing loss is recordable when a significant noise-induced shift in hearing occurs, and when that shift is out of the normal range of hearing. OSHA Form 300: http://www.osha.gov/pls/publications/pubindex.list#300

Slow Response

A sensitivity dampener that is built into the circuitry of most sound level meters. The Slow Response restricts the rapid fluctuations of a sound level meter, making it easier to read and less prone to transient noise. OSHA regulations state that noise measurements for hearing conservation purposes should be taken using the Slow Response mode.

Photo courtesy of Quest Technologies

Sound Level Meter

A noise monitoring device that measures instant noise levels. Since noise monitoring with a sound level meter is specific to the immediate area where the measurement is being taken, these measurements are also referred to as *area sampling*. The input to a sound level meter can be filtered through different weightings [see *A-weighting* and *C-weighting*] to mimic the reception of the human ear. Optional attachments, such as Octave Band filters, can further restrict the noise measurement only to specific frequency bands. Sound level meters used for regulatory compliance must meet specifications in ANSI Standard S1.4-1971, "Specifications for Sound Level Meters."

Hearing Safety Glossary

Standard Threshold Shift [STS]

A significant change in hearing thresholds, defined by OSHA as an average decline of 10 dB or more at 2000, 3000, and 4000 Hz in a given ear, relative to a baseline audiogram. A Standard Threshold Shift can only be determined when at least two audiograms for the same worker are compared – the baseline and the annual audiograms. Optional age corrections can be applied when determining whether an STS has occurred. When an STS occurs, employers are obligated under OSHA regulations to inform the worker, and carry out a series of preventive measures to reduce the employee's noise exposure and refit/retrain the worker in hearing protection.

Temporary Threshold Shift [TTS]

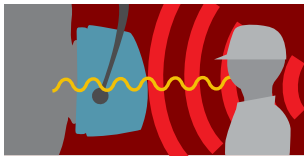
Initial overexposures to noise cause a temporary decline in hearing, which may last for a few minutes or hours. A worker with a *Temporary Threshold Shift* will perceive incoming sound as being muffled, or not as sharp; but once the ear has rested for some time, hearing recovers to normal levels. Physiologists believe the receptor cells in the ear fatigue with loud noise exposures, and require several hours of relative quiet to return to their normal state. Repeated overexposures to loud noise, however, cause permanent damage, from which the ear cannot recover [see *Permanent Threshold Shift*]. Since different people have varying tolerance for TTS, there is no way to predict when a temporary shift in hearing starts to become permanent.

Time-Weighted Average [TWA]

A computed average of all incoming sound levels, that represents what the average noise level would be if that level remained constant over an 8-hour work shift. For example, a worker wears a noise dosimeter for a 2-hour sampling period, during which time he works in fluctuating noise ranging from 83 dB to 98 dB. The resulting noise dose can be converted into an equivalent 8-hour time-weighted average. Even though the sampling period may be less than 8 hours, a time-weighted average allows us to apply the sample measurement to an 8-hour work shift. According to current OSHA standards, the Permissible Exposure Limit is an 8-hour time-weighted average of 90 dBA.

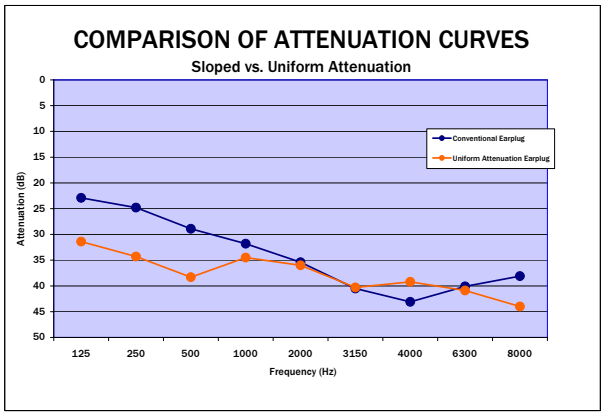
Tinnitus

Persistent ringing in the ears. *Tinnitus* is a common aftermath of receptor cell damage in the inner ear due to overexposure to noise. In response to that damage, the brain generates its own sounds, which are routed back to the ear and perceived as ringing [or sometimes as hissing or buzzing]. Tinnitus in its earliest stages may be seen as a warning sign of overexposure to noise. In its later stages, it is annoying and disturbing, and though treatment options are limited, sufferers should seek medical advice for possible help from an audiologist or physician.



Uniform Attenuation [also called *flat attenuation*]

Conventional hearing protectors inherently attenuate high frequencies more than low frequencies. This produces a muffled and distorted signal when wearing hearing protectors, most noticeable when the incoming signal includes music or speech, not just noise. Hearing protection device designers have overcome some of this high-frequency bias, developing a variety of hearing protectors that attenuate fairly uniformly across all frequencies, a response called *uniform attenuation*. A hearing protector with uniform attenuation will reduce all incoming noise fairly equally, regardless of frequency. In industrial settings, many users of uniform attenuation HPDs report that speech and conversation sounds more natural when compared with conventional hearing protection.



Hearing Safety Glossary

Weighting

Weighting refers to different sensitivity scales for noise measurement. Filters in the circuitry of noise meters [either sound level meters or noise dosimeters] affect the sound level reading, depending on which weighting [if any] is used. A noise measurement using no filters is called *unweighted*. Weightings allow the noise meter to respond more like the sensitivity of the human ear. The most common weighting scales used in hearing conservation are the A- and C-weightings. When used in noise measurements, these are designated dBA and dBC.