



Acoustic Trauma

A sudden occurrence or increase in hearing loss attributed to a single incident. Welding sparks (to the eardrum), blows to the head and a sudden extremely loud sound or blast are examples of events capable of producing acoustic trauma.

Air Conduction

The pathway of sound waves as they are conducted from the outer ear to the middle ear to the inner ear. The typical way sounds travel through our ears for everyday hearing.

Ambient or background noise

Sound from all sources unrelated to a particular sound that is the object of interest or the sound/noise being monitored. Examples of ambient noise include ocean waves, refrigerator and computer hums, air conditioners, traffic etc.

Amplitude

The greatest extent of the vibratory movement (positive or negative change) in atmospheric pressure from its point of rest (no vibration). Sounds with greater amplitude are perceived as louder sounds and sounds minimal amplitude are perceived as silence.

Attenuation (acoustic)

The reduction of sound energy. For instance, earplugs “attenuate” the sound energy reaching the inner ear. Hearing protectors with greater attenuation reduce more noise. (see NRR and uniform attenuation)

Audiogram

The results of a hearing test (hearing thresholds levels) displayed in a graphic form with decibel hearing level on the y-axis and frequency on the x-axis.

Audiometer

The computer or device used to test hearing threshold levels. The equipment generates tones at different loudness levels and frequencies and delivers them to the ear via an earphone, loud speaker or bone conduction vibrator.

Auditory Nerve

Part of the 8th cranial nerve that transmits the electrical signals generated by sound from the inner ear to the brain.

Auricle

The visible part of the outer ear (external ear) - also called the pinna

A-weighting and A-weighted sound pressure level

An electrical or digital filter network used by sound level meters, whose filter output simulates the response of the human ear to low-level sounds. This is done by making the sound level meter less sensitive to very low and very high frequencies. If sound level measurements are made using this filter, they are designated as dBA sound pressure level values. Sound levels measured using the A-weighting filter have a strong statistical correlation to the risk of noise-induced hearing loss. Most measurements of continuous noise exposures are made with the dBA meter setting.

Basilar membrane

A thin membrane within the inner ear which extends the entire length of the cochlea, separating the scala tympani from the scala media and supporting the organ of Corti.

Binaural

Relating to two ears; listening with both ears. In humans, binaural hearing provides cues useful in localizing (determining the direction) from which sounds originate.

Bone Conduction

The pathway of sound waves as they are conducted to the inner ear by way of the bones of the skull.

Cerumen

Ear wax; a substance naturally produced by glands that lie within the skin of the ear canal.

Cochlea

The spiraled (snail-shaped) part of the inner ear that contains the sensory organ of hearing. The cochlea is responsible for converting the mechanical sound waves into electrochemical signals that can be sent to the brain for interpretation.

Conductive Hearing Loss

A loss of hearing due to abnormalities in the outer and/or middle ear that results in a loss of sound transmission to the inner ear through air conduction. This type of hearing loss can often be corrected with medical or surgical treatment.

Damage-risk criteria

A standard which defines the percentage of a given population expected to incur a specified hearing loss as a function of exposure to a given noise exposure.

Decibel (dB)

A base 10 logarithmic unit of measurement expressing the ratio of two sound pressures or powers (energy). One tenth of a Bel. For noise exposure measurements, sound levels are usually measured in decibels of sound pressure level (SPL). The decibel was named after Alexander Graham Bell. The decibel scale is a logarithmic scale in which 0 dB approximates the threshold of hearing in the mid frequencies for young adults and in which the threshold of discomfort is between 85 and 95 dB SPL and the threshold for pain is between 120 and 140 dB SPL. A logarithmic, rather than a linear scale, is necessary because the human ear can respond to a huge range of sound levels (from zero into the trillions) which is impractical to use. Therefore a small change in decibel levels represent enormous changes in sound level. It also means that decibels cannot be added mathematically (e.g. 85 dB + 85 dB = 88 dB and not 170 dB).

Dose

See "Noise dose"

Eardrum

The commonly used name for the tympanic membrane, a 3-layer membrane located at the end of the ear canal which separates the outer ear from the middle ear.

Earplug

A protective device designed to fit into the ear canal to protect the wearer's hearing from hazardous sound levels.

Earmuff

A protective device designed to fit around the external ear to protect the wearer's hearing from hazardous sound levels.

Endolymph

The fluid contained within the membranous labyrinth of the inner ear.

Equal-energy rule

The relationship between sound level and sound duration based upon a 3 dB exchange rate, i.e., the sound energy resulting from doubling or having a noise exposure's duration is equivalent to increasing or decreasing the sound level by 3 dB, respectively.

Eustachian tube

A channel connecting the middle ear with the nasopharynx (back of throat). When the Eustachian tube is open, it equalizes the air pressure within the middle ear.

Exchange Rate

The relationship between intensity and dose. OSHA uses a 5-dB exchange rate. Thus, if the intensity of an exposure increases by 5 dB, the dose doubles. Sometimes, this is also referred to as the doubling rate. The U.S. Navy uses a 4-dB exchange rate; the U.S. Army and the Air Force use a 3-dB exchange rate. NIOSH recommends a 3-dB exchange rate. Note that the equal-energy rule is based on a 3 dB exchange rate

External Auditory Canal

The channel in the external ear from the auricle (pinna) to the tympanic membrane (eardrum). It is the external opening into the ear.

Four kilohertz (4 kHz) notch

A loss of hearing in the 3000 to 6000 Hz region with recovery of hearing at 8000 Hz. This notching is represented on an audiogram as a "dip" in the threshold levels in the 3-6 kHz range. This audiometric pattern is commonly associated with noise-induced hearing loss.

Frequency (f)

The number of cycles per second of a sound wave; perceived as pitch and measured in hertz (Hz).

Hair Bundles

A bundle of stereocilia on top of each hair cell - sound vibrations move hair bundles which signal the hair cells to send a signal to the brain that is perceived as sound

Hair Cells

Microscopic sensory cells within the inner ear that have tiny, hair-like projections on top (stereocilia). In humans the auditory hair cells are located within the organ of Corti on the basilar membrane. These hair bundles are rocked back and forth by the pressure wave in the inner ear fluid. Damage to these hair cells results in sensory hearing loss.

Hazardous noise

Any sound for which any combination of frequency, intensity, or duration is capable of causing permanent hearing loss in a specified population

Hearing

The sensory perception of sound.

Hearing Level (HL)

The number of decibels (dB) above the average normal threshold of human hearing. When human hearing is measured with an audiometer the hearing test results are reported in dB HL. Hearing threshold levels have been established so that 0 dB HTL reflects the best hearing of a group of normal hearing persons.

Hearing Loss

Any loss of sound sensitivity, partial or complete, produced by an abnormality in the auditory system.

Hearing Protection Device (HPD)

A generic term for devices designed to be worn over or in the ears to protect from hazardous sound levels, such as earplugs and earmuffs.

Hertz (Hz)

Unit of acoustic frequency measurement that reflects the number of cycles per second of a sound wave. It replaces the earlier term of "cycle per second (cps). The unit of measure is named after Heinrich Hertz, a German physicist. The frequency range for human hearing lies between 20 Hz and approximately 20,000 Hz. The sensitivity of the human ear drops off sharply below about 500 Hz and above 4,000 Hz.

Impulsive noise

Used to generally characterize impact or impulse noise which is typified by a sound which rapidly rises to a sharp peak and then quickly fades. Typically impulse noise is characterized as bursts of sound with peaks more than 1 second apart. The sound may or may not have a "ringing" quality (such as striking a hammer on a metal plate or a gunshot in a reverberant room). Impulsive noise may be repetitive, or may be a single event (as with a sonic boom). Note: if impulses occur in very rapid succession (such as with some jack hammers), the noise would not be described as impulsive, but rather as continuous.

Incus

The anvil-shaped bone or ossicle of the middle ear that is attached to the malleus and the stapes

Inner Ear

A complex structure of interconnected fluid-filled chambers and canals within the bone of the skull – The inner is composed of two sensory organs; vestibular (balance) and auditory (hearing).

Intensity Level

The amount of energy per unit of area. The reference level in decibels is 10^{-12} watt/m², or 10^{-16} watt/cm²

Internal auditory canal

The channel from the inner ear to the brainstem which provides the pathway for 7th cranial nerve and the auditory and vestibular branches of the 8th nerve.

Inverse square law

A physical principle whereby the intensity of a sound decreases as a function of the square of the distance from the source.

Labyrinth

The system of interconnected fluid-filled chambers of the inner ear, composed of the bony labyrinth (filled with perilymph), that contains the membranous labyrinth (filled with endolymph).

Localization

The ability to determine the specific spatial origination of a sound source.

Logarithm

The exponent that tells the power to which a number is raised; the number of times a number (the base) is multiplied by itself.

Loudness

The subjective impression of the power of a sound. The unit of measurement is the sone. Loudness is characterized along a continuum from 'soft' to 'loud.' Although this is a subjective attribute, it depends primarily upon sound pressure level, and to a lesser extent, the frequency characteristics and duration of the sound

Malleus

The first and largest hammer-shaped bone in the ossicular chain in the middle ear, connected to the tympanic membrane and the incus.

Middle ear

The air-filled cavity between the eardrum and the inner ear, containing the chain of three middle-ear bones (the malleus, the incus and the stapes). The function of the middle ear is to transfer sound energy from the outer ear to the inner ear.

Mixed hearing loss

A type of hearing loss caused by both conductive and sensorineural abnormalities.

Narrowband noise

Sound in a restricted band of frequencies.

Noise

Any unwanted sound.

Noise dose

The noise exposure expressed as a percentage of the allowable daily exposure. If 85 dBA is the maximum permissible level, then an 8-hour exposure to a continuous 85 dBA noise would equal a 100% dose. If a 3 dB exchange rate is used in conjunction with an 85 dBA maximum permissible level, a 50% dose would equal a 2-hour exposure to 88 dBA or an 8-hour exposure to 82 dBA

Noise-induced hearing loss (NIHL)

A permanent sensorineural hearing loss that is attributed to overexposure to noise and for which no other etiology can be determined. NIHL may take years to develop and is subtle in the early stages and easily goes unnoticed by the exposed individual. Tinnitus often accompanies NIHL and is an early warning sign.

Noise reduction rating (NRR)

The NRR is a single-number rating method which attempts to describe a hearing protector based on how much the overall noise level is reduced by the hearing protector. Hearing protectors sold in the U.S. are labeled with the laboratory-based NRR. When estimating A-weighted noise exposures, it is important to remember to *first* subtract 7 dB from the NRR and then subtract the remainder from the A-weighted noise level. The NRR theoretically provides an estimate of the protection that should be met or exceeded by 98% of the wearers of a given device. In practice, this does not prove to be the case because it is based upon laboratory measurements, so a variety of methods for "de-rating" the NRR reflecting "real world" performance have been discussed.

Occlusion effect

The perception of an increased loudness of bone-conducted sound which occurs when the outer ear is covered or blocked. This may result in the increased amplification of body-borne sounds while wearing earplugs or earmuffs (e.g. person notices that their voice sounds like it is in a barrel, or their breathing is loud). Wearing the earplugs deeper in the ear canal or wearing earmuffs with larger cup volume will reduce the occlusion effect.

Octave

The difference between two tones separated by a frequency ration of 2:1.

Octave band

A frequency band which covers a complete musical octave. The ratio of the frequency of the higher band edge to the lower band edge is 2:1. Octave bands are named by their center frequency. Preferred octave bands of interest in hearing conservation are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz.

organ of Corti

The sensory organ of hearing found within the scala media of the cochlea which contains the tectorial membrane and hair cells.

Oscillation

The back and forth movement of a vibrating body.

Ossicles or Ossicular Chain

The three small bones (malleus, incus and stapes) that form a chain in the middle ear.

Otalgia

Pain in the ear.

Otoacoustic emissions

Low-level sounds produced by the inner ear.

Otoscope

A special flashlight device with a funnel-like speculum on the end, designed to provide observation of the ear canal and tympanic membrane.

Ototoxic

Poisonous to the ear. Sensory damage to the cochlear or vestibular systems from exposure to a chemical.

Outer Ear

The outermost portion of the hearing mechanism, filled with air, whose primary function is to channel sound waves to the middle ear.

Oval Window

A membrane-covered opening of the vestibule of the cochlea that is attached to the footplate of the stapes. The oval window separates the middle ear from the inner ear. Vibrations of the stapes footplate sets the oval window into vibration and generates pressure waves in the fluids of the cochlea.

Perilymph

The fluid contained in the bony labyrinth of the inner ear.

Perception

Physical sensation (e.g. touch, taste, hearing, vision) as interpreted by the brain

Period

The duration (in seconds) of one cycle of vibration. The period is the reciprocal of frequency (e.g. the period of a 2000 Hz tone is 1/2000 of a second).

Permanent threshold shift (PTS)

A decrease in hearing thresholds (sensorineural hearing loss) due to damage that occurs after prolonged exposure to noise or immediate after exposure to very high sound levels that does not recover.

Phase

A particular point in time during the cycle of a sound wave; and expressed as an angle in degrees.

Pinna

the visible part of the outer ear, also called the auricle. If you “pierce your ears”, this is what you pierce.

Pitch

The psychological correlate of frequency. The perceptual aspect of sound that depends on our ability to perceive different sound frequencies; high-pitched sounds are those with relatively high sound frequencies (e.g. above 2,000 cycles per second) while low-pitched sounds are generally those with relatively low sound frequencies (e.g. 200 cycles per second or lower).

Presbycusis

The gradual increase in hearing loss attributed to the aging process, and not related to medical conditions or noise exposure.

Prevalence

The total number of existing cases of a disease or condition present in a population at any given time.

Puretone

A sound (tone) of only one frequency.

Rarefaction

The portion of a sound wave where the molecules become less densely packed per unit of space.

Reverberation

A short-term echo. The persistence of sound in an enclosed or partially enclosed space after the source of sound has stopped, resulting from reflection and refraction of sound waves.

Round window

A small, round membrane covered opening to the cochlea located beneath the oval window, which permits the displacement or movement of fluid within the cochlea.

Scala media

The fluid filled duct in the cochlea separating the scala vestibule from the scala tympani. It is filled with endolymph and contains the organ of Corti.

Scala Tympani

The duct in the cochlea below the scala media, filled with perilymph.

Scala vestibule

The duct in the cochlea above the scala media, filled with perilymph.

Sensorineural hearing loss.

A loss of hearing sensitivity due to damage or alteration of the sensory mechanism of the cochlea and/or auditory neural structures.

Sinusoidal or sine waves

The waveform of a puretone showing simple harmonic motion.

Slow response

A sensitivity setting on a sound level meter that is built into the electronic circuitry. This circuit restricts the rapid fluctuations in sound level and makes it easier to read the measurements. Noise exposure measurements are made with the SLM in the slow response mode.

Sound level meter (SLM)

A device which measures sound and provides a readout of the resulting measurement. Some provide only A-weighted measurement, others provide A- and C-weighted measurements, and some can provide weighted, linear, and octave (or narrower) band measurements. Some SLMs are also capable of providing time-integrated measurements

Sound pressure level (SPL)

A measure of the ratio of the pressure of a sound wave relative to a reference sound pressure. Sound pressure level in decibels is typically referenced to 20 μPa . When used alone, (e.g., 90 dB SPL) a given decibel level implies an unweighted sound pressure level.

Sound Wave

A longitudinal wave of motion, spread through oscillating molecules, initiated by a vibrating surface or by a sudden, rapid force (as in an explosion) - in the case of sound waves, the molecules do not actually move to a new location, instead each set of molecules "bumps" the molecules next to it, progressively transferring motion to new sets of molecules further and further away from the sound source until the wave motion dies out.

Spectrum

The distribution of sound energy across frequency bands.

Stapes

The third and smallest stirrup-shaped bone of the middle ear that connects to the incus and attaches to the oval window of the cochlea.

Stereocilia

Small hair-like projections (protoplasmic filaments) on the top of hair cells in the cochlea – also see Hair Bundle

Tectorial membrane

A gossamer membrane located above the organ of Corti in the scala media in which the tops of stereocilia of the hair cells are embedded.

Temporary threshold shift (TTS)

Initially a short-term sensorineural hearing loss usually associated with overexposure to intense noise; hearing typically recovers after being away from the noise exposure. However, if repeated exposures to hazardous sound levels occur, the temporary changes will eventually become permanent.

Threshold

In hearing testing, the level at which a sound stimulus (puretone) is barely perceptible. Clinically, the response criteria is that the threshold is the sound level just high enough for the listener to detect the sound at least 50 percent of the times it is presented. Usually expressed in dBHL.

Time-Weighted Average (TWA)

A measure of noise exposure computed by averaging all of the varying sound levels encountered during a measurement interval and normalizing it to an eight-hour workday period of time.

Tinnitus

The perception of ear or head noises, usually described as ringing, hissing or roaring sounds; which occur in the absence of an external source of sound.

Traveling wave theory

The theory that sound waves move in the cochlea from base to apex along the basilar membrane. The crest of the wave resonates at a particular point on the membrane, resulting in the perception of a specific pitch.

Tuning Fork

A special two-pronged metal device that when struck produces a sound (tone) of fixed pitch. It is used as a pitch reference when tuning musical instruments.

Tympanic membrane

A very thin 3-layer round membrane that separates the external ear canal from the middle ear. The 3-layers are comprised of an outer layer of skin, a middle layer of connective tissue, and an inner layer of mucous membrane. The ear drum is the first component in the system of mechanical transmission of sound energy through the middle ear. Also known as the eardrum.

Uniform attenuation (flat attenuation)

The ability of a hearing protector to reduce the sound levels an equivalent amount for all frequencies. Traditional hearing protectors attenuate the higher frequencies more than the lower frequencies. A uniform attenuation is more desirable in terms of preserving music appreciation or speech perception abilities.

Vibration

The regular to-and-fro (oscillating) movements of an object (mass) or medium forced from a position or state of equilibrium.

Wavelength

The distance between repeating points of a wave pattern on two successive cycles of a tone. In a sine wave, the wavelength is the distance between the peaks or crests of the wave pattern..

*adapted from the following resources;

- Dangerous Decibels: Educator Resource Guide
- Martin, F. N., & Clark, J. G. (2006). Introduction to audiology. (9th Ed.). Boston: Allyn and Bacon.
- NIOSH: Preventing occupational hearing loss: a practical guide. <http://www.cdc.gov/niosh/docs/96-110/>
<http://www.cdc.gov/niosh/docs/96-110/>
- NASA: [http://adl.grc.nasa.gov/Excerpts from the Guide to Specifying Equipment Noise Emission Levels](http://adl.grc.nasa.gov/Excerpts%20from%20the%20Guide%20to%20Specifying%20Equipment%20Noise%20Emission%20Levels)
- Plante, E., & Beeson, P. M. (2004). Communication and communication disorders: A clinical introduction. (2nd Ed.). Boston: Pearson.