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The Invisible Environment Fact Sheet Series

Noise

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Noise is defined as unwanted sound. Noise is an inescapable part of everyday life—the television, a plane flying overhead, a faulty muffler on a passing car, dogs barking, children laughing. Mild noise can be annoying; excessive noise can destroy a person’s hearing. People do not easily become accustomed to noise. The slightest unwanted sound can become very annoying if it continues for any length of time. While the continuous hum of a busy freeway may be ignored by some nearby residents, others will never be able to ignore it and increasingly will find it irritating.

How Humans Hear

The visible part of the ears are sound-gathering scoops that guide sound waves along a one-inch canal, which acts as a resonating chamber. When they reach the eardrum, they become vibrations. These vibrations are picked up in the middle ear by three tiny, linked ear bones and are mechanically passed deeper to the inner ear where hair cells translate them into electrochemical impulses. The auditory part of the brain interprets this stimulus and decides how far away it is, where it is, and what it is.

What the Ears Hear

Sound occurs when waves of compressed atmospheric particles travel through the air. The waves are created when atmospheric particles alternately are squeezed closer together than normal, then pulled farther apart than normal (see Figure 1). Sound waves move outward from the vibrating source and weaken as they travel. They may be reflected or bent by obstacles so the sound that reaches the ear may be different from the sound that was originally generated.

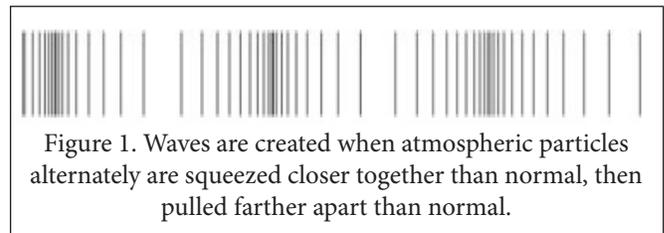


Figure 1. Waves are created when atmospheric particles alternately are squeezed closer together than normal, then pulled farther apart than normal.

Measuring Sound

The frequency and intensity of sound are measured. Sound-producing vibrations are repetitive or cyclical and are measured in Hertz (Hz), which notes the number of cycles that occur per second (cps). The greater the frequency, the higher the pitch. Children’s ears respond to frequencies as high as 40,000 Hz, while the range for adult ears narrows considerably, mostly by loss in the high-frequency range.

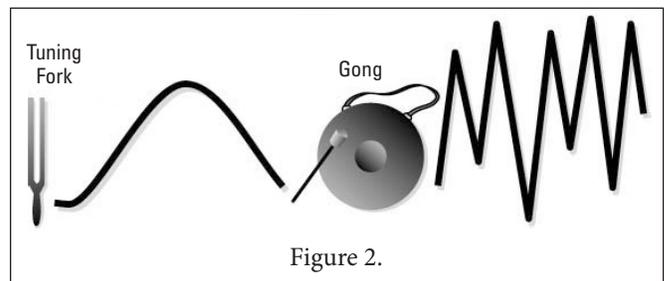


Figure 2.

The intensity or force of a sound determines its loudness and is measured in decibels (dB). The greater the force, the louder the sound. Each increase of three decibels doubles the loudness. The difference between 100 dB of a garbage truck and 110 dB of a race car represents an increase of more than 300 percent.

The Difference Between Sound and Noise

Not all people are affected the same way by the same sounds. We often take for granted the sounds we hear every day. On different occasions and in varying situations, however, common everyday sounds can interfere with our routine task. When this happens, sounds become noise.

What may be a disturbing noise for one person may be a pleasant sound for someone else. For example: A couple lives in a small town and every morning a nearby rooster crows at daybreak. The wife finds it a pleasant way to awaken each day; the husband can't stand it. He awakens before the rooster crows and waits for it to begin. When it does, he flies into a rage. Train whistles, children playing, someone coughing during a symphony, and people talking in a movie are examples of sounds that can evoke extreme reactions.

Sounds that are generally considered to be pleasant create variations in pressure with a regular pattern. Sound waves commonly translated as noise often have irregular patterns (see Figure 2). The patterns created by human voices have both irregular and regular sound pulses. An adult with good hearing can hear frequencies between 20 and 20,000 hertz (Hz). Frequencies between 2000 Hz and 8000 Hz are considered most annoying; those below 500 Hz or above 10,000 Hz are considered less annoying.

Noise as an Irritant

It is not so much the pitch or loudness of a sound that makes it unbearable as it is its repetitive nature, the distraction it causes, and the lack of control over it. A voice in normal conversation is generally around 60 dB. Normal city or freeway traffic registers 70 dB. Some cities have incorporated the use of rubber asphalt made from recycled tires in an attempt to reduce the level of traffic noise.

Noise as a Psychological Fact

Research on noise indicates that there is a psychological element to the level of sound that one considers to be "noise." Introverted people seem to be more bothered by noise than extroverted people. Individuals prone to depression, hypochondria, and anxiety or who are going through a difficult emotional experience such as divorce or unemployment tend to be more sensitive to extraneous sounds and consider them noise.

How Noise Damages the Ear

Normal hearing depends on the health of the three components of the human ear: the inner, middle, and outer ear. There are three kinds of hearing loss: conductive, neural, and sensory. Conductive hearing loss occurs

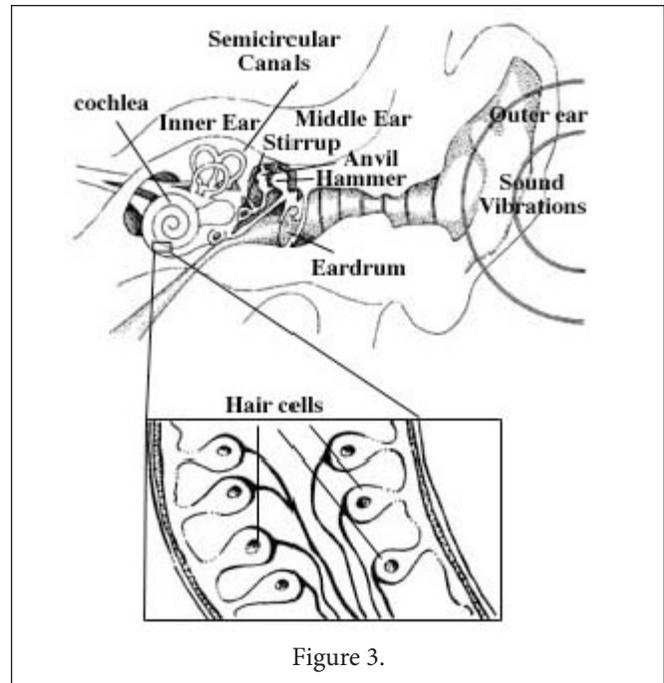


Figure 3.

when something happens to the outer or middle ear, such as excessive ear wax, a damaged ear drum, or fluid in the middle ear. Neural hearing loss is caused by damage to auditory nerves. Sensory hearing loss is caused by damage to the inner ear (cochlea) and is the most common form associated with noise.

The cochlea contains thousands of tiny hair cells that transmit sound impulses to the auditory nerve. An explosion of 140 dB can cause permanent deafness, for it destroys certain cells in the inner ear that do not regenerate. The middle ear has a reflex action that reduces the transmission of sound and helps prevent damage. It is too slow, however, to protect against sudden bursts of sounds such as gunshots. Extended exposure to excessive noise levels can flatten or disfigure hair cells or cause them to fuse together; this can reduce the ability of the hair cells to transmit sound. Sensory hearing loss is generally irreversible, but further loss can be prevented by using protective equipment or by reducing the amount of noise in the workplace. The most common causes of conductive hearing loss in the workplace would be damage to the eardrum due to a blow to the head or an explosion. Examples of safe levels and injury range levels of sound are shown in the table on the next page.

Noise Damages More Than the Ears

In addition to contributing to hearing loss, too much noise can affect health in other ways, too. There are immediate effects that may be temporary or may become longer lasting. These include cardiovascular problems with

Safe Range	Sound in Decibels (dB)	Injury Range	Sound in Decibels (dB)
Stream flow, rustling leaves	15	Race car, loud thunder, rock band (sustained)	120/130
Watch ticking, soft whisper	20–30	Jack hammer from 3 feet	100
Quiet street noises	40	Jet airplane takeoff from 120 feet	120
Normal conversation	45–60	Pain threshold (close)	130
Normal city or freeway traffic	70	Rocket launch from 150 feet	180
Vacuum cleaner	75		
Hair dryer	85		
Lawn mower, heavy equipment	90		
Garbage truck	100		
Screaming baby	115		

an accelerated heartbeat and high blood pressure, gastric-intestinal problems, a decrease in alertness and ability to memorize, nervousness, pupil dilation, and a decrease in the visual field. Effects that may be longer lasting include insomnia, nervousness, bulimia, chronically high blood pressure, anxiety, depression, and sexual dysfunction.

A Health Problem or a Social Irritation

Noise generates conflicts between the participating and nonparticipating groups. People generally tolerate noise more easily if they are causing it, if they feel it is necessary, and/or if they know its source.

Every exposure to loud noise destroys some hair cells. Continuous exposure to noise at a level no louder than people shouting, over a period of years for 8 hours a day, 5 days a week can cause some degree of hearing loss. This type of hearing loss is permanent.

Noise in the Workplace

“This office is so noisy, I can’t think!” When noise levels in a workplace are loud enough to require people to raise their voices in order to talk, the sounds are above 85 decibels. If people are exposed to such noise levels for eight hours a day, the Occupational Safety and Health Act (OSHA) requires the workplace to develop a formal hearing conservation program. This can include measuring noise, engineering controls to reduce noise, hearing examinations for exposed employees, and personal protective equipment. Sound below 85 decibels is not regulated. Noise levels above 58 dB can interfere with voice communications and affect thought processes for some people.

Employees may sense noise in two ways. They most often hear it as it travels through the air from its source.

Less frequently, employees may “feel” the noise as the noise source vibrates and sends vibrations through the building structure.

According to OSHA’s permissible noise exposures table, the higher the decibel level, the shorter the acceptable duration of exposure per day. For example, the operator of a jack hammer (100 dB) may spend no more than two hours per day exposed to that noise level. Airport employees who work around jet airplanes as they rev up their engines (120 dB) may spend no more than 15 minutes per eight-hour day exposed.

A Growing Concern

Noise pollution is an increasing problem in developing countries with road traffic noises being the major contributor. Two percent of the U.S. population considers aircraft to be a major noise nuisance. Among the sources of neighborhood noise problems and countless complaints and court cases are stereo systems, household appliances, and barking dogs. Many U.S. towns and cities have noise ordinances that prohibit or restrict certain noises at certain times, including animal noise, outdoor entertainment, construction, and other equipment and machinery.

Possible Solutions

Effective solutions to noise will vary depending on the nature of the problem. When complaints are made about noise, try to identify which specific characteristic of the noise is offensive so control measures can be explored. Is the noise too loud, too unpredictable, or too high pitched? Having neglected equipment and systems serviced, or enclosing noisy machines in a separate room may be the answer. When noise sources are diffused, isolating people with dividers may offer some relief if the dividers are at least 5 feet high and are placed as close to the floor as possible.

A separate conference room is needed for confidential conversations. Noise can penetrate drop ceilings and travel

long distances above ceilings before reentering the work space through transfer grills or other openings. Conference rooms need slab-to-slab walls with appropriate sound absorptive interiors. Repainting acoustical ceilings can reduce the sound absorption properties.

Active noise control systems may eliminate an annoying noise or may generate a desirable noise. An active noise control system may produce a sound that is out of phase with the disturbing noise and cancel it out. Another system may produce background noise sometimes called “white noise” to mask other noises or for privacy. Determining the level of background noise is often a compromise. It should be able to provide speech privacy but not interfere with being able to hear the conversation in the room. Music is an acceptable approach except that musical tastes are so diverse it is difficult to find selections that are acceptable to everyone. Ventilation systems can provide a masking effect unless they kick on and off periodically. In that case, they may be more disruptive than helpful.

People who work in a very noisy environment or who have excessively noisy leisure time activities should wear ear protectors. With protectors, employees can remain in that environment for eight hours. The highest

permissible noise exposure for the unprotected ear is 15 minutes per day.

Other countries are addressing noise issues. Australia is the most advanced with noise reduction regulations. Examples of what some Australian states are doing to reduce noise include the following:

- Lawn mowers, chain saws, and jack hammers must carry a “noise” label.
- When police in Adelaide, a city in southern Australia, spot an unsafe or noisy car on their roads, they suspend the car’s registration until it is repaired in an authorized garage.
- In New South Wales (and in some parts of the U.S.), noisy vehicles can be stopped and tested by the side of the road.

Switzerland is the only country that requires that the best possible technology for reducing noise always be used. Contractors, for example, must encapsulate already low-noise-producing truck engines with the costs covered by the users. The Swiss Society of Engineers and Architects has defined the required norms for soundproofing building interiors, stairwells, lifts, and heating and ventilation systems.

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