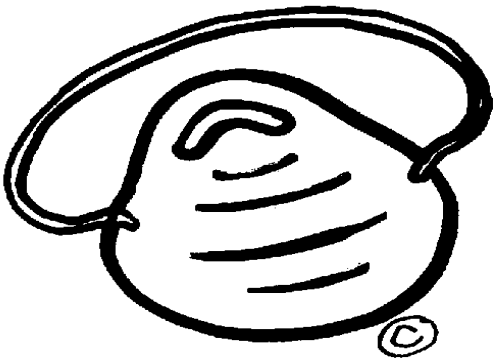
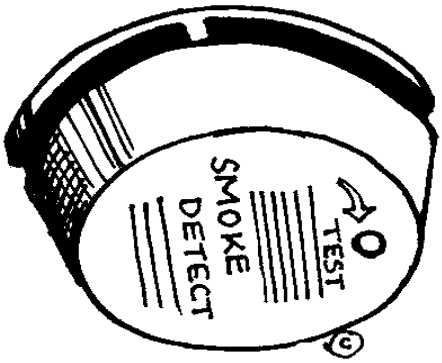
Environmental Health

Indoor Air Quality

Hearing





September 2004

KSC/CCAFS Health Education and Wellness Program
Kris S. Calderon, PhD, CHES

Environmental Health 2004
Indoor Air Quality & Hearing

Indoor Air Quality

Air: The environmental agent

In the last several years, a growing body of scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Other research indicates that people spend approximately 90 percent of their time indoors. Thus, for many people, the risks to health may be greater due to exposure to air pollution indoors than outdoors.

In addition, people who may be exposed to indoor air pollutants for the longest periods of time are often those most susceptible to the effects of indoor air pollution. Such groups include the young, the elderly, and the chronically ill, especially those suffering from respiratory or cardiovascular disease.

Just the facts

Indoor Air Quality in Your Home

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home. High temperature and humidity levels can also increase concentrations of some pollutants.

Pollutant Sources at home

1. Combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products
2. Building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products
3. Products for household cleaning and maintenance, personal care, or hobbies
4. Central heating and cooling systems and humidification devices
5. Outdoor sources such as radon, pesticides, and outdoor air pollution.

Amount of Ventilation

If too little outdoor air enters a home, pollutants can accumulate to levels that can pose health and comfort problems. Unless they are built with special mechanical means of ventilation, homes that are designed and constructed to minimize the amount of outdoor air that can "leak"

into and out of the home may have higher pollutant levels than other homes. However, because some weather conditions can drastically reduce the amount of outdoor air that enters a home, pollutants can build up even in homes that are normally considered "leaky."

Indoor Air Quality at Work

What Causes Problems?

Three major reasons for poor indoor air quality in office buildings are the presence of indoor air pollution sources; poorly designed, maintained, or operated ventilation systems; and uses of the building that were unanticipated or poorly planned for when the building was designed or renovated.

Sources of Office Air Pollution

As with homes, the most important factor influencing indoor air quality is the presence of pollutant sources. Commonly found office pollutants and their sources include environmental tobacco smoke; asbestos from insulating and fire-retardant building supplies; formaldehyde from pressed wood products; other organics from building materials, carpet, and other office furnishings, cleaning materials and activities, restroom air fresheners, paints, adhesives, copying machines, and photography and print shops; biological contaminants from dirty ventilation systems or water-damaged walls, ceilings, and carpets; and pesticides from pest management practices.

Ventilation Systems

Mechanical ventilation systems in large buildings are designed and operated not only to heat and cool the air, but also to draw in and circulate outdoor air. If they are poorly designed, operated, or maintained, however, ventilation systems can contribute to indoor air problems in several ways.

For example, problems arise when, in an effort to save energy, ventilation systems are not used to bring in adequate amounts of outdoor air. Inadequate ventilation also occurs if the air supply and return vents within each room are blocked or placed in such a way that outdoor air does not actually reach the breathing zone of building occupants. Improperly located outdoor air intake vents can also bring in air contaminated with automobile and truck exhaust, boiler emissions, fumes from dumpsters, or air vented from restrooms. Finally, ventilation systems can be a source of in door pollution themselves by spreading biological contaminants that have multiplied in cooling towers, humidifiers, dehumidifiers, air conditioners, or the inside surfaces of ventilation duct work.

Use of the Building

Indoor air pollutants can be circulated from portions of the building used for specialized purposes, such as restaurants, print shops, and dry-cleaning stores, into offices in the same building. Carbon monoxide and other components of automobile exhaust can be drawn from underground parking garages through stairwells and elevator shafts into office spaces.

In addition, buildings originally designed for one purpose may end up being converted to use as office space. If not properly modified during building renovations, the room partitions and ventilation system can contribute to indoor air quality problems by restricting air recirculation or by providing an inadequate supply of outdoor air.

What's the damage?

Health effects from indoor air pollutants may be experienced soon after exposure or, possibly, years later.

Immediate effects may show up after a single exposure or repeated exposures. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Symptoms of some diseases, including asthma, hypersensitivity pneumonitis, and humidifier fever, may also show up soon after exposure to some indoor air pollutants.

The likelihood of immediate reactions to indoor air pollutants depends on several factors. Age and preexisting medical conditions are two important influences. In other cases, whether a person reacts to a pollutant depends on individual sensitivity, which varies tremendously from person to person. Some people can become sensitized to biological pollutants after repeated exposures, and it appears that some people can become sensitized to chemical pollutants as well.

Certain immediate effects are similar to those from colds or other viral diseases, so it is often difficult to determine if the symptoms are a result of exposure to indoor air pollution. For this reason, it is important to pay attention to the time and place the symptoms occur. If the symptoms fade or go away when a person is away from the home and return when the person returns, an effort should be made to identify indoor air sources that may be possible causes. Some effects may be made worse by an inadequate supply of outdoor air or from the heating, cooling, or humidity conditions prevalent in the home.

Other health effects may show up either years after exposure has occurred or only after long or repeated periods of exposure. These effects, which include some respiratory diseases, heart disease, and cancer, can be severely debilitating or fatal. It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable.

How can I test for this?

The federal government recommends that you measure the level of radon in your home. Without measurements there is no way to tell whether radon is present because it is a colorless, odorless, radioactive gas. Inexpensive devices are available for measuring radon. EPA provides guidance as to risks associated with different levels of exposure and when the public should consider corrective action. There are specific mitigation techniques that have proven effective in reducing levels of radon in the home.

For pollutants other than radon, measurements are most appropriate when there are either health symptoms or signs of poor ventilation and specific sources or pollutants have been identified as possible causes of indoor air quality problems. Testing for many pollutants can be

expensive. Before monitoring your home for pollutants besides radon, consult your state or local health department or professionals who have experience in solving indoor air quality problems in non-industrial buildings.

Prevention

Source Control

Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, like those that contain asbestos, can be sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions. In many cases, source control is also a more cost-efficient approach to protecting indoor air quality than increasing ventilation because increasing ventilation can increase energy costs. Specific sources of indoor air pollution in your home are listed later in this section.

Ventilation Improvements

Another approach to lowering the concentrations of indoor air pollutants in your home is to increase the amount of outdoor air coming indoors. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Opening windows and doors, operating window or attic fans, when the weather permits, or running a window air conditioner with the vent control open increases the outdoor ventilation rate. Local bathroom or kitchen fans that exhaust outdoors remove contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate.

It is particularly important to take as many of these steps as possible while you are involved in short-term activities that can generate high levels of pollutants--for example, painting, paint stripping, heating with kerosene heaters, cooking, or engaging in maintenance and hobby activities such as welding, soldering, or sanding. You might also choose to do some of these activities outdoors, if you can and if weather permits.

Advanced designs of new homes are starting to feature mechanical systems that bring outdoor air into the home. Some of these designs include energy-efficient heat recovery ventilators (also known as air-to-air heat exchangers).

Air Cleaners

There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive table-top models to sophisticated and expensive whole-house systems. Some air cleaners are highly effective at particle removal, while others, including most table-top models, are much less so. Air cleaners are generally not designed to remove gaseous pollutants.

The effectiveness of an air cleaner depends on how well it collects pollutants from indoor air (expressed as a percentage efficiency rate) and how much air it draws through the cleaning or filtering element (expressed in cubic feet per minute). A very efficient collector with a low air-circulation rate will not be effective, nor will a cleaner with a high air-circulation rate but a less efficient collector. The long-term performance of any air cleaner depends on maintaining it according to the manufacturer's directions.

Another important factor in determining the effectiveness of an air cleaner is the strength of the pollutant source. Table-top air cleaners, in particular, may not remove satisfactory amounts of pollutants from strong nearby sources. People with a sensitivity to particular sources may find that air cleaners are helpful only in conjunction with concerted efforts to remove the source.

Over the past few years, there has been some publicity suggesting that houseplants have been shown to reduce levels of some chemicals in laboratory experiments. There is currently no evidence, however, that a reasonable number of houseplants remove significant quantities of pollutants in homes and offices. Indoor houseplants should not be over-watered because overly damp soil may promote the growth of microorganisms which can affect allergic individuals.

Hearing

Noise: The environmental agent

The average, otherwise healthy, person will have essentially normal hearing to at least age 60 if his or her unprotected ears are not exposed to high noise levels (i.e., levels above 85 dBA). According to the American National Standards Institute, at age 60, the median material hearing impairment is only 17 dB and 12 dB for males and females, respectively. Aging alone should not prevent the average person from enjoying normal hearing throughout all or most of his or her working career. Unfortunately, this is not the case for those who are occupationally exposed to high noise levels.

Noise is not a new hazard. It has been a constant threat since the industrial revolution. Too much noise exposure may cause a temporary change in hearing (your ears may feel stuffed up) or a temporary ringing in your ears (tinnitus). These short-term problems usually go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent, incurable hearing loss or tinnitus.

It is recommended to remove hazardous noise from the workplace and the home whenever possible and using hearing protectors in those situations where dangerous noise exposures have not yet been controlled or eliminated.

Just the facts

Estimates suggest that there are upwards of 5 million, perhaps as many as 30 million Americans occupationally exposed to noise levels greater than 85 dBA (NIDCD, 1999; Berger et al., 2000).

At present exposure limits, one in four of these workers will develop a permanent hearing loss as a result of trying to earn a living (Prince, et al., 1997). Many of whom will also develop tinnitus in addition to a hearing loss.

According to the National Institutes of Health, approximately one third of all hearing loss can be attributed to noise exposure, and “occupational hearing loss is the most common cause of noise-induced hearing loss.”

Noise-induced hearing loss is one of the most common occupational diseases and the second most self-reported occupational illness or injury. Industry specific studies reveal:

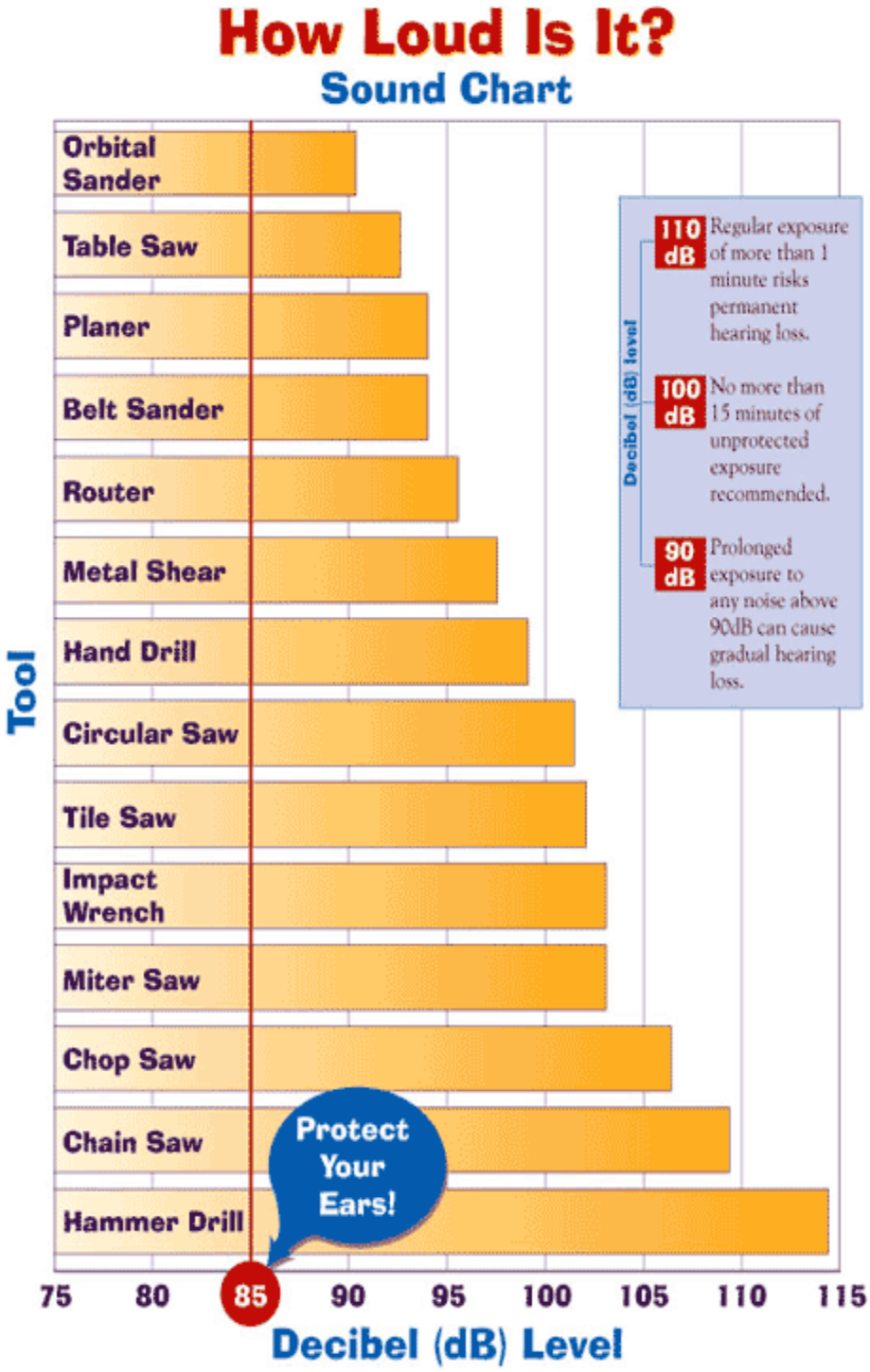
- 44% of carpenters and 48% of plumbers reported that they have perceived hearing loss.
- 49% of male, metal, non-metal miners will have a hearing impairment by age 50 (vs. 9% of the general population) rising to 70% by age 60.

While any worker can be at risk for noise-induced hearing loss in the workplace, workers in many industries have higher exposures to dangerous levels of noise. Industries with high numbers of exposed workers include: agriculture; mining; construction; manufacturing and utilities; transportation; and military.

What’s the damage?

Loud noises can cause hearing loss by damaging the delicate hair cells in the inner ear. As noise levels increase, the tiny cilia at the top of the hair cells can be injured or broken off. Entire groups of these hair cells can even be torn away. Hair cells don't repair themselves. So when enough hair cells are damaged, a hearing loss results.

Sound is measured in decibels. A normal conversation takes place at about 60 decibels. A woodshop noise level is about 100 decibels, and a chainsaw noise measures about 110 decibels, according to the National Institute on Deafness and Other Communication Disorders (NIDCD). A hand drill measures 98dB, a spray painter 105dB, a hammer drill 114dB, and a pneumatic percussion drill 119dB. Prolonged exposure to noise above 85 decibels can cause hearing loss. A short, intense sound—an explosion, for example— may cause immediate hearing loss. But usually hearing loss occurs gradually after prolonged exposure to loud noise. It may occur so gradually you may not even realize you are losing your hearing. Over time, sounds may simply become muffled or distorted. Look at the sound chart below for dB level of other noise.



Tinnitus, a ringing or roaring sound, sometimes described as the sound of crickets in one or both ears, can accompany both immediate and gradual hearing loss.

Tinnitus occurs when the damage to hair cells hasn't gotten to the point where they produce nothing, says Don Morgan, vice president of clinical research and medical affairs for Decibel Instruments, a Fremont, Calif.-based hearing aid research and manufacturing company. Rather, the hairs produce ongoing sounds because they are partially damaged. That is, they are constantly stimulated because they are irritated. The brain perceives this constant irritation as sound.

Hearing loss can be progressive if you continue exposing yourself to the same noise, Morgan says. Today you may have a minor or moderate hearing loss, but after further exposure, the loss may become more severe. However, once you stop the exposure, the hearing loss won't get worse.

Testing

To see if you may be in an environment that could cause hearing loss, ask yourself the following questions:

1. Is the noise at my workplace so loud that I have to raise my voice significantly for someone an arm's length away to hear me?

2. When I leave work and am in a quieter environment, do my ears feel plugged?

3. Do I hear a mild ringing or whooshing noise that goes away after an hour or two?

If you answer yes to either of these questions, take some sound advice: Get your hearing tested and protect your ears.

Anyone regularly exposed to hazardous noise should have a hearing test every year. Those who are not exposed to hazardous noise should have a hearing test every 3 years. Anyone who notices a change in his/her hearing should have a hearing test right away.

Prevention

Noise-induced hearing loss is fully preventable. But once acquired, it's permanent and irreversible. Employers and workers must take preventive measures to preserve and protect workers' hearing. We hope the information in this issue answers many of your questions about hearing loss and is useful to you in your hearing loss prevention efforts.

Removing hazardous noise from the workplace through engineering controls (e.g. installing a muffler or building an acoustic barrier) is the most effective way to prevent noise-induced hearing loss. Hearing protectors such as ear plugs and ear muffs should be used when it is not feasible to otherwise reduce noise to a safe level. NIOSH recommends hearing loss prevention programs for all workplaces with hazardous levels of noise. These programs should include noise assessments, engineering controls, audiometric monitoring of workers' hearing, appropriate use of hearing protectors, worker education, recordkeeping, and program evaluation.

Noise Controls

Control high pressure air noises

High pressure air used for cleaning, transporting, cooling, etc. can create an A-Weighted sound level exceeding 100 decibels, or exceeding 100 dB(A). You can control it two ways:

1. Reduce air pressure as much as possible. Most of the time workers use 90 pounds per square inch (PSI) of air to blow away chips when drilling, to clean a surface before painting, or to cool a hot spot in a process. But it's possible that 70-80 PSI would be acceptable. This simple change can reduce noise from 5-15 dB(A).

2. Use quiet designed air nozzles. Very often workers use crimped tubes or conventional air nozzles for supplying high pressure air. There are many low priced quiet air nozzles on the market that can significantly reduce noise. These nozzles, priced from $6-$70, can reduce noise from 5-20 dB(A).

Control air exhausts

Air exhausts from air cylinders, air motors, etc., can create noises of 95-105 dB(A). Pipe away the exhausts to a remote location. If possible, pipe the exhaust to a hollow member close to the exhaust port. If a hollow member is not available, pipe the exhaust to outside the building or to an unattended remote location. This method will virtually eliminate the exhaust noise. If there are multiple exhausts, adjust the piping to route it away.

Incorporate noise control when guarding equipment

When installing safety guards on your equipment, consider using Lexan instead of open guarding. You can achieve noise reductions in the 10-12 decibel B(A) range if you can block high frequency noise sources, such as lightweight part impacts, air noises, etc. The cost for noise control is minimal, yet noise control benefits are notable.

*See the Noise Reduction Ideas Bank in the resources section for more information.

Choosing Hearing Protection

Expandable foam plugs

These plugs are made of a formable material designed to expand and conform to the shape of each person's ear canal. Roll the expandable plugs into a thin, crease-free cylinder. Whether you roll plugs with thumb and fingers or across your palm doesn't matter. What's critical is the final result—a smooth tube thin enough so that about half the length will fit easily into your ear canal. Some individuals, especially women with small ear canals, have difficulty rolling typical plugs small enough to make them fit. A few manufacturers now offer a small size expandable plug.

Pre-molded, reusable plugs

Pre-molded plugs are made from silicone, plastic or rubber and are manufactured as either “one-size-fits-most” or are available in several sizes. Many pre-molded plugs are available in sizes for small, medium or large ear canals.

A critical tip about pre-molded plugs is that a person may need a different size plug for each ear. The plugs should seal the ear canal without being uncomfortable. This takes trial and error of the various sizes. Directions for fitting each model of pre-molded plug may differ slightly

depending on how many flanges they have and how the tip is shaped. Insert this type of plug by reaching over your head with one hand to pull up on your ear. Then use your other hand to insert the plug with a gentle rocking motion until you have sealed the ear canal.

Advantages of pre-molded plugs are that they are relatively inexpensive, reusable, washable, convenient to carry, and come in a variety of sizes. Nearly everyone can find a plug that will be comfortable and effective. In dirty or dusty environments, you don't need to handle or roll the tips.

Canal caps

Canal caps often resemble earplugs on a flexible plastic or metal band. The earplug tips of a canal cap may be a formable or pre-molded material. Some have headbands that can be worn over the head, behind the neck or under the chin. Newer models have jointed bands increasing the ability to properly seal the earplug.

The main advantage canal caps offer is convenience. When it's quiet, employees can leave the band hanging around their necks. They can quickly insert the plug tips when hazardous noise starts again. Some people find the pressure from the bands uncomfortable. Not all canal caps have tips that adequately block all types of noise. Generally, the canal caps tips that resemble stand-alone earplugs seem to block the most noise.

Earmuffs

Earmuffs come in many models designed to fit most people. They work to block out noise by completely covering the outer ear. Muffs can be "low profile" with small ear cups or large to hold extra materials for use in extreme noise. Some muffs also include electronic components to help users communicate or to block impulsive noises.

Workers who have heavy beards or sideburns or who wear glasses may find it difficult to get good protection from earmuffs. The hair and the temples of the glasses break the seal that the earmuff cushions make around the ear. For these workers, earplugs are best. Other potential drawbacks of earmuffs are that some people feel they can be hot and heavy in some environments.

Miscellaneous devices

Manufacturers are receptive to comments from hearing protection users. This has led to the development of new devices that are hybrids of the traditional types of hearing protectors. Because many people like the comfort of foam plugs, but don't want to roll them in dirty environments, a plug is now available that is essentially a foam tip on a stem. You insert this plug much like a pre-molded plug without rolling the foam.

Scientists are developing earmuffs using high-tech materials to reduce weight and bulk, but still effectively block noise. On the horizon may be earplugs with built in two-way communication capability.

Still, the best hearing protector is the one that is comfortable and convenient and that you will wear every time you are in an environment with hazardous noise.

See the Hearing Protector Device Compendium in the resources section for more information.

References

Environmental Protection Agency (2004). Indoor Air Publications. Accessed at http://www.epa.gov/iaq/pubs/insidest.html.

NIOSH (2004). Noise and Hearing Loss Prevention. Accessed at http://www.cdc.gov/niosh/topics/noise/default.html.

NIDCD (2004). Wise ears at work. Accessed at http://www.nidcd.nih.gov/health/wise/wiseears_atwork.asp.

Resources

INDOOR AIR QUALITY - Information Clearinghouse (IAQ INFO)
P.O. Box 37133
Washington, DC 20013-7133
(800) 438-4318; (703) 356-4020
(fax) 703-356-5386 or e-mail: iaqinfo@aol.com
Operates Monday to Friday from 9a.m. to 5p.m. Eastern Standard Time (EST). Distributes EPA publications, answers questions on the phone, and makes referrals to other nonprofit and governmental organizations.

Noise Reduction Ideas Bank
http://www.lni.wa.gov/Safety/Topics/ReduceHazards/NoiseBank/search.asp

Hearing Protector Device Compendium
http://www2a.cdc.gov/hp-devices/hp_srchpg01.asp