Using Hearing Protectors in the Real World

With Such Big NRRs, Why are People Losing Hearing?

The previous article on hearing protectors, “The noise reduction rating - fact and fiction,” discussed the discrepancies between the NRR and the attenuation that workers actually receive on the job. In general, the attenuation realized in the field is only about one-half to one-third of the laboratory values on which the NRR is based and the field attenuation varies quite a bit both among individual users and among protectors.

As a rule, ear muffs tend to give somewhat more attenuation than ear plugs because they are more easily sized and fitted and they do not need to be carefully inserted into the ear canal. Also, both types of protectors provide considerably less attenuation for low frequency sound than they do for the high frequencies. Thus, the high-pitched noise of aluminum sawing, for example, may be more easily attenuated than the rumble of a locomotive engine, even though they may both be at approximately the same overall sound level.

But there are many more reasons why hearing protectors may give less noise reduction in the workplace than their laboratory-based NRR would indicate.

The Laboratory Provides “Ideal” Conditions

Laboratory testing of hearing protector attenuation is done according to a predetermined protocol set forth in ANSI standard S12.6-1984 or S3.19-1974. The subjects are trained listeners, most of whom have performed the test many times. They insert the plugs or don the muffs under the close supervision of a laboratory experimenter. Protectors are sized correctly and, of course, they are new and in good condition. The subjects insert the plugs deeply into the ear canal. If a muff’s headband is uncomfortably tight, they usually ignore it. They can put up with some discomfort for the limited duration of the test. These procedures are followed to try to provide uniform testing so products can be compared.

Workplace Conditions are the Real World

In the workplace, employees must wear hearing protectors for extended periods, often for the whole day, so comfort becomes a vitally important factor. If a protector is uncomfortable, it will be worn loosely, or possibly not at all. In addition, workers put on and take off their protectors without benefit of a laboratory experimenter, and usually without any supervision at all. Ear protectors that are improperly inserted or fit loosely are likely to develop leaks through which the noise can easily enter the ear canal. Consequently, the protector’s attenuation is greatly reduced.

There are many reasons why protectors will develop attenuation leaks when they are worn on the job. Here are the major ones:

1. Improper sizing. Ear plugs sometimes come in several sizes. It is important to offer all sizes and to pick the correct size. Wearers tend to fit plugs too loosely, causing gaps between the plug and the ear canal, or too tightly, causing a comfort problem, which can result in plugs that are worn in the pocket rather than in the ear. In some cases, the same individual will have two differently-sized ear canals, so each ear should be sized separately.

2. Faulty insertion. This is probably the most common reason for attenuation leaks in ear plugs. Most users have had little or no training in inserting ear plugs, so they may not know how to do it properly. Also, unlike the laboratory situation, users tend to insert the plugs loosely if they know that they must wear them for long periods of time.

3. Compatibility problems. Hearing protection often needs to be worn with other types of protective gear, such as helmets and safety glasses. Ear muffs are incompatible with helmets unless they are specially mounted on the helmet. Temple bars of safety glasses can break the seal of ear muff cushions,
allowing noise to leak into the ear. The small pads through which certain temple bars may be inserted will certainly improve the worker’s comfort, but the muff’s attenuation will still be somewhat reduced. In addition to safety equipment, long hair, beards, and large earrings can interfere with the seal of ear muff cushions.

4. Communication. Workers will often remove their hearing protectors or loosen them so that they can communicate with each other, hear warning signals, or hear the sounds of their machines. Safety and health professionals will point out that the protector will attenuate both the desired signal and the unwanted noise by the same amount, so one need not remove or loosen the protector. Although this is theoretically true, most protectors do change the nature of sounds (by changing the frequency spectrum) because they attenuate the high frequencies more than the low frequencies. In addition, workers who already have a noise-induced hearing loss will have a more difficult time hearing the desired sounds when they wear protectors, giving them another reason to loosen their protectors and let them leak. Because of this, a hearing protector with the highest NRR may not give the best overall protection.

5. Wear and tear. Nothing lasts forever, and that applies to ear muffs as well as ear plugs. Although the foam plugs are reusable for a few wearings, they will begin to be less flexible, no longer molding nicely to the ear canal, and will develop attenuation leaks. Pre-molded and custom-molded plugs will shrink with age, and some will crack, becoming brittle and less malleable. Ear muff headbands may lose their tension, the ear cups may no longer fit securely, and the cushions may deteriorate with age, becoming brittle and no longer conforming to the head. Some premolded ear plugs may need replacing in just a few weeks if the wearer develops a considerable amount of ear wax or perspiration. In any case, protectors should be checked at least every six months.

6. User modification. Sometimes workers will become creative in their treatment of ear protectors, to the detriment of the protector’s attenuation. To improve comfort without changing the protector’s appearance at a distance, workers may cut the flanges of a pre-molded plug or cut a foam plug across its diameter. In this way the plug may hardly be inserted at all, and yet it will still appear to be in the ear canal. Muffs may be modified by springing the headband. Or they can be “personalized” by drilling holes in the form of one’s initials into ear cups. In both instances, considerable attenuation will be lost.

Such activities as chewing gum, talking, and moving around could also be included in the category of normal wear and tear. These activities can loosen the fit of hearing protectors and lead to the development of attenuation leaks. Thus it is a good idea for the wearer to be aware of this possibility and to check the protector’s fit periodically. Plugs need not be removed and reinserted, but rather pushed somewhat deeper into the canal as necessary.

Despite this laundry list of problems, ear protectors can be worn comfortably and effectively on the job. This condition is realized when employers as well as employees are well trained in all aspects of these devices and use them conscientiously.

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Measuring the Attenuation of Hearing Protectors in the Workplace

The ideal way to measure hearing protector attenuation in the workplace is to use methods and equipment that resemble the laboratory attenuation test. Such methods have been used in several field experiments of ear plug attenuation, but the equipment is not yet commercially available and the methods are not standardized. Just to get a good idea of on-the-job attenuation, however, employers or hearing conservation professionals may use commercially-available noise-reducing earphone enclosures (large, dome-shaped earphones) or even conventional supra-aural headsets (the kind that accompany audiometers).

Those who use this method should keep in mind that the test could be influenced somewhat if the ear plug’s stem or other external part should come in contact with the earphone’s receiver, its sound transmitting part. There are two types of noise-reducing earphone enclosures, the “Audiomate” and the “Madsen ME-70,” in which the earphone is slightly recessed, which may lessen the chance of interference by a protruding ear plug.

The way to test ear plug attenuation on the job is to approach a worker, unannounced, during the work shift and hand the worker a sign that says “Please don’t touch your ear plugs” and “Follow me.” Then take him or her to the audiometric test room or booth and proceed to test the hearing with the plugs in place. After that, instruct the worker to remove the plugs and conduct another audiometric test. The difference between the two audiograms represents the amount of attenuation that the plug is providing at each test frequency. Usually it is necessary to test only a few frequencies in each ear, such as 500, 1000, and 2000 Hz. It is always a good idea to follow these sessions with some counseling, indicating to the worker whether or not adequate attenuation is occurring, and, if the attenuation is inadequate, providing advice on how to improve it.

Another useful procedure is to give a group of workers an audiometric test before the beginning of the work shift and again at the end of the shift. If the hearing threshold levels in certain workers show a deterioration in the second test, then the hearing protectors are not providing sufficient attenuation or perhaps they are not even being worn. Counselling, refitting, and retraining should improve the situation, and the tests may be repeated at a later date.

The attenuation of ear muffs can also be tested in the field, but the procedure is a bit more complicated. It requires the use of two dosimeters with the smallest possible microphones. One of the microphones is worn on the worker’s shoulder and the other is placed carefully inside the ear muff. At the end of the work shift the two dosimetric readings are compared, converted to time-weighted average exposure level in decibels (TWA). The difference between the two readings is the attenuation provided by the muff. This procedure should be carried out by someone who is trained in the use of this kind of instrumentation.

The Development of a New ANSI Standard

At this time professionals in hearing conservation are working on the development of a new ANSI standard. ANSI Standard S12 Working Group 11 is attempting to develop a laboratory standard that will more closely approximate the use of hearing protection in the real world. Several laboratories are working together on important issues, such as the selection and training of subjects and the supervision of hearing protector fitting. Because this kind of consensus standardization usually takes years to accomplish, a new standard may not be available for quite some time. But there is some promise that the gap between the NRR and the attenuation realized in the field may be narrowed.