

## Responses to Questions and Complaints Regarding Hearing and Hearing Protection (Part II)

BY ELLIOTT H. BERGER  
Senior Scientist, Auditory Research

In this EARLog we continue the dialogue that was begun in EARLog #8<sup>1</sup>, by presenting additional information to assist hearing conservation administrators in formulating responses to questions, complaints, and excuses regarding the use of hearing protection devices (HPDs).

**Question:**

Can hearing protectors cause headaches, nosebleed, ulcers, insomnia or eyestrain?

**Response:**

Headaches may be caused by an HPD (primarily circumaural devices) that fits too tightly, or is in some other way uncomfortable. The HPD should be resized, refitted or another device issued.

There are no known medical or physiological reasons why HPDs should be suspected of causing any of the remaining maladies listed above<sup>2</sup>. However, when an employee voices such complaints, this indicates dissatisfaction with the HPD he is wearing, a misunderstanding of the need for its use, or a real health problem that has been mistakenly attributed to the use of the HPD. The best response will be a patient and accurate assessment of the situation and determination of the actual cause of the disorder.

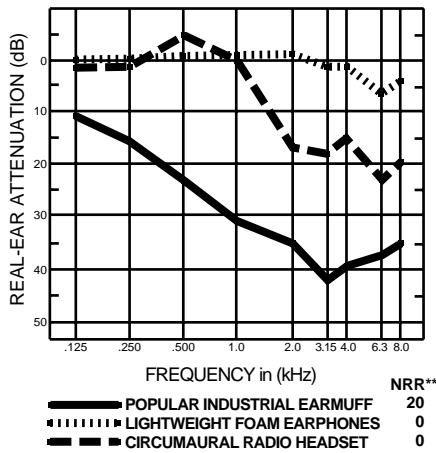
**Question:**

Can I use stereo earphones for protection against noise and enjoy the music at the same time?

**Response:**

In Figure 1 we have plotted the attenuation of a circumaural radio headset and also of a more popular set of lightweight foam supra-aural stereo earphones. The foam earphones offer almost no protection. Even the circumaural device pro-

**ATTENUATION OF RECREATIONAL EARPHONES VS. A POPULAR INDUSTRIAL EARMUFF\***



\*All data from E+A\*RCAL<sup>SM</sup> Acoustical Laboratory.  
\*\*Noise Reduction Rating per U.S. EPA

Figure 1

vides no more than approximately 20 dB of attenuation at high frequencies, and actually significantly amplifies sounds at some frequencies. This protection is inferior to that of a well designed, properly fitted HPD. Furthermore, these devices alone, can generate equivalent noise exposures up to approximately 100 dBA<sup>3</sup>.

Since these devices offer so little attenuation, a greater concern is that employees might turn up the music to mask (i.e., "drown out") the factory noise. Products are available which have been specifically designed to offer adequate protection and at the same time play music or transmit voice communications. Although generally expensive, such devices are suitable for use, especially when they have built-in signal limiting circuitry so that they are not capable of presenting hazardous sounds to the ear.

**Excuse:**

I don't need to worry about losing my hearing since I can always get a hearing aid.

**Response:**

Although eyeglasses can in most cases correct a vision problem to a nearly normal condition, it is a misconception that hearing aids can do likewise for a noise induced hearing loss. Correctable vision problems generally result from ocular distortions and not the loss of the optic nerve cells, whereas noise damage is due to destruction of the nerve (hair) cells in the cochlea that enable us to hear. Hearing aids can restore the ability to detect and discriminate sounds to a certain extent, but when insufficient hair cells are present to receive the amplified sounds that the aid provides, the results are not fully satisfactory...and if wearing an HPD 8 hours/day is objectionable, will it be any more acceptable to wear a hearing aid (which feeds sound into the ear through an earplug like device) for all of one's waking hours?

**Question:**

Isn't it important to wear earmuffs rather than earplugs at high sound levels, since at such intensities the sound transmits directly through the bones of the skull and can bypass an earplug?

**Response:**

Sound transmission around an HPD via bone conduction is present regardless of sound level and limits the maximum attenuation that a perfect hearing protector can provide to about 50 dB<sup>4,5</sup>. It may be compared to keeping the light out of a dark closet by shutting its colored glass door. Light enters through the open doorway as does sound through the open ear canal. Shutting the door is akin to putting on an HPD, with more heavily tinted glass representing a better protector. Light passing through the keyhole is analogous to the bone conducted sound. It will control the illumination of the closet if the glass door is very dark or opaque. When the glass is less tinted or even clear, however, the keyhole light is insignificant.

As the illumination outside the closet increases, additional light enters the keyhole, but the ratio of the keyhole light to the light passing through the door remains constant.

Similarly, bone conduction is insignificant compared to normal air conduction unless the HPD's attenuation approaches the 50 dB limitation imposed by bone vibration, a limitation which is constant regardless of sound level. Thus, if a muff or a plug offers bone conduction limited protection at a low sound level, the same will hold true at a high sound level.

Since the areas of the skull around the external ear are only a small portion of the total bone conduction mechanism, covering them with an earmuff is of small significance, perhaps 3-4 dB in the 1-2 kHz region<sup>5</sup>. Thus the relative performance of plugs compared to muffs is not, in practice, determined by the bone conduction paths but by factors inherent in the design of the HPDs and their interface to the head. In fact, a well designed insert such as a foam earplug, can offer attenuation comparable to or exceeding that of earmuffs at most frequencies.

**Question:**

Since my entire head is affected by the sound and can transmit energy to my inner ear, does a hard hat, which covers part of my skull, reduce the bone conduction?

**Response:**

In order to block the sound and reduce the bone vibration, it would be necessary to wear a completely rigid helmet with a face plate that formed a virtual airtight enclosure about the head. A hard hat, which covers only part of the head and has many gaps through which the acoustical energy can penetrate, is of little value in reducing the ear's response to the bone conducted sound.

**Question:**

Are your hearing protectors either ANSI or OSHA approved?

**Response:**

ANSI does not approve hearing protectors. The ANSI standard, S3.19-1974,

Table 1

SELECTED FEDERAL AND NATIONAL AGENCIES RESPONSIBLE FOR DOCUMENTS RELATING TO NOISE
<b>ANSI</b> American National Standards Institute
<b>ASTM</b> American Society for Testing and Materials
<b>EPA</b> Environmental Protection Agency
<b>MSHA</b> Mine Safety and Health Administration
<b>NIOSH</b> National Institute for Occupational Safety and Health
<b>OSHA</b> Occupational Safety and Health Administration

describes how to measure the attenuation of HPDs. Testing a device by the methods of that standard in no way confers any approval or attributes any particular degree of quality to the device. It simply characterizes the laboratory attenuation of the protector, however good or bad that may be. In addition, no federal or state agencies or other U.S. standards writing organizations (see Table 1) approve or disapprove of particular HPDs, although the EPA currently requires labeling of HPD packaging<sup>6</sup>.

The only other agency with a hearing protection related regulation is OSHA, whose Hearing Conservation Amendment<sup>7</sup> requires the HPDs that are used reduce an employee's 8 hour time weighted average noise exposure to 90 dBA or less, and in the case of employees demonstrating significant threshold shifts, to 85 dBA or less. The method for assessing the amount of reduction to be expected from HPDs is outlined in Appendix B of the amendment.

**Question:**

Can I hurt my eardrum if I insert a plug too deeply or remove it too quickly?

**Response:**

The sensitivity of the adult ear canal to pressure or pain increases significantly as the eardrum is approached. The discomfort experienced due to touching these deeper portions of the canal will alert the user to stop pushing on the plug before the device reaches the eardrum<sup>8</sup>.

Furthermore, the design of most inserts will prevent inserting them the length required (about 22 mm) to touch the eardrum. A more likely problem is earwax impaction, which can result from the insertion of earplugs, particularly of the pre-molded variety. For this reason, the person fitting earplugs should visually examine the ear canal up to the depth that the plug will be inserted. Persons with chronic earwax impaction problems should consider using semi-aural or circumaural HPDs.

For plugs that create an airtight seal, such as pre-molded inserts, rapid removal can be painful and potentially damaging to the eardrum. The plugs should be removed with a slow twisting motion to gradually break the seal as they are extracted from the ear. With foam and fibrous plugs, which do not create a pneumatic seal (and hence cause less of a blocked-up feeling), there is little possibility of generating a sudden large pressure change upon rapid removal, and thus virtually no likelihood of damaging or rupturing the eardrum.

In EARLog #10 we will conclude this dialogue portion of the EARLog series.

**References and Footnotes**

- Berger, E.H. - The EARLog Series, is available upon request from Aearo Company.
- Council for Accreditation in Occupational Hearing Conservation (1978). *CAOHC Manual*, edited by M.H. Miller. Fischler's Printing, Cherry Hill, NJ.
- E-A-RCAL<sup>SM</sup> Laboratory Internal Research Notes, N2719 49.
- Berger, E.H. (1980). EARLog #5 - Hearing Protector Performance: How They Work - and - What Goes Wrong in the Real World, available upon request from Aearo Company.
- Berger, E.H. and Kerivan, J.E. (1982). "A Rigorous Examination of the Real-Ear Attenuation at Threshold Method (125 Hz-2kHz)," *J. Acoust. Soc. Am. Suppl.* 1, Vol. 71, S52.
- EPA (1979). Noise Labeling Requirements for Hearing Protectors, Federal Register, Vol. 42, No. 190, 40 CFR Part 211, 56139-56147. NOTE - Regulation currently unenforced due to EPA budget and manpower reductions.
- OSHA (1983). Occupational Noise Exposure; Hearing Conservation Amendment. Federal Register, Vol. 48, No. 46, 9738-9783.
- Gasaway, D.C. (1982). Personal communication based upon 22 years of experience supervising the USAF hearing conservation program, during which time there was not a single verifiable incident of eardrum damage due to HPD usage.

