

QuickFit Earplug Test Device

Objective

To improve the level of hearing protection by providing workers with an inexpensive, easy-to-use device to check earplug fit.

Background

Approximately 30 million workers are exposed to hazardous noise on the job, placing them at risk of permanent hearing loss, tinnitus, and other disorders. Although the preferred solution is to eliminate noise through engineering controls or to reduce noise exposure through administrative controls, hearing protectors are critical when noise is unavoidable.

Studies of hearing protector users have shown that average protection values in the real world are much lower than the labeled noise reduction ratings determined in laboratories with trained and motivated subjects. Even worse, many hearing protector users get virtually no protection at all because of poor fit. The studies also show that users have a harder time achieving adequate protection levels with earplugs than with earmuffs. It's difficult for users to tell if earplugs are working well just by looking at them. A more accurate approach is to check how much they block or "attenuate" noise. Earplugs vary in their attenuation characteristics, with most providing a maximum of 20–35 decibels of noise reduction when worn correctly. Any earplug that's suitable for use in noisy settings will attenuate noise by at least 15 decibels.

Personal fit testing is an effective way to help hearing protector users improve the fit and protection levels of the devices. However, existing fit-testing systems are expensive and unsuitable for use at many industrial worksites.

Approach

To offer a simpler, more affordable fit-testing device, the National Institute for Occupational Safety and Health (NIOSH) developed the QuickFit. The key innovations of the device are its low cost and simple operation. Low cost is achieved by using off-the-shelf MP3 player components (along with a few inexpensive secondary parts) and housing them in a standard earmuff shell. Simple operation was achieved by limiting the test to a single critical test signal and a single "go" or "no-go"

pushbutton operation that checks for at least 15 decibels of protection. Figure 1 shows how the MP3 player and other components are configured in the QuickFit design, while Figure 2 shows the assembled prototype.

The QuickFit procedure is a highly simplified variation of the standard hearing protector evaluation specified in ANSI Standard S12.6. The QuickFit tests only one octave band centered at 1000 Hz, i.e., a digital bandpass filter was used to process a sample of random noise, limiting the band to the region from 500 Hz to 2000 Hz. Using just a single test frequency saves time and serves the purpose of checking for adequate fit since well-fit hearing protectors will have good attenuation on all frequencies. The test signal was then processed to pulse at ½-second intervals.

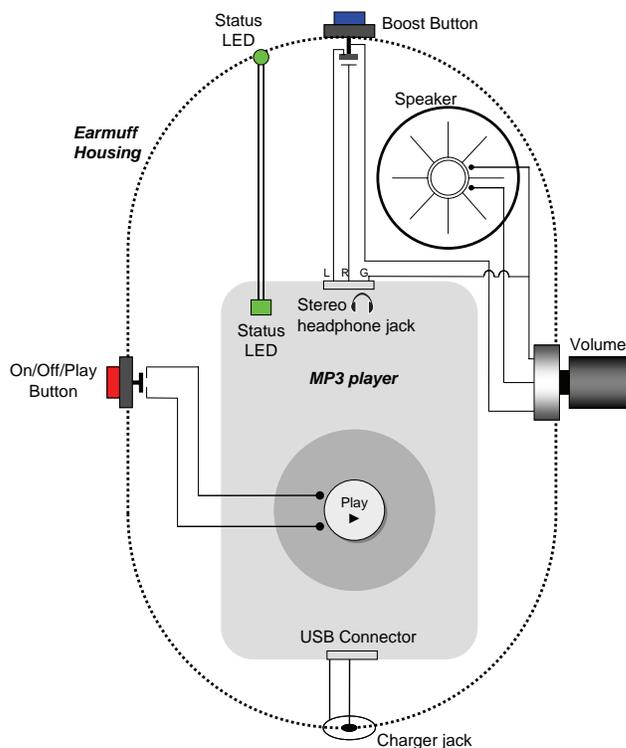


Figure 1.—Diagram of components and circuits in the NIOSH QuickFit prototype. All components fit easily within a housing based on a hearing protection earmuff.



Figure 2.—Assembled prototype of the QuickFit device.

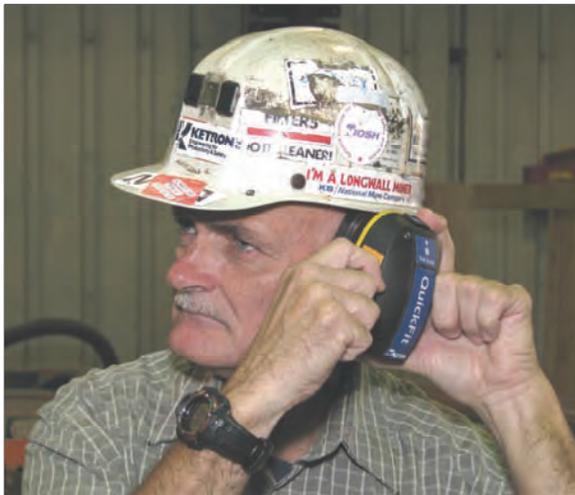


Figure 3.—Worker adjusting the volume control on the QuickFit device to set his hearing threshold before inserting an earplug.

The QuickFit also streamlines testing by checking for just one attenuation value: 15 decibels. If a protector is poorly fitted, it will usually provide far less than 15 decibels of attenuation. Protectors suitable for noisy environments are generally rated to provide at least 20 decibels of attenuation, so they should completely block a sound just 15 decibels over the user's hearing threshold. The 15-decibel boost in the QuickFit device is achieved by storing the test signal at two different levels in the left and right channels of the digital sound file. The right channel is recorded at a level 15 decibels higher than the left channel and is switched on by pressing the "boost" button.

The device works by comparing two "threshold" tests—one without hearing protection and one with an earplug inserted. To use QuickFit, the user first turns on the device by pressing the power button. The device will automatically play the test sound (a pulsing random noise that sounds like "whooshing" to most people). The device is then placed over the ear to be tested, and the user adjusts the volume control until the sound is right on the edge between audible and too quiet to hear (Figure 3). That sound level approximates the "threshold of hearing." Next, the

user sets the device aside and inserts an earplug following the NIOSH Roll-Pull-Hold method or other technique suitable to the specific plug being worn (<http://www.cdc.gov/niosh/mining/topics/hearingloss/earplug.htm>). The user then places the QuickFit against the protected ear while pressing the "boost" button. If the boosted test sound cannot be heard through the earplug, the user passes the test and has attained at least 15 decibels of protection. If, however, the test sound is still audible through the plug, the user has failed and should refit the plug or try a different type, followed by a retest with the QuickFit.

Related Developments

A Web-based variation on the QuickFit concept is available online as QuickFitWeb for users who have access to a computer and the Internet. It uses the same test sounds as QuickFit except that the sounds are played through the user's computer speakers. QuickFitWeb is available on the NIOSH Web site at: <http://www.cdc.gov/niosh/mining/topics/hearingloss/quickfitweb.htm>. The site also contains MP3 files that can be downloaded to a portable music player equipped with headphones to perform the QuickFit procedure.

Recommendations

Noise-induced hearing loss is 100% preventable, but once acquired it is permanent and life-altering. Individual fit testing of hearing protectors is a recommended "best practice" by the National Hearing Conservation Association's Alliance Program with NIOSH and the Occupational Safety and Health Administration (see http://www.hearingconservation.org/docs/AllianceRecommendationForFitTesting_Final.pdf). The QuickFit products are tools for workers to ensure that their hearing protection is actually working and preventing hearing loss. Manufacturers and other entities interested in disseminating the QuickFit technologies are encouraged to contact the NIOSH developers for partnership opportunities.

For More Information

Publications on hearing loss prevention in the mining industry can be downloaded from the NIOSH Mining Web site at: <http://www.cdc.gov/niosh/mining/pubs/programareapubs14.htm>. General information about noise and hearing loss is available at: <http://www.cdc.gov/niosh/topics/noise>.

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To receive NIOSH documents or for more information about occupational safety and health topics, contact: **1-800-CDC-INFO** (1-800-232-4636), **1-888-232-6348 (TTY)**, e-mail: cdcinfo@cdc.gov, or visit the NIOSH Web site at <http://www.cdc.gov/niosh>

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