How Hearing Protector Fit Testing Is Transforming Hearing Conservation

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

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Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

The adoption of individual hearing protector fit testing is steadily gaining traction in industry as a powerful tool for helping to improve occupational hearing conservation programs. The driving force behind this growing trend is the ability to accurately estimate the attenuation a given hearing protector provides for an individual, in contrast to the traditional approach of relying solely on single number ratings, such as the noise reduction rating (NRR) used in the U.S. or single number rating (SNR) used in Europe. The benefits of hearing protector fit testing are being realized by employers and employees alike, and fit testing has become a recommended best practice in hearing loss prevention. This article describes the recent evolution of hearing protection fit testing, and the use of these systems and their adoption by industry, regulators and health advocacy groups.

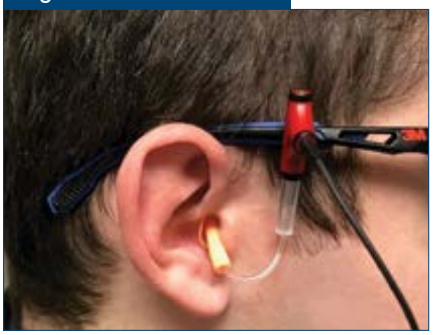
What Is Hearing Protector Fit Testing?

Personal hearing protector fit testing, also known as field attenuation estimation systems (FAES), is the measurement of the amount of noise reduction, or attenuation, a hearing protector provides while it is being worn by a specific individual. This real-world measurement is referred to as a personal attenuation rating (PAR). The purpose of hearing protector fit testing is to validate that the attenuation provided by a specific hearing protector model is adequate for the individual based on how it fits with their own ear canal geometry and their level of workplace noise exposure.

Why Is Fit Testing Needed?

Until recently, the most practical way for employers to quantify the amount of noise reduction a hearing protector provided to an individual in the workplace, as required by many regulatory agencies globally, was to use an SNR based on a laboratory test. Examples include the NRR used in the U.S., SNR used in Europe, and the sound level conversion (SLC80) used in Australia and New Zealand. However, more recently studies have shown that

Figure 1

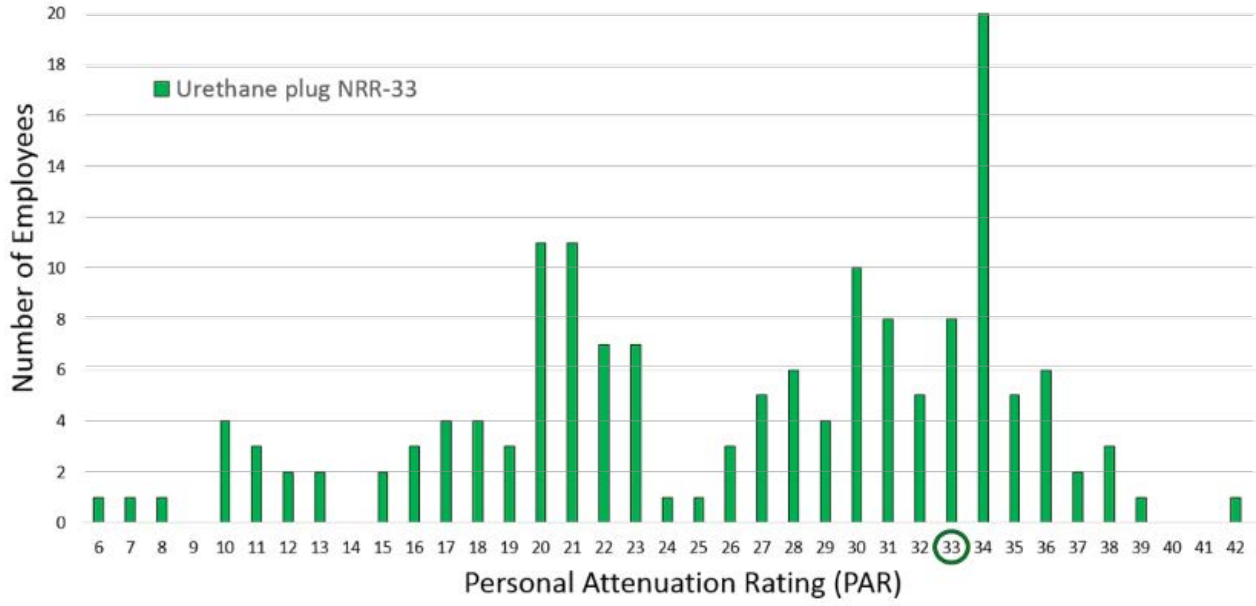


3M™ E-A-Rfit™ Dual Ear Validation System.

Figure 2

NIOSH HPD Well-fit™.

Figure 3



Real-world fit variability.

although these ratings may be a simple and convenient way to select hearing protectors, they are not always good at predicting the attenuation individuals will receive when using the hearing protector in the workplace. Evidence shows that there can be a large range in attenuation achieved by individuals in the workplace for the same model of hearing protector.

A 2008 study showed the wide distribution of PARs in a population of workers. Some workers received more attenuation than the NRR would predict, while others received much less (Fig. 3).[2]

The main sources of this variability include individual differences in training and proficiency at inserting hearing protectors properly. A 2013 study found that of 327 experienced users tested, 17% had to be re-trained before achieving an adequate fit (Fig. 4).[2] Another key source of fit variability is due to differences in individual ear canal size (too big or too small) or shape (sharp bends), such that those workers need to switch to a different model before achieving an adequate fit.

How Does Hearing Protector Fit Testing Work?

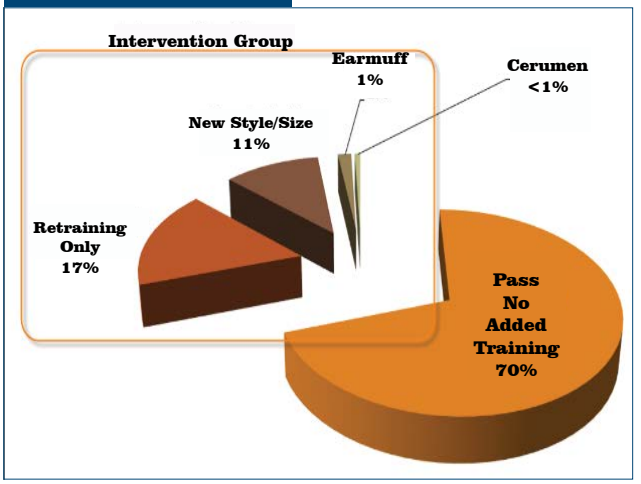
There are a variety of FAES technologies available on the market. They all compare sound levels just outside the hearing protector to sound levels just inside the hearing protector. The difference between these two sound levels is used to compute the amount of noise attenuation the hearing protector is providing. The final computed result is referred to as the PAR. There are three available fit testing technologies.

Field-REAT (subjective) — Field-REAT (Real Ear Attenuation at Threshold) is similar to audiometric hearing testing. The threshold at which the subject can just begin to hear a test signal is measured with and without the hearing protector. Because this system relies on feedback from the test subject, each frequency and each ear must be tested sequentially. And audibility thresholds must be measured in a quiet environment. The NIOSH HPD Well-Fit™ system (commercialized as FitCheck Solo™ by Michael and Associates) uses Field-REAT technology.

Loudness Balancing (subjective) — Loudness balancing is similar to Field-REAT in that it relies on feedback from the test subject. But instead of measuring the threshold of audibility, the subject is asked to indicate when the test signals are perceived to be balanced between the right ear and left ear. Since loudness balancing is not audibility thresholds, it can be conducted with more background noise than Field-REAT. Honeywell's Varipro™ system uses this technology

Field Microphone in Real Ear (objective) — Field microphone-in-real-ear (F-MIRE) consists of a dual-element microphone assembly that attaches to specially probed hearing protectors to allow measurement of the sound level inside the test subject's ear canal while the hearing protector is worn. As the subject

Figure 4



Initial fit test results.

is exposed to a test signal, the sound level just inside the hearing protector is simultaneously compared to the sound level just outside the hearing protector, as measured by the external microphone.

F-MIRE is considered an objective measurement system since it does not depend on a response from the test subject. This allows both ears to be tested across seven frequencies simultaneously in just a few seconds. It also allows for normal background noise (up to 85 dB) to be present during the testing as compared to subjective FAES systems, which require quieter test environments. F-MIRE systems can also test earmuffs. The 3M™ E-A-Rfit™ Dual Ear Validation System uses F-MIRE technology.

What Is a PAR?

The PAR for a given hearing protector is the noise attenuation achieved by the individual for whom it has been measured. In simple terms, it is the difference in decibels between the sound levels on the inside of the hearing protector and just outside the hearing protector. As compared to the laboratory-derived NRR rating, which requires that the average attenuation be calculated based on a group of test subjects, PARs tell us how much attenuation a particular hearing protector model is providing when fitted in the actual user's ear, by the actual user.

Research Supports Hearing Protector Fit Testing

Recent research shows many advantages to hearing protector fit testing, including:

1. A reduced likelihood of hearing loss. A study titled "A Mixed-Methods Assessment of Hearing Conservation Program Effectiveness"[3] looked at a company's expenditures for different aspects of its Hearing Conservation Program (HCP) at 13 different facilities. They found that the four facilities which implemented hearing protector fit testing had significantly lower rates of age-corrected hearing loss (STS). The authors concluded: "Fit testing — a best practice not required by any current HCP regulation — may be a high-impact expense, i.e., one that can result in an outsized reduction in NIHL. A variety of fit-testing technologies ... appear to be becoming more integrated into hearing conservation programs that are based on best practices, rather than simple compliance with OSHA regulations."[3]
2. Improved use of hearing protectors. A 2015 study of offshore oil rig inspectors found that 40% of workers were not getting sufficient attenuation on the initial fit test. Without the PAR results, these workers would not have been identified as being at risk for developing noise-induced hearing loss (NIHL). The authors concluded that the labeled NRR has little predictive value in determining the level of noise reduction a worker receives: "Forty percent or more of the workers were not getting sufficient attenuation from their hearing protectors. Through training and re-fitting, NIOSH was able to help 85% or more of the workers receive the appropriate amount of noise reduction. Without fit testing, nearly half of the oil rig inspectors would have been at risk for developing noise-induced hearing loss from their job exposures."[5]
3. Ability to evaluate attenuation when combined with other personal protective equipment (PPE). When using earmuffs, any interference with the seal of the cushion to the head can reduce the attenuation. This can be caused by a variety of objects, such as baseball caps, hair nets, the temples of safety eyewear and other types of obstructions. Fit testing earmuffs can be done while wearing the usual combination of PPE to help identify causes of sound leakage and troubleshoot options to ensure the worker is adequately protected. A study done in 2016 concluded that: "Earmuffs are often selected as the preferred type of hearing protector due to ease of use and durability. On the other hand, earmuffs are more susceptible than earplugs to the interference and compatibility issues provided by other PPE when worn with earmuffs."[6]

Key Benefits of Fit Testing

Why implement hearing protector fit testing? Incorporating fit testing into an HCP can offer a multitude of benefits. For example, conducting hearing fit testing helps employers to:

1. Identify workers with poorly fitting hearing protectors before they develop hearing loss.
2. Create a unique training opportunity where employees can experience how correctly fitting hearing protectors impacts protection:
   - PAR results are seen immediately following test.
   - One-on-one training targets the specific fitting issues observed.
   - PAR improvements are seen immediately after re-training and re-inserting the earplug correctly.
   - Workers can feel and hear the difference when their hearing protectors are properly inserted.
3. Refine hearing protector selection based on individually validated protection levels.
4. Supplement hearing loss intervention strategies by helping to ensure employees with hearing shifts are properly trained and protected.
5. Implement a proactive, best practices approach to hearing loss prevention.

A New ANSI/ASA Standard for Hearing Protector Fit Testing

ANSI/ASA S12.71-2018 is a voluntary consensus standard titled "American National Standard Performance Criteria for Systems that Estimate the Attenuation of Passive Hearing Protectors for Individual Users." It is the first standard to establish criteria that hearing protection fit test systems should meet to ensure accurate measurements and transparent reporting of results. A central component of this standard is that fit test system results must be benchmarked against the laboratory "gold standard," the Real Ear Attenuation at Threshold (REAT) method, which is the test method required by the U.S. Environmental Protection Agency (EPA) for establishing NRR.

OSHA, NIOSH and NHCA Recommend Fit Testing as a Best Practice

The use of hearing protector fit testing is a recommended best practice by:

- U.S. Occupational Safety and Health Administration (OSHA).
- National Institute of Occupational Safety and Health (NIOSH).
- National Hearing Conservation Association (NHCA).

According to the Best Practice Bulletin from the OSHA, NIOSH and NHCA Alliance: "Research studies have suggested that when individuals are involved in the fitting process and receive positive feedback on the proper fit of their earplug, they will be more likely to have a positive attitude about protecting their hearing and will be more apt to use hearing protection correctly and consistently in the workplace. This positive outcome should result in reducing noise-induced hearing loss in the workplace." The NIOSH Criteria for a Recommended Standard also recommends fit testing as best practice. "Today, the issue of hearing protection attenuation is best addressed by testing the performance of hearing protection objectively. This fit testing technology is a huge advancement in efforts to save workers' hearing."

Hearing Protection Fit Testing Helps With OSHA Compliance

To be sold in the U.S., a hearing protector must be tested, according to a standardized method, and labeled with the NRR. OSHA's noise standard 29 CFR 1910.95 requires employers to offer noise-exposed workers hearing protectors that can adequately reduce the hazardous noise exposure. The allowable methods for calculating the sufficiency of hearing protectors are included in Appendix B of the standard.

Since the standard was written before the availability of FAES technology, there currently is no provision for using PAR values that exceed values calculated using Appendix B. If the noise exposure is high enough that the noise reduction calculated using Appendix B is insufficient, then feasible noise controls and/or dual hearing protection should be used.

However, a recent OSHA Letter of Interpretation states that fit testing can be used to meet the training requirements of section 1910.95 (i)(4) and the requirement to ensure proper initial fitting in section (i)(5)1:

"OSHA 29 CFR 1910.95(i)(4): The employer shall provide training in the use and care of all hearing protectors provided to employees.

OSHA 29 CFR 1910.95(i)(5): The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors."

Although OSHA does not require fit testing, this interpretation letter specifically recognizes fit testing as an acceptable way to fulfill the initial fitting requirement.

Summary

The rapidly increasing availability of real-world fit test data is shedding light on just how unreliable single-number ratings are for predicting noise attenuation for individuals. A growing body of published research shows that fit testing is significantly improving the effectiveness of hearing conservation efforts around the globe. This growing body of evidence, along with acceptance by regulatory and occupational health agencies as a best practice, makes it clear that hearing protector fit testing is here to stay.

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