VeriPRO™

Assessing Fit Effectiveness of Earplugs

Presented by
Howard Leight Acoustical Laboratory
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HOWARD LEIGHT by SPERIAN

Introduction

The published Noise Reduction Rating (NRR) is a laboratory estimate of a hearing protector's effectiveness. But how well does that protector actually perform in the ear of a noise-exposed worker in the workplace?

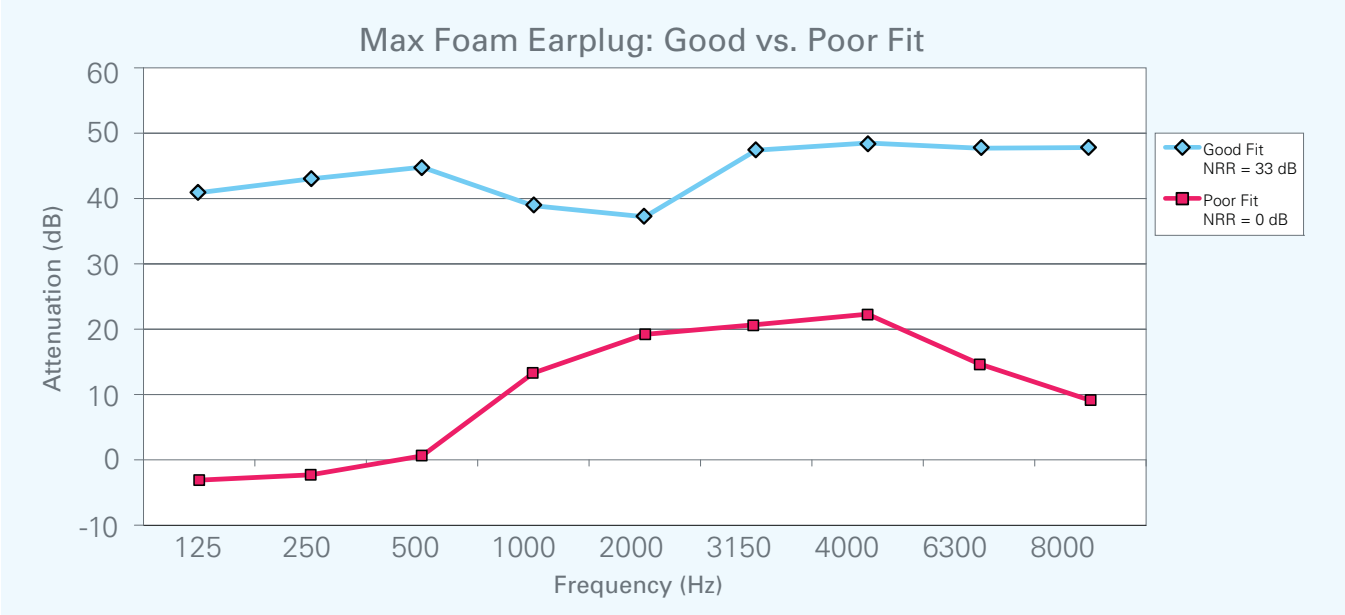


Figure 1. Demonstration of good and bad earplug attenuation across 125-8000 Hz using the Howard Leight® Max® single-use earplug. Test data from Howard Leight Acoustical Laboratory, San Diego, CA.

Figure 1 shows the difference in attenuation between two fittings of the same earplug in the same worker's ear on the same day. In both cases, the earplug appeared to be far enough in the ear canal to visually satisfy a cursory compliance check. However the difference is that a good insertion — i.e., when the earplug is deeply inserted and achieves a good seal in the ear — is enough to cause a 30+ dB improvement in attenuation. The worker with a poor fit may be lulled into a false sense of protection when he detects slight muffling of high-frequency sounds or when some of the "edge" is taken off shrill noise. But because the poor fit has seriously compromised low-frequency protection, the effective overall protection is 0 dB!

For decades, in fact, studies in the workplace have shown hearing protectors to be underperformers: real-world attenuation (noise blocking) is quite often less than the published NRR for many workers. These studies have spawned a variety of de-rating schemes for hearing protectors which are often misunderstood or misapplied, such as the 50% OSHA de-rating; or the NIOSH 75 / 50 / 30% de-rating for earmuffs, formable earplugs, and pre-molded earplugs respectively.

More recent studies, however, offer some good news: a significant core of workers do achieve good attenuation. For these users, the earplugs are working!

Field Attenuation of Earplugs

A field attenuation test was performed in 2007 by the Howard Leight Acoustical Laboratory on more than 100 workers at eight different facilities during their standard work shifts. Locations and workers were not pre-screened, and workers were tested with their own earplugs they routinely wear on the job, with no modifications. The tested earplugs were from four different manufacturers. Workers received no training or coaching as part of the test, but were simply asked to insert the earplugs as they normally do on the job. No feedback or correction was offered if they fit the earplug incorrectly.

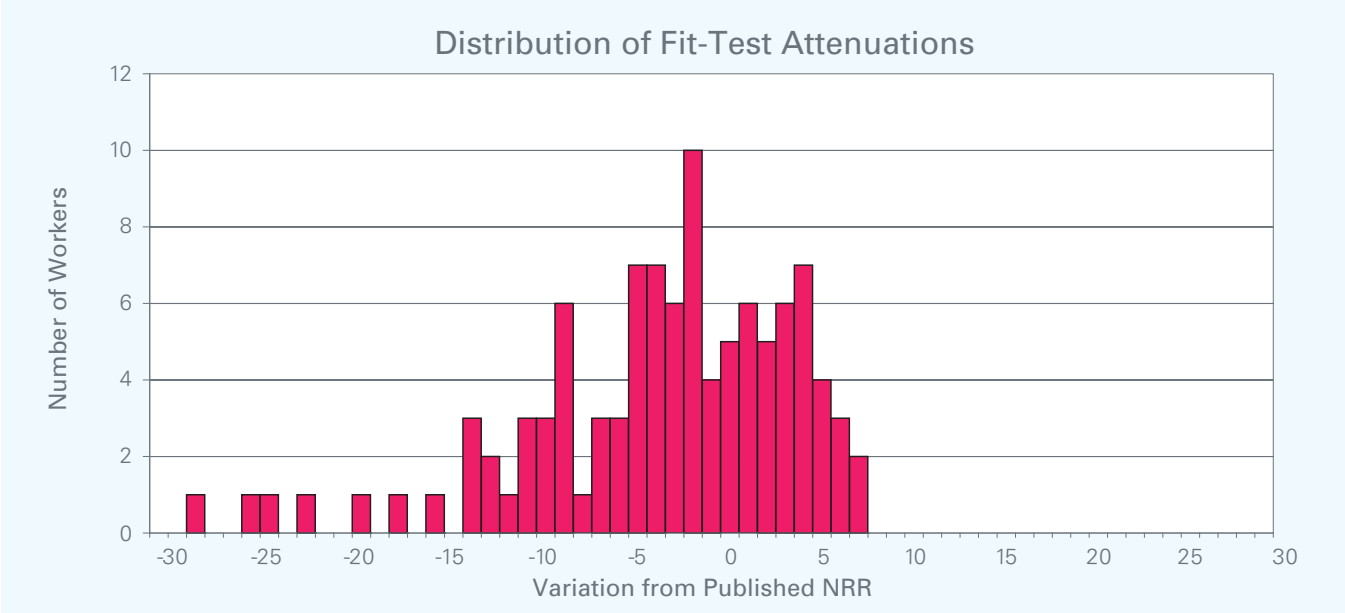


Figure 2. Distribution of fit-test attenuations. Test data from Howard Leight Acoustical Laboratory, San Diego, CA.

Figure 2 shows a bar chart of results for the 104 workers, and their variation from the published NRR (at the 0 dB on the vertical axis). Surprisingly, nearly one-third of the workers achieved higher attenuation than the published NRR for their particular earplug (shown by the bars above the 0 dB axis). About one-third were within 5 dB below the published NRR (shown by the bars between the 0 dB axis and -5 dB). And about one-third of the workers had attenuation that was more than 5 dB below the published NRR.

This chart shows the danger in using de-rating policies like the oft-misapplied 50% de-rating. If a safety manager were to summarily assume that all earplugs only achieve half of their published NRR in the field, then clearly two-thirds of the workers in this study would be seriously overprotected, since they are already achieving much higher protection than 50%.

Likewise, these results should remind safety managers that the published NRR is simply a laboratory estimate of the protection achievable when the earplug is properly fit. Whether a particular user falls near the top or the bottom of that bar chart depends on a number of factors.

Factors Contributing to Good Fit

When various factors were evaluated to predict a good earplug fit, one factor stood out: ***one-on-one training***. That is, the more often a worker had received Individual Training in the proper use of hearing protectors, the higher the probability of a good fit. The same could not be said for Group Training; when measuring good attenuation in the field, it appeared to make no difference whether a worker had attended zero, five or ten group training sessions in hearing protection. (There are other good reasons to offer group training in a Hearing Conservation Program, though group training is not the best method for teaching hearing protector fitting procedures.)

Enforcement was also a good predictor of positive earplug performance, but only when it was coupled with one-on-one training. When strong enforcement policies were in place without proper training, workers were actually more likely to have a poor fit than a good fit.

Finally, the study looked at the question of whether an employee who achieved low attenuation with one type of earplug would get the same low results from other types as well. Interestingly, workers who tried a second pair of earplugs often had major leaps in attenuation, bringing them closer to the published NRR and confirming the wisdom of offering a variety of suitable hearing protectors.

Assessing Effective Fit

Until recently, there was no widespread method to accurately assess the fit effectiveness of an earplug in actual use by an employee. The closest approximations were visual and acoustic checks:

Visual Check. For earplugs with a stem (a firm protruding piece intended to be grasped by the user for insertion), only the tip of the stem should be visible to someone looking at you from the front, or when you view yourself in a mirror. All flanges of a flanged-earplug should be well inside the ear canal. For earplugs without stems (most foam earplugs), the ends of the earplugs should not be visible to someone looking at you from the front. An earplug that is clearly visible from the front is a warning sign of poor insertion.

Acoustic Check. A hearing protector is only useful when it achieves an acoustic seal in the ear canal. An acoustic seal causes a very pronounced lowering of noise levels. Here is one way of checking the acoustic seal of an earplug. With earplugs inserted, users cup their hands firmly over their ears and release. The earplugs should be blocking enough noise so that covering the ears with your hands results in no significant change in noise level.

Measuring Real-World Attenuation of Earplugs

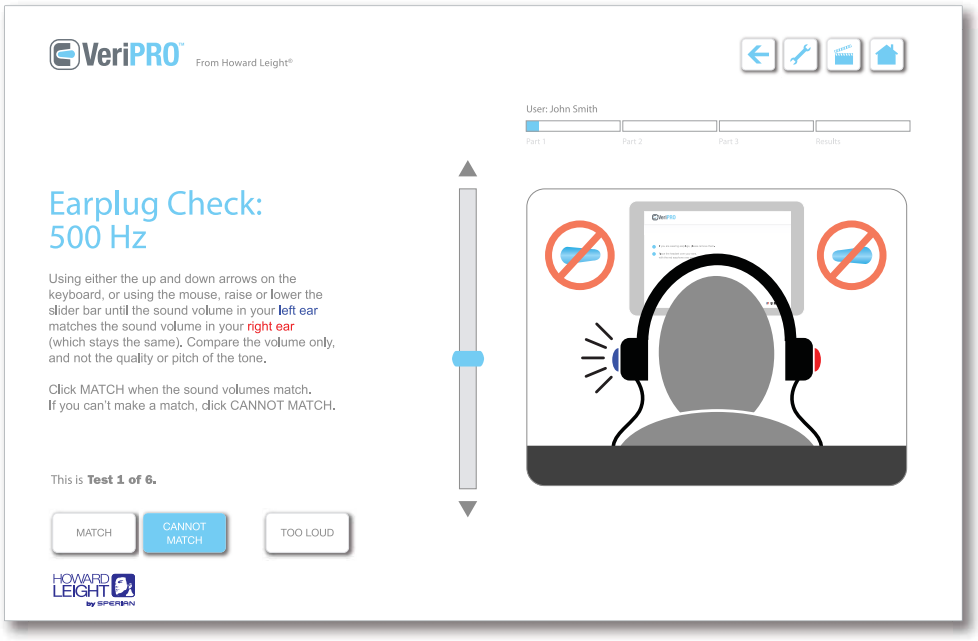
Howard Leight's new VeriPRO™ technology makes it possible for safety managers to ensure that their employees are getting the most out of their hearing protection devices. Developed in conjunction with the House Ear Institute (www.hei.org), VeriPRO measures real-world attenuation of unmodified earplugs and can be used as a means to improve individual employee training, thus enhancing the overall effectiveness of Hearing Conservation programs.

VeriPRO consists of software and an optimized headset, and utilizes a three-part process to determine the effectiveness of an employee's earplug fit over a range of frequencies. The result, known as a Personal Attenuation Rating (PAR), identifies the actual protection an employee receives from his or her earplug in each ear. This allows safety managers to determine if their employees are receiving optimal protection, require additional training on how to fit their earplugs, or need to try a different model.

VeriPRO benefits both safety managers and employees alike. For the safety manager, it fulfills OSHA's requirements for training with documented results. For employees, VeriPRO demonstrates the importance of hearing protection in the workplace, and helps them select and compare protectors to find the best choice for their ears and specific applications.

Unlike other fit-testing systems, VeriPRO can be used with any earplug, and performed in virtually any setting. VeriPRO offers two test protocols. The Complete Check runs employees through five frequencies to determine PAR and is recommended for annual use. The Quick Check is a simplified test of earplug fit at one frequency, used as a fast and easy pass/fail check for more frequent use. VeriPRO also includes short training videos on how to properly fit Howard Leight earplugs. Employee results are captured and stored in the program, and can be analyzed to determine program trends.

The VeriPRO package consists of PC-based software, an audiometrically optimized headset, an audio processor, Quick Reference Guide and USB cable.



500 Hz Earplug Check of Howard Leight VeriPRO Complete Check.

Choice of Earplugs

Fit-testing of earplugs with VeriPRO also confirms the value of choice. Employers who only offer one type of earplug to noise-exposed workers unknowingly rob themselves of one of their best tools in preventing hearing loss: a selection of protectors. Fit-testing research in the field showed the following:

- When new hires were given the choice of several different earplugs, only one-third of them initially chose their best-protecting earplug. In other words, for new employees, the "first choice" is often their "worst choice."
- Workers who achieve low Personal Attenuation Ratings with one type of earplug often show immediate and significant improvement just by trying a different earplug. If the goal is to offer the best protection to noise-exposed workers, a safety manager's best tool can be a true variety of suitable hearing protectors.
- Sixty days following fit-testing using multiple earplugs, 80% of tested workers could recall the best-fitting earplug. Fit-testing results provided "sticky training" — training that made a behavioral difference in noise-exposed workers over time.

Verification of Protection Levels

Concurrent with the verification of Personal Attenuation Ratings, VeriPRO calculates each employee's Safe and Protected Exposure Levels in relationship to their current noise exposure levels. Mapped onto a Noise Thermometer, VeriPRO also identifies potential risks of an individual's protection and noise exposure.

Safe Exposure Level

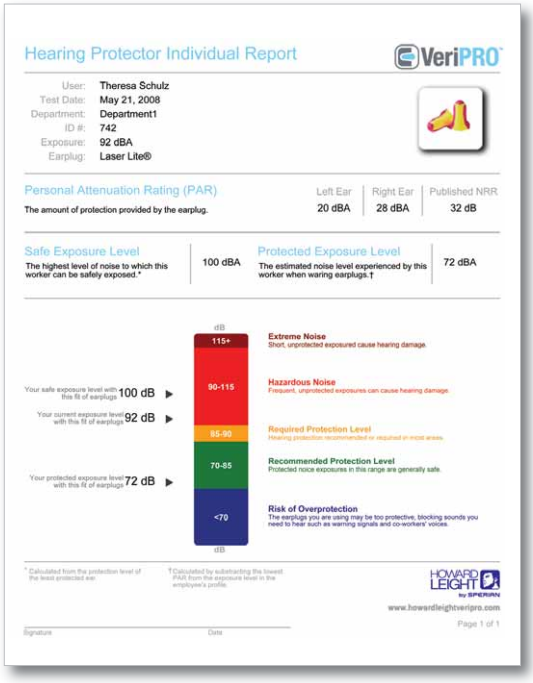
This is the highest time-weighted average noise level an employee can safely be exposed to, based upon the current earplug fit measured by VeriPRO. It is calculated by taking a safe noise exposure of 80 dBA and adding the lower PAR.

Example:

Safe Noise Exposure =	*80 dB*
Lower PAR =	*20 dB*
Safe Exposure Level =	*100 dB*

The employee may be exposed to up to 100 dB of noise with this fit of this earplug without additional risk of hazardous noise exposure or underprotection.

At times, the published NRR and its optimal achievement may be overprotective in marginal noise environments. In fact, a low PAR is not by itself a problem. For example, a worker in 90 dB of noise might obtain a PAR of 10 dB, and be adequately protected. But when the PAR is too low for the worker's noise exposure, then there's a problem and intervention is needed.



Protected Exposure Level

This measure estimates the noise level heard by the workers while wearing earplugs, when exposed to the noise level previously entered for that person. It is calculated by subtracting the lower-ear PAR from the noise level previously entered in the VeriPRO user's set-up.

Example:

TWA Exposure Level =	*92 dB*
Lower PAR =	*20 dB*
Protected Exposure Level =	*72 dB*

The employee's Protected Exposure Level with that fit of that earplug is 72 dB.

A high PAR often means the worker is obtaining the published attenuation value or higher. Usually, this is not a problem. But if the worker is in a hearing-critical job, then overprotection may be a concern: verbal communication may be hindered, and warning alarms might not be heard.

In certain hearing-critical jobs, overprotection might be just as hazardous as underprotection. VeriPRO is a valuable tool in identifying and avoiding overprotection. As a general guideline, hearing protection should bring Protected Exposure Levels (the noise level under the earplugs) to between 70–85 dB (from ISO Guideline EN-458).

As part of its standard reports, VeriPRO calculates the Protected Exposure Levels for any worker whose noise exposure is entered into the system.

Conclusion

Research has shown that a considerable proportion of employees already achieve effective attenuation with their existing earplugs with proper fit, and that other employees can improve results with training and the ability to choose from a variety of earplugs. However, group or casual training yields minimal results in reducing hearing loss. In fact, most employees soon forget Hearing Conservation training provided by posters, brochures or large group sessions.

A personal approach to Hearing Conservation training includes fit-testing with the worker's own earplugs, and a selection of various earplugs from which the employee can choose the most comfortable and most protective model. Such experiential training increases the measured attenuation of the earplug, increases the observed use of hearing protection, and sticks over time.

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