Hearing Protection Fit-Testing eBook

June 2021

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Executive Summary

The 3M Hearing Protection Fit-Testing eBook focuses on the benefits of fit testing and what it means to your hearing conservation program - including how the world is moving toward fit testing. Now, fit testing is recognized as a best practice, and it's critical to know what to look for in a fit-test system.

This eBook will walk you through how using fit-test systems can help better protect workers and how the acceptance of fit testing is changing hearing conservation. We'll also explore studies from around the globe and across several industries on how fit-test systems perform in real-world conditions, looking at the results, costs, value, impact on other PPE and more. You'll find out more about the 3M™ E-A-Rfit™ Dual-Ear Validation System and how it complies with the European guidance document EN 458: 2016 and why it might be an ideal fit for your Hearing Conservation Program (HCP).

Finally, we'll help you assess or start your hearing conservation program and provide solutions for managing a successful program for years to come.

The Case for Fit Testing

The European guidance document EN 458:2016 on selection, use and maintenance of hearing protectors outlines the benefit of individual fit testing as a way of improving field performance of hearing protectors. [1]According to Eurostat 16 million European workforce suffer from work related hearing difficulties. Noise-induced hearing loss is the most common reported occupational disease in the EU.[2]

With each new hearing protection recommendation, standard, regulation and eye-opening statistic, it's clear that fit testing is an excellent solution to help protect your workers.

I'm new to this. What's fit testing?

Think about trying to wear a respirator that doesn't fit correctly. You wouldn't be confident entering a hazardous environment knowing your respirator wasn't able to provide adequate protection, would you? That's why respirator fit testing is required for certain countries and certain work processes e.g. asbestos removal—and why hearing protection fit testing, although not mandated in EMEA, is crucial for the safety of your workers.

As defined by 3M in a 2018 technical bulletin, hearing protector fit testing, "measures 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' or PAR. The purpose of hearing protector fit testing is to verify that the attenuation is adequate for the individual and to help validate hearing protectors that can be used successfully in their work environments."

Why is it needed?

It comes down to the fact that no one shares the same set of ears. Everyone has their own unique ear canals—that's why there can be a large range in attenuation achieved by individuals in the workplace using the same model of hearing protector. Even if you give everyone a high SNR earplug, you should expect they won't all receive the same attenuation.

Plus, there's the issue of inserting hearing protectors properly. One study found that out of 327 experienced users tested, 30% were not properly protected—putting them at risk of noise-induced hearing loss (NIHL). It also found that 17% had to be retrained before achieving an adequate fit. Without fit testing and training, those workers could have suffered NIHL.[3]

How does it work?

There are different types of fit-test systems, but in general, the worker selects the hearing protector normally used, and then it is tested on the worker to learn how much noise reduction there is. Some of the systems are subjective, meaning that the worker must respond to a sound. Other systems are objective and don't depend on the worker's hearing or ability to a test signal. The point is that the attenuation or protection provided is determined on the individual worker the way the worker typically uses the tested hearing protector.

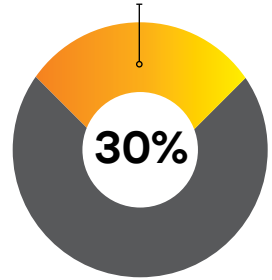
A study found that out of

327

experienced users tested,

30%

were not properly protected.[3]



▸ [Read the Hearing Protection Fit Testing: What, Why and How Technical Bulletin.[3]]

Is your Hearing Conservation Program ready for the trend that's changing practices?

Evidence suggests that hearing protection fit testing can change the practice and outcomes of hearing conservation programs. The European document EN 458:2016 Hearing protectors – Recommendations for selection, use, care and maintenance – Guidance document outlines the benefits of fit testing as a way of helping improve field performance of hearing protectors.

The EN 458 guidance document suggests that fit testing is a useful way to determine if the selected hearing protector provides sufficiently good fit to achieve desired sound attenuation.

Fit testing is also a very helpful training and motivational tool which may help reduce noise-induced hearing loss in the workplace and help improve employer's safety compliance.

Fit testing is even more important now in Europe as hearing protectors have been redefined as Harmful Noise in the European PPE Regulation (EU) 2016/426 and elevated into the same high-risk category as respiratory protection, for example.

"Fit testing can play a valuable role in training and in achieving and documenting an effective hearing protection programme in the workplace."[4]

► Read the bulletin.[4]

The impacts are felt across industries worldwide.

With over 22 million workers exposed to hazardous noise levels that exceed NIOSH's exposure limit of 85 dBA and over 27 million Americans living with noise-induced hearing loss[5], it's no mystery as to why people are taking a serious look at this issue. Reading the studies linked in this chapter will help you appreciate these quotes and stats in their full context.

Fit testing and reducing Standard Threshold Shift (STS) rates.

A U.S. metal manufacturer found that fit-testing expenditure was a significant predictor of non age-corrected STS rates.

Two recent studies analyzing metal manufacturing facilities across the U.S. demonstrated a significant link between training expenditures that include fit testing and reduced STS prevalence—with fit-testing expenditures being the strongest predictor of non-age corrected STS rates.

In addition, the studies also drew a connection between spending on training and fit testing to reduce hearing impairment and lower high-frequency hearing loss rates.

The results demonstrate the power of incorporating fit testing into hearing conservation programs to verify workers are being appropriately protected for their noise exposure.

"Training on insertion techniques like those provided by employer HCPs has been consistently shown to increase PARs in workers."

—Neitzel, Sayler et al., 2017 International Journal of Audiology.

▸ Find the full study here.[6]

Over 27 million Americans living with noise-induced hearing loss.[5]

"Higher expenditures for training and hearing protector fit testing were significantly associated with reduced STS."[6]

The cost and effectiveness of HCPs.

The US Federal regulations require employers to deliver "effective" hearing conservation programs, but evaluating the effectiveness can be difficult. A team of researchers set out to learn about program effectiveness by doing an in-depth audit of the hearing conservation programs in 14 different US metal manufacturing sites owned by the same company. Specifically, they looked for associations between how much is invested in providing hearing conservation programs and how much hearing loss there is in those facilities. Several useful observations were identified, including:

- Overall, about 15% of the workforce had hearing loss.
- Spending more on training and doing hearing protection fit testing was associated with fewer cases of hearing shifts.

"The fact that the few plants that did have fit testing costs had lower rates of age-corrected STSs indicates that 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."

—Sayler et al., 2018, International Journal of Audiology.

- Read the study.[6]

Fit testing on the rig.

A 2015 study by the National Institute of Occupational Safety and Health (NIOSH) discovered that 40% of workers were not getting sufficient attenuation on an initial fit test. Without knowing their PAR results, workers at risk of developing noise-induced hearing loss (NIHL) would not have been identified. The study concluded that a hearing protector's NRR has little predictive value in knowing the degree of noise protection 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."

—Murphy, Themann, Taichi, Murata, US Centers for Disease Control and Prevention, NIOSH, July 2015.

- Read the study.[14]

Fit testing fits a variety of verticals.

The positives are clear—fit-testing can help enhance your hearing conservation program. Are there negatives? Not really, even if there's concern about the initial cost of implementation. Reducing incidents of noise-induced hearing loss not only saves money in the long run—it saves people's hearing—and that's priceless.

Hearing shift rates declined from

5.5%

to

1.3%

per year[7]

Fit testing in China.

A 2018 study (Liu, et al) was conducted to gain insight into the hearing protection practices of Chinese workers and value of hearing protection fit testing.

The Field Attenuation Estimation System (FAES) was used to measure the PARs of one foam earplug used at the factories. The study concluded that fit testing demonstrated value for verifying sufficiency of attenuation.

The training along with fit testing contributed to enhanced PARs and sustained effectiveness over time.

"Significant improvment was shown on post-intervention PARs as well as follow-up visit PARs."[8]

- Find the study.[9]

NRRs and your HCP.

The Noise Reduction Rating (NRR) of hearing protectors is often a significant factor in making purchasing decisions and at-the-ear exposures in noisy environments. Fit testing can help you effectively evaluate an NRR by ensuring a hearing protector's attenuation is adequate. Find out why depending solely on the NRR of your hearing protection could undermine your hearing conservation program.

- Read "The Naked Truth about NRRs."[11]

More than a numbers game.

Improving PARs and reducing NIHL are big concerns, but so is how we look at hearing protection. It's time to elevate the conversation about hearing protection to always include fit testing. Because without it, it's difficult to be sure you and your workers are adequately protected.

What performance criteria should you look for in fit-test systems?

Depending on the standards the fit testing system is compliant with, there can be specific criteria which the fit-test system should comply with. These can be useful factors to consider when assessing your fit-testing system selection.

The 3M™ E-A-Fit™ Dual-Ear Validation system is compliant with ANSI/ASA S12.71-2018, which means it is compliant with the following criteria -

1 Calibration/Verification Procedure
The interval for a physical calibration shall be defined, recommended not to exceed 2 years. Objective FAESs shall have a procedure to check the sensitivity of the microphones on a daily basis.

2 Maximum Allowable Ambient Sound
The maximum allowable ambient noise level limit must be specified in user instructions.

3 Maximum Sound Exposure Caused by the Test Signal
The FAES test signals must not exceed an exposure of 80 dB L_{A8hn} or level of 105 dB L_{Amax} over the course of a work shift to the unprotected bystander. If the FAES output exceeds these limits, the manufacturer must specify suitable protective methods.

4 Bias or Nonlinearity of Fit-Test Results
Bias or nonlinearity is evaluated by comparing the FAES measurement results to the REAT reference test values. The manufacturer must assess and minimize any bias to decrease the measurement uncertainty.

5 Range of Valid Attenuation Measurements
The full range of measureable attenuation values must be assessed and reported. For psychophysical FAESs, this applies to people whose hearing thresholds show up to 25 dB of hearing loss (dBHL).

6 PAR Uncertainty
The components of uncertainty must be evaluated, documented and made available to the user.

Fit-testing hearing protection can help you:

- Identify employees who are unable to properly fit hearing protection
- Select appropriate hearing protection devices that yield adequate protection
- Educate employees about noise-induced hearing loss

—Murphy, 2013, CAOHC Update.[12]

Fit-Test Systems: What to ask before you buy.

In addition to any performance criteria, there are some more detailed questions you should consider before you invest in an appropriate fit test system. If each of these questions cannot be answered with a confident 'yes', it may be worth considering other options.

Questions
Does the system test both ears at once?
Can the system test both earmuffs and earplugs?
Does the system measure 7 frequencies used to predict protection?
Can fit tests be done if there is background noise in the test area?
Is the system objective?
Is the fit test fast?
Can the system be used to test workers with hearing loss?
Does the system display the uncertainty of the PAR value?

The future of hearing protection is fit testing.

- Read the bulletin.[3]

How is the 3M™ E-A-Rfit™ Dual-Ear Validation System different?

The 3M™ E-A-Rfit™ Dual-Ear Validation System assesses the amount of attenuation provided to a user of hearing protection The system uses an objective method called field microphone in-real-ear (F-MIRE). The sound levels in the ear canal underneath the hearing protector and the sound levels outside the hearing protector are measured with dual-element microphones. One microphone element measures the ear canal signal with a probe tube that passes through the earplug or earmuff cushion. The second microphone element measures the external sound level during testing. The difference between these two measurements allows the attenuation of the hearing protector to be estimated.

Real world, real results.

At a textile factory in China, the 3M™ E-A-Rfit™ Dual-Ear Validation System was used to measure the personal attenuation rating (PAR) on an over-the-head style earmuff.

In order to know how PAR varies over time, PARs were obtained several times throughout the same work shift to capture different fits on 39 workers. Follow-up fit tests were conducted at 6-month or 12-month intervals for a larger group of workers.

The testing and one-on-one training helped show the workers proper placement and use of their earmuffs to achieve better, consistent attenuation.

"Over the course of the evaluation, one-on-one training and fit testing improved PAR and helped reduce the negative impact caused by the use of protective hair covers."

▸ Read the article.[9]

Tests
7
frequencies in 2 ears at the same time
(125Hz to 8000Hz)

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

Helping protect employees.

The SNR of hearing protection has limited utility as a predictor of individual protection. That's why we recommend getting a Personal Attenuation Rating (PAR). Why guess when you can know?

The 3M™ E-A-Rfit™ System uses F-MIRE (Field Microphone-In-Real-Ear) technology to generate a unique PAR for each worker in under 5 seconds for both ears, measuring 7 standard test frequencies. PAR results are used to help employers confirm that each worker has the right hearing protection attenuation in order to help prevent noise-induced hearing loss.

- Tests both ears simultaneously in less than 5 seconds
- Science-based, quantitative testing
- Fast, clear and accurate results
- Tests 7 frequencies—125Hz to 8000Hz
- Seamless software integration
- Compact design
- Earplug, earmuff, and banded HPD testing capability
- Know that you are getting the protection you need

Training employees on using hearing protection.

3M™ E-A-Rfit™ System testing sessions give employers the opportunity to teach/retrain workers on how to wear hearing protection properly. Because the 3M™ E-A-Rfit™ System tests both ears in under 5 seconds, employers have more time to dedicate to training their employees on important aspects, such as the proper earplug insertion technique and/or identifying the 3M earplug that is the best fit for workers with larger and smaller ear canals.

Product selection.

Hearing protector selection involves the user finding the ear plug and/or earmuff that best meets their personal needs for comfort, attenuation and the size of their ear canal. The operator is able to test a variety of hearing protectors available from 3M.

Recording all aspects of the fit test session.

3M™ E-A-Rfit™ System's PAR results, fit test dates and other information can be saved as part of program management for your company. This will help you ensure employees have the proper fit and know how to use their hearing protection—and have a record of it.

Dual-ear testing in less than 5 seconds

The 3M™ E-A-Rfit™ advantage.

The 3M™ E-A-Rfit™ Dual-Ear Validation System is objective, fast and accurate, and lets you test earplugs or earmuffs on both ears simultaneously.

The quick testing process allows trainers more time to concentrate on coaching and problem solving.

- Learn more.

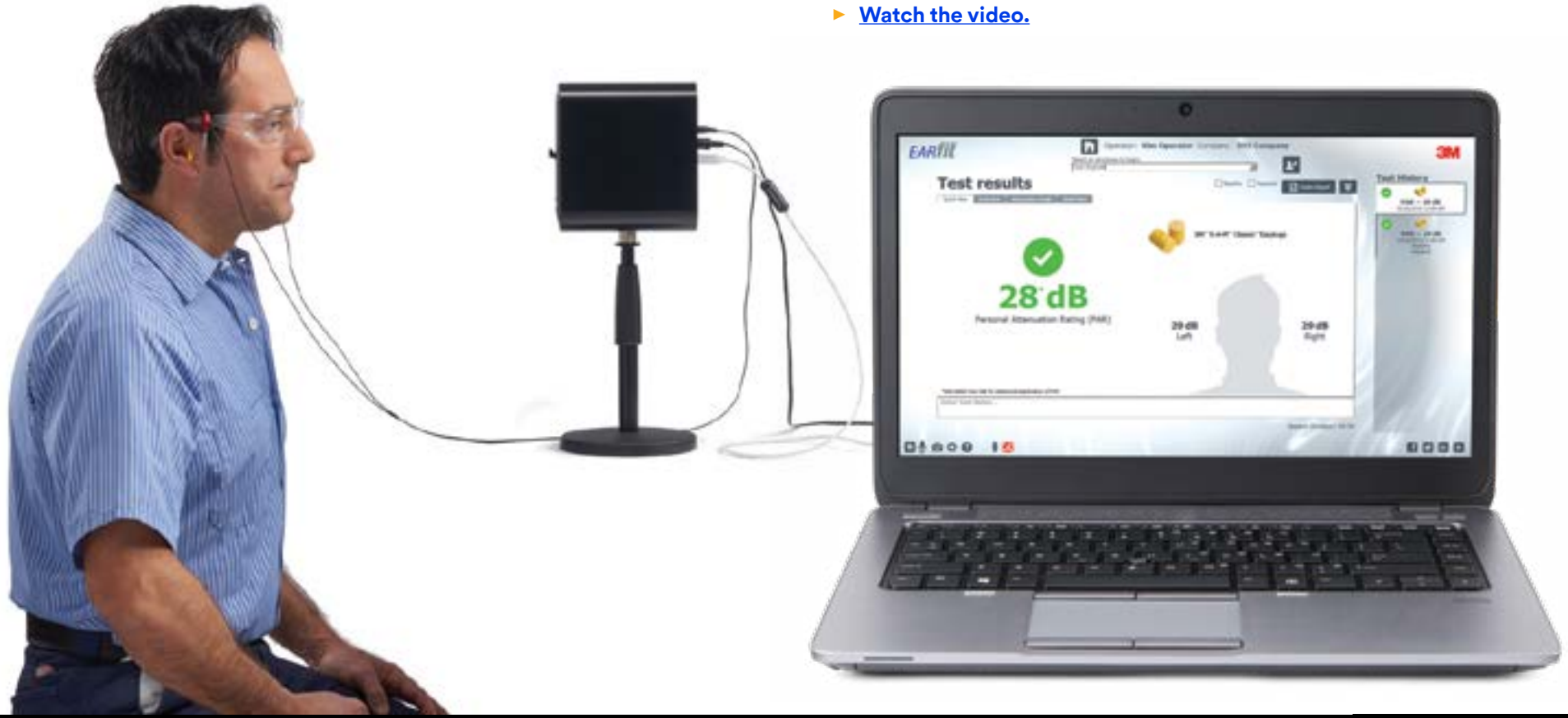
Complete step 2 in under 5 seconds

1 Fit.
Have the employee insert their earplugs or put on their earmuffs.

2 Test.
Connect to microphones and begin speaker test sound.

3 Assess.
Use PAR to customize hearing protector selection.

- Download the product brochure.
- Watch the video.



Here are some frequently asked questions about the 3M™ E-A-Rfit™ Dual-Ear Validation System that can help make an informed choice on suitable fit test system.

Question	Answer
Does the system test both ears at once?	Yes. 3M™ E-A-Rfit™ System tests both ears at the same time in under 5 seconds.
Can the system test both earmuffs and earplugs?	Yes. 3M™ E-A-Rfit™ System can test most of the 3M earplug, earmuff and PELTOR™ Communication products.
Does the system measure 7 frequencies used to predict protection?	Yes. 3M™ E-A-Rfit™ System objectively measures attenuation at 7 frequencies, from 125 Hz to 8000 Hz, all at the same time to better estimate the full spectrum of a worker's overall protection.
Can fit tests be done if there is background noise in the test area?	Yes. Fit tests using 3M™ E-A-Rfit™ System can be done virtually anywhere, even if it is noisy in the background (up to 85 dBA). It does not require a quiet or sound-treated room for testing.
Is the system objective?	Yes. With objective systems, the worker does not have to respond or make a judgement about the test signals—simplifying the process and reducing prep time. This approach also allows the 3M™ E-A-Rfit™ System to test 7 frequencies simultaneously, in under 5 seconds.
Is the fit-test fast?	3M™ E-A-Rfit™ System tests both ears at the same time in under 5 seconds, allowing quick identification of workers needing intervention, documentation of results, and supports efficiencies in your hearing conservation program.
Can the system be used to test workers with hearing loss?	Yes. Because 3M™ E-A-Rfit™ System uses an objective measurement technology it can be used on all workers, regardless of their hearing ability. Even workers who have a hearing loss can be tested.
Does the system display the uncertainty of the PAR value?	Yes. 3M™ E-A-Rfit™ System has always taken a conservative approach by displaying the PAR minus the uncertainty value as the overall PAR result. The uncertainty value is shown in the software, on the Detail View tab, for each PAR measurement.

3M™ E-A-Rfit™ Dual-Ear Validation System Compliance with ANSI/ASA S12.71-2018 FAQs.

- Download it now.

Ready to demo?

- Find a local authorized service provider.

How to elevate an HCP: by the numbers.

Fit testing can take your hearing conservation program to a new level. An easy-to-implement system like the 3M™ E-A-Rfit™ Dual-Ear Validation System can help change worker behavior and may contribute to reduced hearing loss—as well as improving the cost effectiveness of your hearing conservation efforts.

The study concludes that fit testing can help identify workers who are at risk for NIHL. Additionally, the study highlights the benefit of training individual workers on the correct use of hearing protectors.

▸ See the study.[10]

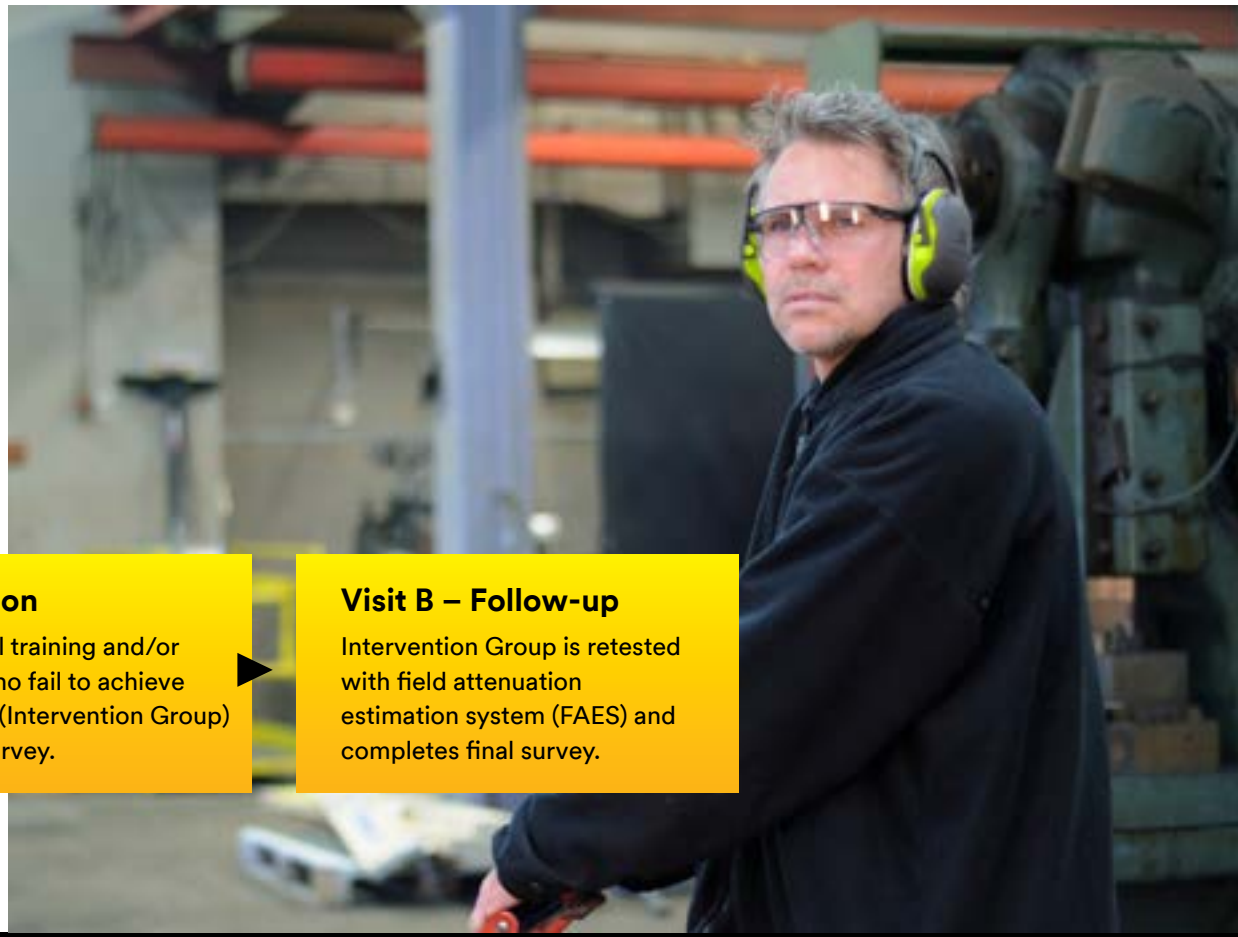
Identify workers at risk.

Fit testing can help you quickly identify workers at risk of under protection. With fit testing and training they can improve their PAR and maintain it over time.

The 3M™ E-A-Rfit™ Dual-Ear Validation System was used to conduct fit tests on workers. Data were collected during two plant visits approximately six months apart.

Participants were 327 workers; 85% male with 10+ years of experience, 70% of total workforce was 40 years of age or older. They had never experienced fit testing prior to this study.

The following study protocol was executed according to the following plan:



Visit A – Baseline
Workers complete survey followed by a hearing protector fit test

Visit A – Post-Intervention
Investigator provides additional training and/or offers new earplug for those who fail to achieve enough protection at baseline. (Intervention Group) Repeat fit test and complete survey.

Visit B – Follow-up
Intervention Group is retested with field attenuation estimation system (FAES) and completes final survey.

Driving continued improvement.

Study 1 –

Lowering standard threshold shift (STS) rates

In an Australian study on heavy industry, of the many intervention strategies implemented, fit testing contributed to the reduction of 10 dB standard threshold shifts (using age correction) over time.

This study analyzed annual audiometric data to determine the number of permanent hearing shifts that occurred in employees in two bauxite mines, three alumina refineries and two aluminum smelters. Annual hearing shift rates were calculated based on the number of employees tested per year.

▸ See the study.[7]

Across all operations, hearing shift rates declined from

5.5%

per year in 2006 to

1.3%

per year in 2013

(P < 0.001)

Although they tried many actions to reduce STS, the biggest predictors of non-age corrected STS were education and quantitative fit testing.

Study 2 –

HCP costs in metal manufacturing and minimizing NIHL

An extensive evaluation of the effectiveness of hearing conservation programs was conducted on different hearing conservation programs. Fourteen facilities from the same company participated. One important finding was that the 4 facilities that did fit testing had significantly lower rates of standard threshold shifts. Also, the facilities that invested more money on training had significantly lower rates of persistent standard threshold shifts. For this company, these findings indicate that investing in training and fit-testing hearing protection has long-term value by reducing hearing loss.

The study characterized overall and specific costs associated with hearing conservation programs at US metal manufacturing sites, and examined the association between these costs and several noise-induced hearing loss (NIHL) outcomes.

NIHL outcomes assessed included rates of standard threshold shifts (STS) and high-frequency hearing loss, as well as prevalence of hearing impairment, for each participating facility.

The study calculated per-person HCP costs that best predicted the NIHL outcomes.

▸ See the study.[6]

Average annual costs ranged from

$308 ± 80 per worker

($67K-$397K for whole HCP)

Increased workplace spending on training and fit testing may help minimize NIHL.

Study 3 –

The value of fit testing in construction industry

On a construction site in the UK, fit testing study played a vital role in helping check whether workers achieved the desired level of attenuation from their chosen hearing protector.

The objective was to gain insight into the hearing protection practice at Thames Tideway and the value of fit testing. A field attenuation estimation system (FAES) was used to measure the personal attenuation ratings (PARs) of different earplugs used in different application at Thames Tideway in London.

Requiring a minimum PAR value of 10dB, the study showed that 40% of wearers did not achieve this PAR value on first attempt. Upon intervention with training more users were able to achieve the desired value. Furthermore, the study highlighted scaffolders as a group of operators demonstrating more at risk from NIHL and development of Tinnitus. The study recommended that fit testing should be made mandatory at all other sites involved with the construction project.

- See the study.[8]

Fit testing yielded an improvement in PARs which led to the recommendation for mandatory fit testing at other sites of the project.

Study 4 –

The impact of other PPE on hearing protection

Another study looked at how combinations of other PPE can interfere with hearing protection. Fit testing was used to help identify when combinations of PPE, such as earmuffs—when worn with safety glasses or other headgear—can reduce the attenuation received from the earmuffs. This information can be used to select alternative PPE and teach proper fitting.

Although a popular choice due to their durability and ease of use, earmuffs often cause compatibility issues when worn with other PPE.

The study investigated the effects of a range of PPE and apparel on the level of protection achieved by headband earmuffs. Measurements of PAR were taken for 28 test subjects using a field microphone-in-real-ear (F-MIRE) system. Subjects were tested with combinations of headband earmuffs and various PPE including safety glasses, goggles, reusable respirators and more.

Results of the study revealed a reduction in PAR of up to 7% (3 to 7 dB) when safety glasses were worn with headband earmuffs, and other items such as hairnets, golf style caps and fleece beanies had attenuation reductions of 4 dB, 6-9 dB and 12-13 dB respectively.

- See the study.[13]

It's important to know how different PPE combinations affect attenuation. This will help you to select options that work together to effectively protect your workers.

"...revealed a reduction in PAR of up to 7 dB when safety glasses were worn with headband earmuffs."[13]

Ready to assess your program?

Whatever the status of your current hearing conservation program, it's always a good idea to stop and take a look at where you are. When you look around you can always reach out to 3M, we are available to support you with our solutions and expertise.

Ready for a demo?

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

Hearing Protection Fit-Test eBook References

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3M strongly recommends fit testing of hearing protectors. Research suggests that many users will receive less noise reduction than indicated by the NRR due to variation in hearing protector fit, fitting skill and motivation of the user. If the NRR is used, 3M recommends that it be reduced by 50% or in accordance with applicable regulations.