

Recommended Applications of the E-A-RFit™ Validation System in a Workplace Hearing Conservation Program

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INTRODUCTION

The E-A-RFit™ Validation System is a quick and accurate method of estimating real-ear attenuation for a given fitting of a pair of earplugs. This versatile system has been designed and built to be an integral part of a comprehensive workplace hearing conservation program. It may be used for basic program auditing, follow-up evaluation of standard-threshold-shifts (STSs), full training and evaluation, and other scenarios. Depending upon its implementation, the E-A-RFit System can provide varying degrees of precision and effectiveness.

Field Microphone In Real Ear (F-MIRE) Testing (Berger, Kieper, and Voix, 2007)

Laboratory measurement is not a reliable prediction of individual hearing protector attenuation, as many studies have shown. This makes it difficult to properly assign hearing protectors to employees and to match attenuation to actual exposure in critical high-noise environments and in lower noise environments.

Field measurement methods provide a viable alternative. One of these methods, the field microphone in real ear (F-MIRE) approach, incorporates a single small dual element microphone and associated proprietary technology (Voix and Laville, 2002 and 2004; Voix, 2006). One section of the dual-element microphone couples through the earplug to pick up the sound pressure levels in the ear canal, and the other section measures the external sound environment.

THE E-A-RFIT SYSTEM USES THE F-MIRE APPROACH

The specially probed earplugs utilized in the E-A-RFit System, allow one to test, in a matter of seconds, the attenuation obtained by an employee, regardless of the fit of the hearing protective device (HPD). The actual measurement takes about 10 seconds per fitting, per ear, and provides data at the standard 7 test frequencies from 125 Hz to 8 kHz, as well as an overall noise reduction rating called the Personal Attenuation Rating (PAR). The PAR is computed similarly to a Noise Reduction Rating (NRR) except it is calculated individually for each employee and it does not include a standard deviation correction or 3 dB spectral uncertainty factor.

E-A-RFIT RECOMMENDED APPLICATIONS

Here are three options for incorporating the E-A-RFit Validation System into a hearing conservation program. These three options have been designed to suit the needs of employees and environments present in the majority of hearing conservation programs. Naturally, a program designed around your workplace's particular needs could specifically address your and your employees' unique needs.

OPTION 1: AUDIT MODE (GOOD)

The E-A-RFit Validation System may be used to simply audit the protection achieved by a group of employees. With this application, wearers are just asked to fit their earplug as they normally would, and a single E-A-RFit measurement is taken. As long as the wearer's workplace noise exposure is entered, the E-A-RFit System can then make a determination of the adequacy of the protection for that worker. The largest uncertainty in the protection estimate arises from the variation in fit for an individual wearer with a particular earplug. Because of this fit variation, indications of the variability are built into the system, so that the Personal Attenuation Rating (PAR) can be adjusted accordingly. When only single measurements are made on each ear, the fit-variation corrections are based upon values from studies in the E-A-RCALSM laboratories.

Utilizing the E-A-RFit System as an audit device can provide important information on the performance of the wearer's hearing protectors in a hearing conservation program. Furthermore, increased utilization of the E-A-RFit System beyond the audit mode improves measurement certainty and the ability of the wearer to attain superior performance.

The Audit Mode would be considered a base level application of the E-A-RFit System. And while the Audit Mode is acceptable for wearers who are exposed to levels of noise below 90 dBA, we recommend more extensive use of the E-A-RFit System at higher noise levels. Specifically, above 100 dBA we do not recommend use of the Audit Mode. When using the Audit Mode, measurements should be made at least every three years.

OPTION 2: FIT & TRAIN MODE (BETTER)

The Fit & Train Mode utilizes the E-A-RFit System to provide fit training with repeat measurements, and more regular checks, including follow-up confirmation testing. This application is an ideal way to optimize the use of the E-A-RFit System.

Certified E-A-RFit technicians have been trained in the proper fitting of earplugs that they validate. The graphical tools included in the E-A-RFit System software allow wearers' fits to be compared with others who have worn the same earplug. Through this comparison, the E-A-RFit technician can identify wearers who may need additional training, and can then provide that training—complete with confirmation that improved fitting and protection was achieved. The E-A-RFit technician may also find that a particular earplug does not provide an acceptable fit—even with proper fitting technique. The wearer is then guided to select from other, more suitable alternatives.

Increased timely checks beyond the simple audit check will also provide valuable information on a wearer's ability to consistently fit the earplug. Beyond the initial fit validation, a follow-up confirmation test is recommended. For individuals exposed to noise levels between 95 dBA and 100 dBA, this confirming validation test may be given up to a year from the initial validation test. For those exposed to noise levels above 100 dBA, the confirmation test should be given between 3 weeks and 3 months after the initial fit test.

The increased usage techniques of the Fitting and Testing Mode may enhance your hearing conservation program beyond the approach of the simple Audit Mode.

OPTION 3: ULTIMATE E-A-RFIT USAGE MODE (BEST)

For optimum precision in predicting employee protection and enhancing individual use and performance, we recommend the comprehensive Ultimate E-A-RFit Usage Mode. This application recognizes that the more measures that are taken on each individual, the better will be the personal predictions, to the extent that the individual conscientiously tries to fit the hearing protection device consistently each time. An attendant goal from the use of the system with employees is to educate them via repeat fittings (i.e. practice) to wear the device correctly. Evidence also suggests that fit testing can demonstrate to employees their ability to better protect themselves and influence their personal health outcomes, a concept called “self efficacy.” This has motivational value.

The Ultimate E-A-RFit Usage Mode includes the following steps, which are also outlined in the E-A-RFit software:

Step 1: Measurement Process

- A.** Input the employee’s noise exposure [time-weighted average (TWA)] and the employer’s target exposure value into the software.
- If no value is entered for a target-exposure, the software defaults to a value of 80 dBA, providing a 5-dB margin of safety below the OSHA action level of 85 dB TWA.
 - With noise data in the E-A-RFit System, the *Fitting Profile* graph on the *Testing Screen* for each ear during the measurement process will display the estimated attenuation, and predicted protection relative to the target value. Ideally, each fit of the plug should provide attenuation, less the variability (also displayed in the chart) that is at or below the target value. The variability on this screen is based on separate experiments that E-A-R has previously conducted.
- B.** The employee should refit and retest the plug in each ear, with all values saved or “banked.”
- This group of personal saved values will then be used on the subsequent *Results* screens to estimate a binaural protection value tailored to the particular individual (see Step 2).
 - If four or more fittings have been tested and saved, then the variability will be computed from that data in addition to the laboratory-based uncertainty calculation described above.

Step 2: Results

Once the employee has successfully fit the plug being tested in both ears, the *Results* screen presents the average values for the group of saved test results. These reflect the estimated protection and uncertainty for this set of fittings. Use these data to verify that the employee is receiving adequate protection in the selected noise environment.

Step 3: Exposure-Based Testing and Follow Up

Conduct Initial, Confirmation and Periodic Testing of employees with the E-A-RFit System according to the following schedule:

Initial Testing: Ideally at least four fittings will be tested and banked in each ear. However, in recognition of the need to minimize test times, the table below indicates that for TWAs up to 100 dBA, only two fittings may be tested and utilized as long as both fittings indicate sufficient protection for the selected target level. If not, additional fittings or alternative plugs should be tested.

Confirmation Testing: This is a follow-up test on a subsequent visit. Tests of multiple fittings, at least four in each ear on each visit, should be accomplished for best reliability in the estimations, as well as to provide additional training for the employee. The recommended time frame for Confirmation Testing is greater than three weeks, but within three months of the initial test. The time frame may be extended to as much as one year in lower-noise environments, but as the exposures approach and exceed 100 dB the need for the confirmation testing in a timely manner increases and becomes more critical.

Periodic Testing: This phase includes subsequent follow-up tests. Suggested time frames for this testing are prescribed here and listed in Table 1 below.

- Above 100 dBA, sound levels are so hazardous that periodic E-A-RFit testing is recommended.
- Above 110 dBA, the levels are so intense that even 90 seconds of disuse is hazardous (re: an 85 dBA with 3-dB trading rule), so both annual Periodic Testing and the use of dual protection is recommended (earplugs worn underneath earmuffs) regardless of E-A-RFit System predictions.

Table 1: Ultimate E-A-RFit Usage Mode Recommended Implementation

Exposure (TWA)	Initial Testing (No. of fittings)	Confirmation Testing (>3 wk & < 3 mos)	Periodic Testing		Dual Protection (Earplug + Earmuff)*	Audiometry
			Requirement	Rate		
< 90	2	Optional	Optional	3 years	Not Recommended	Annual
>90, ≤ 100	2	Yes	Optional	3 years	Not Recommended	Annual
>100, ≤ 105	4	Yes	Recommended	3 years	Optional	Annual
>105, ≤ 110	4	Yes	Recommended	2 years	Optional	Annual
> 110	4	Yes	Recommended	Annual	Recommended	6 months**

*The attenuation of dual hearing protection can be estimated by adding 5 dB to the PARs estimated for the earplug via the E-A-RFit Validation System.

**Periodic audiometry is recommended every six months for one year to confirm that hearing is not shifting, then the testing schedule may be relaxed to annual testing.

Step 4 – Situation-Specific Supplementary Testing

Some situations may benefit from regular or more frequent use of E-A-RFit testing. Examples include:

- Workers who show an OSHA standard threshold shift (STS) in the annual audiogram, regardless of exposure.
- Workers who may be approaching a recordable or compensable hearing loss.
- Workers in hearing critical jobs.
- Workers who change job classification and are in different noise environments.

E-A-Rfit Service Level	Good (Audit Mode)	Better (Fit & Train Mode)	Best (Ultimate Mode)
Use E-A-Rfit to conduct quantitative fit test on earplugs	X	X	X
Document HPD performance	X	X	X
Compare HPD performance to exposure for sufficiency	X	X	X
Recommended for workers exposed up to 100 dB TWA	X	X	X
Counsel and train worker to improve HPD usage and performance		X	X
Assist worker in selecting more appropriate HPD if necessary		X	X
Initial and confirming tests recommended		X	X
Recommended for workers exposed up to 105 dB TWA		X	X
Use variability to assess HPD adequacy			X
Multiple tests allow variability decisions based on personal use patterns			X

Exposure Conditions and Special Situations	Good (Audit Mode)	Better (Fit & Train Mode)	Best (Ultimate Mode)	Notes:
<90 TWA	X	X	X	3-year basic schedule
>90 to 100 TWA	X	X	X	Confirming tests recommended, periodic testing encouraged
>100 to 105 TWA		X	X	Confirming tests recommended; periodic testing encouraged; dual HPD optional; tri-annual E-A-Rfit test recommended
>105 to 110 TWA		X	X	Confirming and periodic tests recommended; biennial E-A-RFit test recommended; dual HPDs encouraged
>110 TWA			X	Confirming and periodic tests recommended; annual E-A-RFit test and dual HPDs recommended; augmented audiometry
STS (Standard Threshold Shift) cases		X	X	Meets OSHA requirements for HPD re-evaluation per 1910.95
Worker nearing STS or recordable hearing loss		X	X	Assists in monitoring high-risk cases.
Worker in hearing-critical job		X	X	Best mode recommended when specific HPD assignment is desired.
Worker changes job class and/or noise exposure	X	X	X	Verify HPD choice and performance.

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