# FIT TESTING OF HEARING PROTECTORS

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# **1. INTRODUCTION**

The sound attenuation of a hearing protector, as published by the manufacturer is obtained using statistical calculations from results of measurement performed in a laboratory. Results are therefore, valid for a population but should not be used for individual wearers.

That is precisely the objective of the Field Attenuation Measurement Systems (FAMS) that are intended to measure the attenuation of a hearing protector as worn by the user. Many FAMS are already in the market and are used in the field. Results from the measurements are referred as Personal Attenuation Ratings (PARs) and expressed in dBA. The PAR subtracted for the ambient noise level measured in dBA, is supposed to represent the sound level of the protected ear.

 $SL_{Protected ear, dBA} = SL_{ambient, dBA} - PAR$ 

# 2. FIT TESTING

Fit testing is field verification that a protector is properly worn. In general, it is a simple, fast, qualitative procedure, easy to perform, that does not require specific skills and that allow the potential wearer to test the fit of the protector he is using.

The fit testing principle is well known, especially when applied to respirators: it is a simple test that is performed every time the person is to enter a potentially harmful space such as confined spaces, site on fire, or spaces where the presence of toxic gases or lack of oxygen is suspected.

FAMS, on the other hand, although not intended to be used for every individual who is to be exposed to high noise levels, helps insure that he is wearing the adequate protector in a proper way.

# 3. FIT TESTING OF HEARING PROTECTORS

In the case of hearing protection devices, there are several reasons for the test to be performed, such as:

- a) The wearer can verify the attenuation he is really receiving from wearing the protector under test
- b) It helps training the wearer in the proper way of donning the protector.
- c) Allows for the selection of a protector that is appropriate for the noise environment he is in.

It has to be pointed out that the procedure is not a panacea, since

- a) The test tends to be expensive because of cost of the FAMS and also for the disruption resulting from bringing the worker to the place the test is performed.
- b) Results are valid only for the combination wearer/protector and for the particular test, since the same wearer may don his protector in different way in other occasion, resulting in a different PAR.
- c) Results cannot be extended to the entire population

   no statistics can be developed, unless several measurements are performed on several users, something that detracts the idea of a simple, fast and easy test.

# 4. FIELD ATTENUATION MEASURING SYSTEMS (FAMS)

Several FAMS that operate under different principles are available in the market. In general, they can be divided into two groups: "objective" or "quantitative" and "subjective" or "qualitative". Results from measurements using different FAMS cannot be compared because of the different principles they apply. An ANSI Working Group is working precisely into the issue of validation and comparison of the different systems<sup>1</sup>.

### 4.1 **Objective systems.**

Those systems are based on measurements of sound levels outside and under the protector using a two-microphone probe. The subject "lends" his head for the test and no action is required from him. One of the microphones is exposed to the outside (environmental) noise. When testing earplugs, those are replaced by specially prepared, identical to those under test devices, with a probe tube bored through the plug. The second microphone is connected to this tube, receiving the signal that the protected ear is exposed to. In the case of muffs, the inside microphone is located under the muff being tested. A pink noise sound source generates the test signal. Outputs from both microphones (outside and under the protector), are processed using manufacturer provided software that calculates the resulting PAR.

Following are examples of some of the systems.

<sup>&</sup>lt;sup>1</sup> The ANSI S12/WG 11 Working Group is currently working on the BSR/ASA S12.71-201X the standard Performance Criteria and Uncertainty Determination for Individual Hearing Protector Fit Testing Systems

### 4.1.1 E-A-Rfit<sup>TM</sup> VALIDATION SYSTEM by 3M<sup>2</sup>

In this system the two microphones are attached to an eyeglass frame. One of them receives the signal from the environment, while the second is attached to tubing that is introduced through the plug that is under measurement. This special ("surrogate") plug is identical to the one the user is to wear, except for the tube inserted through the body of the plug. In such a way, the second microphone measures the SL of the protected ear. The system also generates a broadband noise through a loudspeaker located in front of the subject. The resulting outputs from both microphones are combined to allow for the calculation of the attenuation in octave bands and as PAR.

#### 4.1.2 <u>OuietDose by SperianProtection/Michael &</u> <u>Associates<sup>3</sup></u>

As in the previous case, this FAMS requires the use of surrogate ear plugs. The system consists of two dosimeters (contained in one casing) that sample simultaneously sound levels from the environment and behind the protector. The device is worn in the workplace during the entire shift in the usual manner dosimeters are worn. At the end of the shift, the two dosimeters allow for the readings of both  $L_{eq,T}$  (outside and under the protector) to be obtained. Their difference is the PAR. The advantage of this system is that the PAR is the real one obtained as a result of a whole-shift operation. The draw back is that it takes a whole shift to measure just one PAR.

# 4.2 Subjective systems.

They require full participation from the user and are based upon the detection of the hearing threshold with and without the protector. Also, during the test the subject is donning the very protector he is wearing while at work. In such a way the measured PAR appears to be more realistic that the one obtained using an objective system.

Following are examples of some of the systems.

# 4.2.1 Integra Fit by Workplace Integra<sup>4</sup>

It measures subject's hearing threshold of both ears simultaneously with and without the earplugs in place. Test signal of 500 Hz is provided via specialized deep-dome headset. PAR is calculated as the difference between the thresholds found in both tests.

#### <u>4.2.2 VeriPro by Howard Leight<sup>5</sup></u>

Here the measurement of the PAR is performed using a single frequency, loudness balance technique. Signals are conveyed via headset. The test, intended for earplugs, is

independent of the background noise. Testing is done in three steps. In each of them the subject is expected to adjust the loudness of the signal to reach a balance between the loudness perceived in both ears. This is done in three steps: a) no protectors, b) only one plug inserted and c) both plugs inserted.

#### 4.2.3 OuickFit by NIOSH<sup>6</sup>

Is a device that generates an octave band of a wide band, 1 KHz centered noise. It is contained in a single earmuffdevice that has the generator and the controls. The device is applied to the ear that is not protected and the subject adjusts the sound level to his hearing threshold. Then, he inserts the plug and increases the level by15 dBA. If the signal is perceived, then it will indicate that that the resulting PAR is less than 15 dBA. So, the subject is expected to readjust the fitting to increase the PAR to at least 15 dBA.

### 4.2.4 OuickFit.Web by NIOSH<sup>7</sup>

Is a test performed on line, where a pulsed, wideband test signal is received by the subject through headsets from the web. The test is done in two steps: first, the subject adjusts the signal's level to his threshold while his ears are unclouded. Then he dons his earplugs and listens to the signal that is now increased by 15 dBA. As in the previous case, if the signal is not perceived, it will indicate that the subject has achieved a PAR of at least 15 dBA.

<sup>&</sup>lt;sup>2</sup> http://www.e-a-rfit.com/

<sup>&</sup>lt;sup>3</sup> www.howardleight.com/quietdose

<sup>&</sup>lt;sup>4</sup> http://www.workplaceintegra.com/integrafit/index.html

<sup>&</sup>lt;sup>5</sup> http://www.howardleight.com/veripro?locale=us

<sup>&</sup>lt;sup>6</sup> http://www.cdc.gov/niosh/mining/pubs/pubreference/ outputid3060.htm

http://www.cdc.gov/niosh/blog/nsb051208\_quickfit.html