

INTEGRAfit[®]: Frequently Asked Questions

What is INTEGRAfit[®] ?

INTEGRAfit[®] is a hardware/software system designed to perform Real Ear Attenuation Testing on workers wearing earplugs.

What is the Personal Attenuation Rating?

The Personal Attenuation Rating (PAR) is the amount of hearing protection achieved by the earplug as actually worn by the worker. The goal of INTEGRAfit is to obtain a PAR on an earplug.

Is the PAR the same as the Noise Reduction Rating?

No. The Noise Reduction Rating (NRR) is a measure of the attenuation provided by earplugs and earmuffs...in a laboratory. It has long been recognized that the NRR can dramatically over-estimate the amount of noise reduction provided by hearing protectors for any given worker. In fact, studies conducted by hearing protector manufacturers and independent laboratories show that many workers achieve less than 5 decibels of noise reduction...far less than would be predicted by using the NRR.

What about reducing the NRR by 50%? Does that work?

No, and for the same reason. Derating the NRR by 50% would lead one to believe that the worker is receiving about 10 to 15 decibels of protection when the amount actually achieved may be less than 5 decibels. The converse is true as well: if wearing hearing protectors properly, the worker might actually receive more noise reduction than the NRR value. The short answer is that relying upon the NRR is just guessing at how much noise reduction the worker is actually receiving.

What about the new NRR labeling that we keep hearing about? Will that help?

The current NRR is a one-number estimate of protection. The proposed new method for determining the NRR will likely incorporate a two-number 80%-to-20% range of estimated protection. The low end of the range will be the estimated protection achieved by minimally trained users (80%) while the high end of this range will be the estimated protection achieved by proficient users (20%). The new NRR is designed to be used with no derating. While this two-number rating system is more appropriate than a one-number system, it is still a group statistic that can be misleading when applied to the individual worker. In short, the new NRR suffers the same disadvantage as the current NRR. Measuring a PAR is the best method.

Why would the NRR be misleading? Why should we trust the PAR?

How much noise reduction a worker gets from earplugs in the real world depends upon a variety of factors:

- Training
- How well the protector fits the user's ears
- Comfort
- Wearing time
- Motivation
- Other work environment factors (temperature, communication needs, etc.)

The advantage of REAT testing with INTEGRAfit is that it allows accurate measure of noise reduction under real-world working conditions. The NRR is an estimated measure of protection based upon a small sample of workers in laboratory environment; the PAR is an actual measure on the individual worker. Why estimate when you can get an actual measure? The PAR measured with INTEGRAfit will always be more accurate.

How does INTEGRAfit measure a PAR for earplugs?

The procedure is simple. Find the worker on the production floor (hopefully with earplugs in place). Tell that worker not to touch the earplugs, that you are going to measure how much protection the worker is getting from the earplugs, and to follow you. Put the worker in a sound booth or quiet room. Put the specially-designed INTEGRAfit headset over the worker's ears with earplugs in place, and then just press the button. INTEGRAfit will quickly

measure the worker's hearing threshold at the selected frequencies (combination of 500, 1000 and 2000 Hz), in both ears (this is the Earplugs In measure). Then the software will prompt you to remove the INTEGRAfit headset, remove the earplugs, and put the INTEGRAfit headset back over the worker's ears. Press the button again and INTEGRAfit will again measure the worker's thresholds at the selected frequencies in both ears (this is the Earplugs Out measure). The difference between the Earplugs In and Earplugs Out measure is the PAR – one PAR for the left ear and another PAR for the right ear. Simple!

I have an audiometer and regular headphones that I use to conduct annual audiometric testing. Can't I just use the equipment I already have to measure a PAR?

This idea has been around for decades. The problem is that placing regular headphones on the outer ear will affect the fit of the earplugs in the ear canal. This means that the measured PAR will not be accurate to some degree. The measured PAR could be off by a little or a lot, but it will be inaccurate. The whole idea behind INTEGRAfit and the design of the INTEGRAfit IA headset is to develop a method to accurately measure PAR; a method that is both scientifically valid and legally defensible. There are two additional considerations. First, INTEGRAfit IA is not just a fancy audiometer/headset combination. It is also a top notch software package to allow ongoing analysis and trending of PAR results over time. In other words, INTEGRAfit IA is not just a data gathering tool but is also a data analysis tool...data analysis to enhance the effectiveness of the Hearing Conservation Program for the individual worker and for the HCP as a whole. Second, the typical industrial audiometer only measures in 5 dB increments. A 5 dB resolution is not sufficient to accurately measure a PAR.

How long does this test take?

A PAR can be measured in about 3 minutes when testing at 500 Hz, and a little longer when testing the optional 1000 Hz and 2000 Hz frequencies.

Does INTEGRAfit require special earplugs?

INTEGRAfit is not the only system available to measure a PAR. There is a system which uses microphone-in-real-ear (MIRE) technology, but this system

requires specially modified earplugs in order to accommodate the probe tube microphone. With INTEGRAfit there is no need for these expensive modified earplugs. INTEGRAfit will measure a PAR on any earplug.

Do I have to use a sound booth?

A sound booth is preferable, but not necessary. Choose a quiet room with minimal distractions.

The noise reduction characteristics of the specially-designed INTEGRAfit headset was evaluated by an independent laboratory, Michael & Associates of State College, PA using the methodology described in ANSI S3.19-1974 with the following results:

| | Frequency (Hz) | | | | | | |
|--|----------------|------|------|------|------|------|------|
| | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| Earphone Attenuation for INTEGRAfit headphones (EA-IF) | 21.8 | 27.8 | 35.6 | 37.4 | 35.5 | 32.5 | 33.4 |
| Standard Deviation for INTEGRAfit headphones (SD-IF) | 3.6 | 2.3 | 2.9 | 3.0 | 3.0 | 1.9 | 1.9 |
| Earphone Attenuation for Supra-Aural headphones (EA-SA) per ANSI S3.1-1991 Table A.1 | 6.0 | 4.0 | 5.0 | 12.5 | 19.5 | 25.5 | 23.0 |

Based upon this data, Maximum Permissible Ambient Noise Levels (MPANL) were developed at each octave-band frequency by adding the difference between the attenuation achieved by the INTEGRAfit headphones (EA-IF) and standard supra-aural headphones (EA-SA) to the recommended MPANLs found in Table 1 of ANSI S3.1-1999 (R2008). As further recommended by that ANSI standard, one Standard Deviation (SD-IF) was then subtracted in order to decrease the chance that individual listeners will experience a threshold shift greater than 2 dB because they have less than average attenuation.

Thus, it is recommended that octave-band noise levels not exceed the following using the sound level meter's Linear weighting scale:

| | Frequency (Hz) | | | | | | |
|--|----------------|-----|-----|------|------|------|------|
| | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| INTEGRAfit headset MPANLs 500-8000Hz less one Standard | 61 | 57 | 49 | 48 | 47 | 42 | 46 |

| | | | | | | | |
|-----------|--|--|--|--|--|--|--|
| Deviation | | | | | | | |
|-----------|--|--|--|--|--|--|--|

It is further recommended that noise levels not exceed 75 dB SPL at 63Hz and 89 dB SPL at 31.5Hz per the rationale stated in Annex C of ANSI S3.1-1999 in order to reduce the likelihood of extreme low-frequency sound interfering with the test. Should the user not have access to an octave-band analyzer, a basic sound level meter capable of C or Linear weighting can be used to make a gross judgment concerning the appropriateness of the background noise in the testing room. If the background noise measured with this device does not exceed 60 dB SPL, then the room is probably sufficiently quiet for accurate audiometric threshold testing at 500Hz using the INTEGRAfit headset. In any case, audiometric testing requires uninterrupted concentration and care should be taken to minimize distractions such as conversation, ringing phones and visual distractions.

Do I have to be CAOHC certified to use INTEGRAfit?

CAOHC certification is not required to use INTEGRAfit. However, CAOHC certification is recommended for any person who oversees the daily activities of a hearing conservation program.

How accurate is the PAR using just 500 Hz? Should we test the optional 1000 Hz and 2000Hz frequencies?

In talking with those persons most likely to use INTEGRAfit (nurses and safety managers), we learned that they want a system that is simple to use, gives accurate results, and is not time-consuming. Nurses and Safety Managers are busy people who have a lot on their plate in addition to hearing conservation activities. Nurses in particular are strapped for time. Those nurses conducting their own audiometric testing for OSHA/MSHA compliance purposes do not have a lot of time to spend on REAT testing. Testing at only 500 Hz results in a PAR about 3 decibels lower than would be measured if multiple test frequencies were used. In other words, INTEGRAfit is actually a bit conservative – the worker is probably achieving a few decibels more protection than INTEGRAfit is measuring.

250 Hz is probably the best test frequency because it more accurately measures air leaks – the leading cause of poor attenuation – but is also a more difficult frequency to test being more susceptible to background noise interference. It takes a very quiet room to test 250 Hz accurately and quickly.

1000 Hz is the one frequency that most accurately predicts a multiple-frequency PAR (within about 1.5 decibels) but is less accurate at measuring air leaks. 500 Hz is a good alternative: it is better at detecting air leaks than 1000 Hz and is less susceptible to background noise interference than 250 Hz.

Could we have designed a test to measure a low-frequency (500 Hz) and a high frequency (3000 Hz, for instance) to calculate a two-frequency PAR? Yes, we could have and a two-frequency test taking five minutes or so certainly seems reasonable. The issue is that many workers have significant hearing loss at these higher frequencies (3000, 4000 and 6000 Hz). Thus, it can be difficult to obtain a high-frequency PAR using a threshold-based REAT procedure. This is why the first generation of INTEGRAfit products tested at only 500 Hz only. Our new INTEGRAfit products for the iPad® and the Audiometer Version, can test at the following frequencies:

- 500 Hz only
- 500 Hz and 1000 Hz
- 500 Hz, 1000 Hz and 2000 Hz

Adding the 1000 Hz and 2000 Hz frequencies increases the accuracy of the resulting PAR, but also increases the time of the test. These additional frequencies can be valuable when performing Training Tests with the INTEGRAfit software. During Training tests, the subject is tested multiple times with different types and sizes of earplugs to determine the best fit for the level of noise they are working in. The addition of 1000 Hz and 2000 Hz yields a more accurate PAR and EPL (Expected Protection Level) to increase the confidence level of the earplug noise reduction. During Compliance Testing, a quick check to performed to determine if the subject is wearing their hearing protection properly, the 500 Hz only test gives us a nice compromise of testing speed and PAR accuracy.

If I only test at 500Hz, can I be confident that the worker is being protected at higher frequencies?

A fair question given that noise-induced hearing loss tends to occur in the 3000 – 6000Hz range, not at 500Hz.

In 1980, the earplug manufacturer EAR published “EARlog 4 – The Performance of Hearing Protectors in Industrial Noise Environments.” The pdf version of this document is available at <http://www.e-a->

[r.com/pdf/hearingcons/earlog4.pdf](http://www.ear.com/pdf/hearingcons/earlog4.pdf) . Briefly summarized, EAR's research indicated three decades ago that the NRR did not accurately predict how much real-world noise reduction a worker achieved. Important to the present question, the graphs in the Earlog show quite clearly that earplugs and earmuffs provide greater noise reduction at higher frequencies than at lower frequencies.

This is essentially why INTEGRAfit tends to underestimate a multiple-frequency PAR by a few decibels: 500 Hz is a frequency at which maximal noise reduction is not typically achieved. Testing at 500 Hz yields a conservative estimate of a multiple-frequency PAR because it tends to underestimate high-frequency noise reduction. So the answer is Yes, one can be confident that if the 500 Hz PAR is acceptable per EN458 criteria (see below) then the worker is being at least that well protected at higher frequencies.

Remember too from the above discussion that air leaks are the major source of poor noise reduction and that 500 Hz is better at detecting air leaks than higher frequencies.

Why does INTEGRAfit measure in 2 decibel increments? Why not 5 decibel or even 1 decibel increments?

Those familiar with OSHA/MSHA audiometric testing know that such testing is conducted in 5 decibel increments. For REAT testing however the general consensus is that 5 decibel increments is not sufficiently accurate to properly calculate a PAR and then compare it with measured noise exposure levels (which tend to be more accurate than ± 5 decibels).

Testing in 1 decibel increments would seem to be ideal and can be done, but this increases the difficulty of taking the REAT test. Using 2 decibel increments is considerably easier for the test taker which speeds up the test with only a minimal (and practically insignificant) degree of lost accuracy.

How do I know if the measured PAR is enough to protect the worker?

INTEGRAfit will allow you to enter a Time-Weighted Average (TWA) noise exposure level for the worker. This information is obtained from your noise survey. INTEGRAfit will subtract the PAR from the TWA to determine an

Effective Protection Level (EPL). INTEGRAFit will then determine if the EPL is sufficient to protect the worker at the TWA by using the criteria in EN458 (see below).

Bear in mind that all noise surveys are to some degree inaccurate, just as PAR measurements are to some degree inaccurate. The more accurate the noise survey, the more accurate the resulting EPL.

Noise surveys and PAR measures are tools to provide useful information, but not substitutes for common sense. In fact, the above discussion stated that INTEGRAFit tends to underestimate the actual hearing protection received by about 5 decibels on average. This provides a “safety cushion” to hedge against some of the inaccuracies in both noise surveys and REAT measures.

What is the EPL?

The EPL (Effective Protection Level) is defined as the level of noise in which the employee is working (TWA-PAR=EPL).

What is EN458?

EN458 is a European noise standard designed to determine if a worker is achieving sufficient protection. Specifically, it provides criteria for determining whether a worker wearing earplugs or earmuffs is being over-protected, appropriately protected, or under-protected. EN458 has wide acceptance among professional hearing conservationists.

Is INTEGRAFit appropriate for use with Impulse and Impact noise?

First, let's define Impact noise and Impulse noise. Impulse noise is that very fast, very loud noise one hears when firing a rifle, shotgun, handgun or other ordnance. Those most commonly exposed to occupational Impulse noise are military, law enforcement and other security personnel who periodically fire weapons.

Impact noise is that loud, sharp “bang-bang-bang” noise that one would hear in manufacturing processes like metal stamping and rebar fabrication. It is most commonly thought of as metal-on-metal noise though it can really be produced by any material. It is not unusual that the background noise is fairly

quiet with the “banging” process producing nearly all of the daily noise exposure.

Impact and Impulse noise is very different from Continuous noise which is the source of exposure for most workers. This is important because using the TWA to calculate an Effective Protection Level (EPL) can result in under-protection if the noise environment is predominately Impact or Impulse noise. INTEGRAFit IA uses an algorithm developed by the National Institute for Occupational Safety and Health (NIOSH) to calculate a noise exposure level that is different from the TWA. The NIOSH formula requires an estimate of the highest noise exposure level (peak dB SPL) and the number of exposures per day. With this information, INTEGRAFit IA calculates the EPL which can then be compared to the EN458 criteria.

Please note that NIOSH believes the combination of Continuous and Impact/Impulse noise to be more damaging than either alone. NIOSH strongly recommends that the TWA be calculated using a more protective 3-dB Exchange Rate, not the 5-dB Exchange Rate allowed by OSHA and MSHA.

What should I do if INTEGRAFit tells me that the worker is under-protected?

Under-protection can result from a number of factors including:

- Poor earplug insertion procedure
- Tampering with earplugs (cutting off flanges or cutting the earplug in half, for instance)
- Wearing earplugs that are too large or too small
- Lack of proper training in correct insertion of hearing protectors
- Lack of disciplinary effort by management

Most of these are user-related issues and can be resolved with proper training. INTEGRAFit is an ideal tool to help select earplugs which are right for the worker, and to train the worker how to properly wear them. If an insufficient PAR is measured, then an opportunity exists to immediately take action in order to prevent future hearing loss. This would include re-training on proper insertion procedure, or trying different hearing protectors which fit better. INTEGRAFit has a Training mode for just this purpose (see below).

Please note that research shows Training and Discipline to be absolutely critical to the long-term success of the hearing conservation program.

INTEGRAfit is an excellent training tool, but good training alone is insufficient. Training and Discipline are critical to an effective hearing conservation program.

What if INTEGRAfit tells me that the worker is over-protected?

Is over-protection a bad thing? It depends upon the degree of over-protection. NIOSH reports that 76% of all industrial workers need no more than a PAR of 10 decibels, and 90% need no more than a PAR of 15 decibels. However, a recent study conducted by a hearing protector manufacturer shows that about two-thirds of workers are achieving real-world attenuation in excess of 15 decibels, some as high as 40-to-50 decibels! Some amount of over-protection is likely with well-fitting standard hearing protectors and is an acceptable tradeoff – better to be over-protected than under-protected. However, excessive over-protection interferes with speech communication, the hearing of warning alarms, and general loss of auditory contact with one’s surroundings – especially for a person with significant hearing loss. These are issues that not only affect the health & safety of the worker, but can have ramifications for production as well.

When excessive over-protection is measured, the worker should consider a “lighter” hearing protector. It may be appropriate to substitute a non-foam earplug for a foam earplug, or use higher-tech protectors that attenuate less than standard protectors. INTEGRAfit will allow the user to compare a variety of protectors to help determine what is most appropriate for the worker’s noise environment.

Be aware that some workers will actually prefer a degree of over-protection, particularly if accustomed to such already.

In a Continuous noise environment, is the TWA exposure level always the right number to use?

The TWA will be the appropriate number to use for the great majority of workers in typical industrial manufacturing sites because the noise level to which these workers are exposed usually does not vary a great deal from moment to moment. However, there are instances when it makes more sense to use an exposure value other than the TWA.

An example of this atypical case would be a person working in the Press Room of a large newspaper printing operation. It is not unusual for the setup phase of the process to last for hours during which time the ambient background noise level is mostly in the 60s and 70s – safe unprotected noise levels. But when the printing press is turned on, it runs for a few hours at a high ambient noise level, 105 decibels for instance. The resulting TWA might be only 95 decibels, but the worker is actually exposed to 105 decibels when on the production floor. In this case, it makes more sense to protect against the higher exposure level.

What is the difference between the Compliance mode and the Training mode?

The Training mode requires that the first measure be taken with Earplugs Out. The multiple PAR values can be measured to help select the best earplug for the worker and visually display how proper insertion procedure increases the PAR. In the Compliance mode, the idea is to locate the worker on the production floor with earplugs in place, remove the worker to a quiet room and measure a PAR to determine if adequate protection is achieved. Compliance results can be trended over time for an individual worker, a job, a department, even the company as a whole to help determine if the hearing conservation program is becoming more or less effective over time.

When thinking about Compliance testing, it is important to understand how INTEGRAfit differs from other systems. The “Hawthorne Effect” is an important scientific principle stating that in the act of measuring something we must be careful not to affect that which we purport to measure unless we intend to do so. For measuring Compliance, we must minimize the Hawthorne Effect if we are to accurately assess how much real-world protection the worker is actually receiving. The ability to bring the worker out of the production area into a quiet room to get the initial thresholds without touching that worker’s earplugs or earmuffs is critical to measuring how much real-world protection that worker is achieving. Some other fit-test systems require as a first step either the removal of the hearing protection or some further modification that could affect the fit of the protector. This in essence means that some fit-test systems, while fine for Training, are not properly measuring Compliance. To one degree or another, their measurement protocol produces a Hawthorne Effect – they measure something other than the amount of real-world protection being achieved by that worker.

Should I test everyone? How often should I test?

There is no OSHA or MSHA requirement with regard to REAT testing. The company is free to test whom it wishes as frequently as it wishes.

We recommend that all persons be tested initially in Compliance mode to get a baseline compliance level with which to compare future results, and to provide an opportunity for Training.

We also recommend frequent, random Compliance testing to gauge the effectiveness of the hearing conservation program and to find those workers needing additional training. At the touch of a button, INTEGRAfit will randomly select any number of workers for Compliance testing. Frequent testing will quickly reinforce the importance of the hearing conservation program. Remember that testing and training can be conducted rather quickly with INTEGRAfit.

If the company is conducting its own hearing tests for OSHA/MSHA purposes, then an ideal time to conduct a Training test is immediately following the annual audiogram.

Users of Workplace Applications audiometric software are familiar with the Early Warning Shift (EWS) report. The EWS report identifies those persons who would have had a Standard Threshold Shift were it not for age-correction. Thus, the EWS report identifies those persons at risk for an age-adjusted STS (and potentially a recordable hearing loss) in the near future. INTEGRAfit testing and training is recommended for these at-risk persons.

Should I test a person with a Standard Threshold Shift or a Possible Recordable? Will INTEGRAfit help with Workers' Compensation decisions?

Yes, please test persons with Standard Threshold Shifts (STS) or Possible Recordables...though it is strongly advised not to limit testing to only these persons. The better idea is to use INTEGRAfit proactively to constantly improve the hearing conservation program (HCP) thereby reducing STSs and Possible Recordables through the prevention of hearing loss. STSs and Possible Recordables are "lagging" indicators of HCP effectiveness whereas trending compliance values is an excellent "leading" indicator.

When an STS or Possible Recordable is detected, OSHA/MSHA has required follow-up activities. Those include refitting and retraining the worker in the use of hearing protection. What better to determine and document the sufficiency of the worker's hearing protectors than with INTEGRAfit!

INTEGRAfit can provide valuable data to assist with OSHA/MSHA hearing loss recordability and Workers' Compensation decisions. Well-documented evidence of training, adequate protection and employee compliance – especially if gathered on the worker over a number of years – is evidence that the change in hearing may be due to factors other than occupational noise exposure.

Does INTEGRAfit require onsite training?

No and it really is not necessary since the software is so intuitive to use. The INTEGRAfit software uses a step-by-step wizard with both text and pictures to guide the user through the process of testing the earplugs. Workplace INTEGRA also provides easy-to-understand video instructions on how to set up the equipment in a quiet room or sound booth. Workplace INTEGRA will provide internet-based training using WebEx if the user desires, and technical support is just a phone call away.

Will INTEGRAfit measure a PAR for a worker with hearing loss?

One of the reasons that 500 Hz was chosen as the default testing frequency is because the incidence of hearing loss at 500 Hz is low. Our analysis indicates that approximately 8% of occupationally-noise exposed workers have 500 Hz thresholds greater than 20 decibels (20 dB HL).

INTEGRAfit's maximum output at 500 Hz is 90 dB HL. Assuming that a worker obtains 30 decibels of hearing protection from earplugs, the maximum hearing loss that INTEGRAfit will accommodate is 60 dB HL. If a worker obtains 40 decibels of hearing protection...a very high amount of hearing protection even with double protection...the maximum hearing loss INTEGRAfit will accommodate is 50 dB HL. Our analysis shows that less than 1% of occupationally-noise exposed workers have hearing loss greater than 40 dB HL and less than 0.5% have hearing loss exceeding 60 dB HL. The

bottom line is that INTEGRAfit will accurately measure a PAR on 99% of the noise exposed workforce.

Suppose the hearing-impaired worker gets too much attenuation that INTEGRAfit gets no response at 90 dB HL with hearing protection in place. INTEGRAfit will report the measured PAR as at least the difference between 90 dB HL and the Un-occluded Threshold. For instance, if the measured threshold in the Earplugs Out condition is 65 dB HL and the measured threshold in the Earplugs In condition is a No Response @ 90 dB HL, then INTEGRAfit will report the PAR as at least $90 - 65 = 25$ decibels. Thus, we can be assured that the worker is receiving at least this degree of protection. Similarly, the EPL will be reported as at least the difference between the TWA and the reported PAR.

But why limit the audiometer to a 90 dB HL output? Why can't we test at higher output levels? The primary reason is that the audiometer's circuitry simply can't go much above 90 dB HL at 500Hz without significantly distorting the signal. Another factor is that testing in the Earplugs Out condition above about 90 dB HL may not be safe for the person being tested because of a condition known as recruitment. Persons with damaged hearing may experience recruitment – a reduction in the difference between the threshold of hearing and threshold of discomfort. The possibility of recruitment makes it somewhat risky to test persons with damaged hearing above 90 dB HL and is thus best left to hearing health professionals.

***For additional information or for a demo of INTEGRAfit,
please contact Workplace INTEGRA Inc. at
1-888-WPI-0001.***