

HPD: What's Your Number?

Introduction to the technologies and techniques used in hearing protection

Hearing Protection Devices (HPDs) come in all shapes and sizes; some even have “bells and whistles.” But the common characteristic that links all HPDs and greatly differentiates them is their ability to do their job; to protect your hearing from hazardous noise!

Knowing how to determine which HPD does its job the best requires the user to rely upon the manufacturers' published performance data, a little knowledge of the acronyms and a few tricks of the trade.

Here are some of the basics of what you need to know.

Passive Noise Reduction (PNR)

PNR is the reduction of unwanted sounds (noise) through the use of passive materials such as foam and silicone. PNR is particularly effective at reducing mid – high frequency noises. A high PNR figure is highly dependent upon achieving a good ear canal seal. To achieve this seal either the around-the-ear headset conforms to the users head well and clamps tightly, or the in-ear ear tip (foam, silicon flange or custom silicon earplug) is fitted well inside the ear canal without any noise leaks.

- PROs: PNR devices work very well at reducing high frequency and impulsive noise; they are not effective at reducing low frequency noise generated by mobility platforms, such as tactical vehicles, aircraft and boats.
- CONs: Achieving good PNR in a benign laboratory setting is far easier than achieving this in a 'real-life' military operational setting.

Active Noise Reduction (ANR)

ANR is the electro-acoustic reduction of unwanted sounds (noise) through the use of electronics, traditionally

analogue, or more advanced digital processing. It relies on the principle of equal and opposite sounds cancelling each other out.

In a typical setup, an ANR headset uses a microphone to pick up sound. This sound is processed through the electronics and inverted so that it is 180 degrees out of phase with the original noise, and matched so the relative amplitudes of the signals are the same. The headset then plays this anti-phase noise through a loudspeaker within the ear piece so that the original and anti-phase noises cancel out each other. The

result is a much lower residual noise signal.

PROs: ANR systems work best on continuous, well-defined periodic noises. Single frequency 'tones' are straight forward for most ANR systems including analogue. Broadband noise, that is noise made up of many frequencies of different amplitudes, differentiates ANR technologies and reveals the benefit of digital ANR processing.

CONs: In a laboratory setting ANR is not difficult to achieve. The practical application presents several problems and if not addressed will lead to instability and



▶ poor performance. Instability is an undesirable effect. If the ANR system started adding the noises together because it did not process the sound quickly enough, the result would be similar to the screeching 'feedback' sound experienced when putting a microphone next to a loudspeaker in a public address system. Also, ANR headsets do not work as well on high frequency noise. ANR techniques cannot attenuate impulse noise from a weapon's discharge or explosions.

Talk-Through

HPDs are designed to prevent hearing damage, but having users' ears covered degrades their ability to hear naturally.

To try and overcome this effect of the HPD, communication headsets quite often provide a means of replicating the sounds external to the headset so the user can have normal conversations while still wearing the headset as well as maintaining their situational awareness. This is achieved mechanically - using a valve (or port) on the headset, or electronically.

The two different variants of headsets with talk-through capabilities provide protection from impulse noise:

Mechanical talk-through systems use a mechanical acoustic valve that closes when it detects a specific sound pressure level.

Electrical systems provide a means of reproducing the sounds inside the headset or earpiece. A microphone on the outside of the headset listens to the sound; the system then processes it through the use of electronics and presents it to the user through a loudspeaker. When the system detects loud impulse noise, normally it can only do one of the following things to protect the user:

- Shut down the talk-through system completely so that no sound comes through the electronic system.
- Clip the sound so that only sound below a pre-define level is allowed through to the ear.
- Compress the sound so that all sounds are reduced below the set threshold level.

PROs: The two important aspects of impulse protection relate to the speed of response to the impulse noise and the treatment of the sound during the impulse event. The QUIETPRO Intelligent Hearing System uses

a specifically-designed Application Specific Integrated Circuit (ASIC) that performs both digital ANR and talk-through impulse protection. The purpose-built processing engine works entirely in the digital domain - not analogue, therefore operating faster than standard DSP or analogue circuits. Nacre's adaptive algorithm combines several of the sound treatments. The effect is that the speed of response to the impulse event is ultra quick – stopping only the unwanted noise and quickly restoring full natural

hearing. With the QUIETPRO, it is still possible for the user to hear sounds around them even during the impulse noise event.

CONs: Many headsets use analogue electronics to provide impulse protection. It is becoming more common for headsets to use commercial off-the-shelf Digital Signal Processing (DSP) integrated circuits for this purpose. These DSP devices essentially perform in the same way as their analogue equivalents; they do



QUIETPRO allows natural hearing © Nacre

▶ however allow the noise threshold 'trigger' level to be programmed by the manufacturer. The term 'Active' headset is sometimes used to describe the electronic impulse protection or more accurately the Talk-Through control. This can be misunderstood to mean that the headset employs Active Noise Reduction. These are two quite different principles.

High levels of impulse protection are provided by good PNR and effective Talk-Through control.

Manufacturers Attenuation Data – NRR / SNR

The Noise Reduction Rating is the most common way for manufacturers to detail the performance of their HPD. Beware though, the NRR figure only applies to PNR and does not consider the contribution of ANR on an HPD's performance.

Traditionally, NRR figures are measured in accordance with American National Standards Institute (ANSI) S3.19-1974. The European standard EN352-2 provides a Single Number Rating (SNR) figure that manufactures sometimes use instead of the NRR figure (one of those tricks of the trade).

Since rating methods are based upon idealized laboratory testing, some have criticized the NRR and SNR for being too generous in its prediction of noise reduction (attenuation). Studies indicate that while some users in real-world applications achieve these ratings, many users do not. This has led to a variety of inappropriate de-rating methods for hearing protectors, and has contributed to much confusion in knowing how to accurately estimate a hearing protector's attenuation.

In an effort to bring the Noise Reduction Rating more in line with real-world usage, the United States Environmental Protection Agency (EPA) has proposed a new regulation for the testing and labelling of HPDs. Under the proposed regulation, manufacturers will use a new rating system. While it will still be known as the NRR, this new rating will now represent a two-number range of expected protection, as opposed to a single-number estimate.

The proposed method will use a new ANSI-standard lab test protocol, ANSI S12.6-2008 (Supervised Subject Fit), to generate the attenuation ratings. It will now provide an indication of how much attenuation minimally-trained

users (the lower number) versus highly-motivated trained users (the higher number) can expect to achieve. For some hearing protectors, the spread of this range may be quite significant.

Most recently, Nacre independently tested its QUIETPRO Intelligent Hearing System to the proposed new ANSI S12.6-2008 Method A protocol. The initial results showed that in its lower number, it could achieve 33 dB of noise reduction, and 40 dB in its high range.

Selecting HPDs

If you are involved in military operations, the chances are rather high that you will require a Hearing Protection Device. Depending upon their role, some users may even need the 'bells and whistles.' Be sure to select the appropriate device for your needs. Insist that the manufacturers provide you all pertinent information with the product, most importantly the NRR independently tested in accordance with the new standard. ■

Copies of the ANSI S12.6-2008 QUIETPRO test report are available from Nacre.

References:

American National Standards Institute (ANSI) S12.6 2008 Control of Noise at Work Regulations 2005 (the Noise Regulations 2005). Leaflet INDG362(rev1), revised 10/05, reprinted 10/08 <http://www.hse.gov.uk/pubns/indg362.pdf>
 NIOSH National Institute for Occupational Safety and Health <http://www.cdc.gov/niosh/topics/noise/HearForever.org> – a Howard Leight education initiative.
 National Hearing Conservation Association (NHCA).
 Howard Leight Information sheet "Inside the EPA's Proposed Change to the Noise Reduction Rating" http://www.hearforever.org/userfiles/HL1801_Inside_the_EPA_Proposed_Change_to_the_NRR.pdf
 EHS Today Article "NRR: Now Really" Feb 1, 2009. Renee S. Bessette

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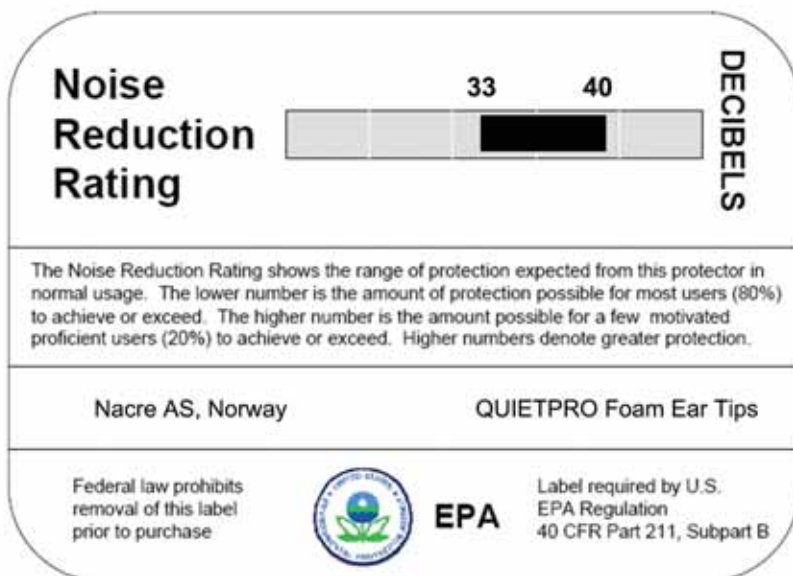


Figure: Potential New NRR Label