Why the NRR is not an accurate measure of hearing protection

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The NRR is often cited as a standard for hearing protection. A product with a higher NRR is supposed to provide better hearing protection than a product with a lower NRR. However, due to the way the NRR is calculated it is really not an accurate indicator of hearing protection. It is a simple, single number for the consumer to evaluate, but it is a flawed number nevertheless.

The NRR is the result of a complex mathematical calculation that averages the attenuation of sound over 9 octave centers, and adjusts for the standard deviation in attenuation of multiple examples of the same product[1]. Typically 30 examples of a given product are measured for their attenuation at 125, 250, 500, 1000, 2000, 4000 and 8000 Hz. The calculated attenuation at each frequency is determined as:

(Average of all measurements) – (2 times the standard deviation of those measurements)

Once this has been calculated for each band, the results are averaged together to create the single NRR number as reported on the product.

However this average does not account for the fact our hearing sensitivity varies with frequency (see the ISO 226:2003[2]). Essentially our ability to hear the lowest and highest frequency tones is poor as compared to our ability to hear midrange tones. And in line with the sensitivity of the ear (high in the midrange, low at the bottom and top of the frequency spectrum), hearing loss starts in the midrange well before any damage occurs at the lower and upper end of the frequency spectrum[3].

Additionally, speech energy tends to be concentrated between 500 and 4000 Hz, meaning that damage in that range will negatively impact the ability to clearly understand speech[4]. Damage to the midrange is more detrimental to the ability of a person to communicate and interact socially than damage to the bass or treble ranges.

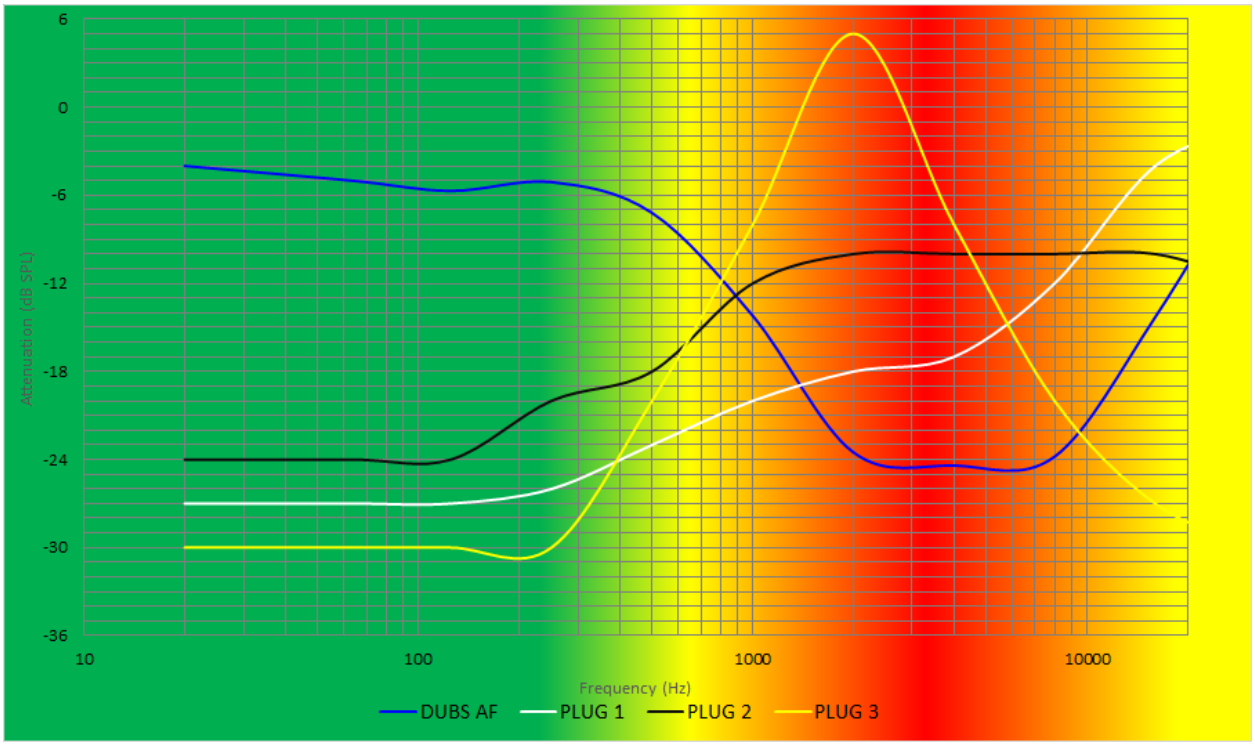
Taken together, it is easy to see that using a formula which equally weights protection at 125 Hz with that at 2000 Hz simply does not match the ability of our ears to hear, nor adequately describe the protection needed to ensure the ability to communicate. A hearing protection device with very high attenuation at 125 to 1000 Hz, and poor attenuation at 2000 and 4000 Hz may have a higher NRR than a device that provides lower – but still very acceptable – levels of protection in the lower frequencies and superior attenuation at 2000 and 400 Hz. But the latter – with the lower NRR – would provide better overall hearing protection because it is better protecting the frequencies where we are more sensitive and more subject to damage – and where damage is much more detrimental to communication.

The DUBS Acoustic Filters, to maximize sonic enjoyment, employ minimal attenuation in the low frequencies. You still hear the bass and midbass. But they provide up to 24 dB of attenuation in the critical midrange frequencies, where sensitivity is high – and the risk of damage is highest. The NRR

[1] http://www.cdc.gov/niosh/z-draft-under-review-do-not-cite/hpdcompdev/pdfs/NIOSH_Compendium_Calculation.pdf
[2] http://en.wikipedia.org/wiki/Equal-loudness_contour
[3] http://www.ccohs.ca/oshanswers/phys_agents/noise_auditory.html
[4] http://www.hdhearing.com/learning/part2.htm

penalizes products that provide a musically satisfying experience yet still provide a strong level of protection in the frequencies where damage occurs.

For example, refer to the following graph:



The vertical axis is attenuation – lower numbers (towards the bottom) indicate more attenuation (reduction in sound). The horizontal axis is frequency – the left side are low frequencies (bass), the right side are high frequencies (treble). The colors indicate your risk of damage from exposure to loud sounds – green areas are low risk of damage, yellow is moderate risk, red is high risk of damage.

The blue curve are our DUBS Acoustic Filters. They provide minimal attenuation in the lower frequencies, and strong attenuation in the midrange. The DUBS Acoustic Filters have a measured NRR of 12.

The other curves are theoretical constructs for the purpose of this discussion. The white curve (PLUG 1) has an NRR of 20; the black curve (PLUG 2) has an NRR of 15, and the yellow curve (PLUG 3) has an NRR of 16. Note that all of them provide LESS protection in the critical midrange, and in one case – the yellow curve – actually AMPLIFIES the sound where it could cause permanent hearing damage in a very short time (it turns the volume up, rather than attenuates, in the critical midrange). Yet all 3 of these alternate designs would have a better NRR than the DUBS Acoustic Filters.

We suggest that, rather than going by the Government required NRR published number, a consumer look for an actual published frequency response, or at the very least a table of attenuation values versus frequencies (as required by EU Directive EN352). This information provides the consumer with actual information regarding actual effective protection where it matters, and not a simple “one number” scale that does not relate to actual effective protection from hearing damage.

