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THE (IN)FAMOUS NRR – NEW DERATING

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NRR stands for Noise Reduction Rating, a way of labeling hearing protectors regarding their sound attenuation. It ranks between 5 and 35; the higher number meaning higher attenuation. Since 1979, the U.S. Environmental Protection Agency (EPA)[1] requires all non-custom hearing protectors to be labeled. That is why NRR has gained such notoriety. The meaning and the way how to use the NRR is found in every single document produced by such important institutions as the NIOSH in the USA, or the CCOHS in Canada.

Besides the fact that the hearing protector's literature is permeated by information on the NRR, what makes it so attractive is the ease of use. By definition, the sound level of the protected ear (in 98% of the population) is calculated as:

$SL_{prot.\ ear}$ (dBA) = $SL_{ambient}$ (dBC) – NRR.

When the environmental noise is measured in dBA, then the formula is:

$SL_{prot.\ ear}$ (dBA) = $SL_{ambient}$ (dBA) – (NRR - 7)

In other words, the only measurement that has to be performed is that of the ambient noise level in dBC or dBA. The rest is simple adding and subtracting.

However, we all know that nothing is as simple as it appears. Numerous studies have been performed comparing the calculated noise level as per the above formula with real-life measurements. Results have shown that the NRR is far too optimistic in that the noise levels at the protected ear are much higher than those calculated.[2] As a consequence, there was a need for "correcting" the calculated value of the NRR, something called "derating."

There are several derating procedures, from a single stage one to another with several stages.

OSHA applies the same derating to all types of hearing protectors as follows:

Apply a 50% factor to the manufacturer's labeled NRR (e.g., if the NRR is 26 dB, use 26 × 0.5 =13 dB)

NIOSH uses different deratings according to the type of hearing protector:

- Earmuffs - Subtract 25% from the NRR
- Formable earplugs - Subtract 50% from the manufacturer's labeled NRR
- All other earplugs - Subtract 70% from the manufacturers labeled NRR

The latest document in Canada dealing with this issue is the CSA Draft Standard Z94.2 – 14 Hearing protection devices - Performance, selection, care, and use. Although not yet a standard, it will shortly be issued for public consultation. It provides guidance in the use and derating of the NRR.

The following section is taken directly from the Draft, as is the Table 2 below:

9.6.5.2

NRR has been widely recognized as a value that substantially overestimates the attenuation that can be achieved under field conditions (the overestimation is greater in the case of earplugs than in the case of earmuffs). Various derating factors — absolute decibel values or percentage deratings — have been proposed but none has good precision and can accurately predict what a group or especially an individual will experience in practice. Nevertheless, some amount of derating is needed in order to provide a degree of predictability from the optimum fit laboratory data. For the purposes of this Standard, Table 2 provides guidance in the application and the derating of NRR.

Table 2. Method for derating and application of the NRR

Device type	Effective rating
Earplugs	50%
Earmuffs	70%
Dual protection	60%

Note: Predicted values shall be rounded to integer values.

Example for Use with C-Weighted Sound Measurements

The measured Leq is 95 dBC. For an earmuff with a labeled NRR of 26 dB, the predicted A-weighted effective Leq when the hearing protector is worn is computed as follows:

95 dBC – 26 (0.7) = 95 – 18.2 = 76.8, which rounds to 77 dBA.

Example for Use with A-Weighted Sound Measurements

If the user wishes to apply the NRR to an A-weighted sound level, then the NRR shall be reduced by 3 dB after the derating is applied. For a measured A-weighted Leq of 95 dBA, and presuming the same earmuff is used as in the preceding example, above with a labeled NRR of 26, the predicted A-weighted effective Leq is computed as follows:

95 dBA – [26 (0.7) – 3] = 95 – [18.2 – 3] = 79.8, which rounds to 80 dBA

Notes

(1) “Earplugs” includes the following types: rolldown foam, push-to-fit, premoulded, formable, custom moulded, and semi-insert. “Earmuffs” includes both cups on a head/neck band and cap-attached earmuffs.

(2) For dual protection, the value in the table is either applied to the reported NRR of the earplug plus earmuff or, in cases where the attenuation data of the combined devices are not available, the value in the table is applied to an estimated dual-protection attenuation that is equal to the higher of the individual NRRs of the two devices plus 5 dB.

(3) The reason that a 3-dB adjustment is required for use of the NRR with A-weighted sound levels is that the derivation of the NRR was based upon measuring sound exposure in dBC in order to estimate the predicted protected level in dBA. The 3-dB adjustment utilized above was selected based on the most current analyses of occupational noise data as found in Gauger and Berger (2004), and in place of the 7-dB adjustment previously specified by the U S National Institute for Occupational Safety and Health. The Gauger and Berger work indicates that a more representative and appropriate correction for prediction errors arising using NRR with A- instead of C weighting is 3 instead of 7 dB.

We hope that the use of the above table will facilitate the work of those responsible for managing hearing conservation programs, providing, at the same time, result that are close to those obtained in the real world.

References

1. US Environmental Protection Agency. Noise labeling requirements for hearing protectors. Washington: Author; Fed. Regist. 44(190),40CFR Part 211, 56130-56147.
2. Berger et al. International review of field studies…" In: Alexon et al Eds., Scientific basis of noise-induced hearing loss. New York: Thieme Medical Publishers Inc; 1996.