Understanding the NRR: How to Calculate Real-World Hearing Protector Performance

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Most countries have requirements for how hearing protectors are to be tested and labeled. The purpose is to provide a standardized method for rating products to help consumers compare protectors and choose the best product for your situation. But before we get into the details of hearing protector ratings, we feel it's important to stress that there are many factors other than noise reduction that determine which hearing protector will ultimately prove most effective in the real world. **Many years' experience shows us that the "best" hearing protector is the one that is appropriate for the noise environment (not too much or too little noise reduction) AND the one that is worn correctly and consistently throughout the workday.**

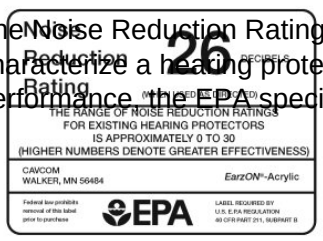
Regulatory matters

When OSHA promulgated its Hearing Conservation Amendment (29 CFR 1910.95) for general industry, it incorporated the existing Environmental Protection Agency (EPA) Noise Reduction Rating (NRR) system for assessing performance of hearing protectors. The EPA developed this laboratory-based system for quantifying noise reduction in the late 1970s and codified it in 40 CFR Part 211, Subpart B. Although numerous changes and improvements have been recommended over the years, the original NRR testing and labeling requirements are still in force today.

Soon after the Hearing Conservation Amendment went into effect, OSHA issued a controversial noise control guideline intended to clarify employer responsibilities for reducing noise given the new Amendment. This compliance directive, CPL 02-02-035, Appendix A, instructs companies to take into account certain factors such as hearing protection, shifts in hearing, cost of controls, etc. when comparing the relative effectiveness of hearing protectors and engineering and/or administrative controls. In this situation, OSHA instructs employers to "apply a safety factor of 50 percent" to the NRR. This directive does not apply to hearing protector requirements under the Hearing Conservation Amendment (OSHA 1910.95 Appendix B; Technical Manual Section III: Chapter 5, Appendix F. Noise Reduction Rating).

When MSHA introduced its latest Occupational Noise Exposure Standard in 1999, Part 62, it did not limit mining operators to use of the EPA's NRR system. Instead, MSHA took a much more flexible approach, allowing hearing protectors to be assessed according to "a scientifically accepted indicator of noise reduction value."

What is the NRR?



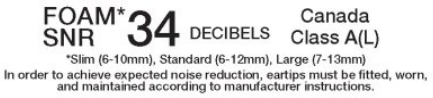
The Noise Reduction Rating (NRR) is a laboratory-derived single-number rating designed to characterize a hearing protector's noise reduction capabilities. To quantify hearing protector performance, the EPA specifies laboratory test protocols that call for a trained experimenter to fit

individual subjects with appropriately sized hearing protectors. Noise attenuation (reduction) values are calculated by comparing the subject's hearing threshold results with and without the hearing protector in accordance with ANSI Standard S3.19 test procedures. Test results are reported for individual octave band test frequencies 125-8000 Hz and then calculated into a single-number overall Noise Reduction Rating.

The NRR is intended to be used to estimate the amount of protection provided by the hearing protector. The EPA originally estimated that the level of noise entering a person's ear, when the hearing protector is well-fitted and worn as directed, is approximated by the difference between the environmental noise level and the NRR. Read further for lessons learned over the years about applying the NRR.

Hearing protector packaging labels must list the single-number NRR, product name, and manufacturer information (see example primary NRR label). A secondary label must also be included that provides further detail regarding the average amount of noise reduction across the required ANSI test frequencies (125 to 8000 Hz) and instructions on how to apply the NRR. example: EPA format for primary NRR label

Other Rating Systems



Although safety professionals in the United States are most familiar with the NRR, there are many different rating systems used in other parts of the world. As example, Canada allows a number of hearing protector ratings including a classification system that divides hearing protectors into Classes A, B or C, determined by how much noise reduction is provided in a specified laboratory setting (CSA Z94.2-14 Hearing Protection Devices). Class A hearing protectors offer the highest protection and may be used in 8-hour time-weighted average noise exposures up to 105 dBA; Class B protectors are rated for average noise exposures up to 95 dBA, and Class C up to 90 dBA. In addition, the suffix 'L' for "low frequency" is added to class A, B, or C when a hearing protector provides at least 20 dB of attenuation at 125 Hz.

How is the NRR used?

Following is a step by step summary of how to apply the laboratory-derived single-number NRR to determine compliance for hearing conservation purposes according to OSHA 191.95(j). Most people are surprised to learn that the NRR system was originally intended for use with broad-spectrum workplace noise readings. According to OSHA, however, employee time-weighted-average noise exposures must be calculated using an A-scale frequency setting on the sound measurement equipment (the A-scale is a weighted frequency setting more closely matched with human damage-risk criteria). To adapt the NRR to A-scale noise readings, a 7dB correction is required. The bottom line: if the employer collects A-scale noise information, but not C-scale, then 7 dB must be subtracted from the NRR to assess hearing protection for the workplace. The end goal of an NRR calculation is to ensure that the worker's protected noise exposure has been reduced to a "safe" level, in most cases considered 85 dBA TWA or below.

NRR METHOD

To estimate worker's protected noise exposure using the laboratory-derived Noise Reduction Rating (NRR):

1. Determine the employee's workplace noise exposure in dBA TWA*
2. Calculate the estimated noise reduction as follows:
o Start with the manufacturer's NRR for this hearing protector (NRR)
o Subtract 7 dB (if using A-weighted noise exposure values*)
o Divide in half to estimate "real world" performance (required if reviewing feasibility of engineering controls)
3. Subtract the noise reduction estimate from the employee's workplace noise exposure to approximate protected exposure *(target 85 dBA TWA or below):*

Workplace Noise Exposure* - [(NRR - 7)] = Estimated Protected Exposure
for HEARING CONSERVATION PROGRAM COMPLIANCE
Workplace Noise Exposure* - [(NRR - 7)/2] = Estimated Protected Exposure
for ENGINEERING NOISE CONTROL REVIEW

**Note: If workplace noise exposure readings are available in C-weighted form (dBC TWA), there is no need to deduct 7 dB when estimating protection using the product's NRR.*

Example
For a noise exposure of 95 dBA TWA and a hearing protector with NRR of 29:
95 - (29-7) = 73 dBA TWA estimated protected exposure (COMPLIANCE)
95 - [(29-7)/2] = 84 dBA TWA estimated protected exposure (ENGINEERING REVIEW)
In this example, both calculations are below the target of 85 dBA TWA

A Special Case: Dual Hearing Protection

Although most noise exposures encountered in industry today can be adequately addressed with a well-fitted earplug or earmuff, some exposures exceed the capabilities of traditional hearing protectors. When intensely loud noise cannot be controlled at the source, it may be necessary for workers to wear both earplugs and earmuffs at the same time, often referred to as "dual hearing protection" or "double hearing protection." The OSHA Technical Manual allows employers to add 5 dB for the second hearing protector. An example: if wearing an earplug with an NRR of 25 together with an earmuff (also with an NRR of 25), expect a combined NRR of 30. Keep in mind, however, that this rule of thumb is a general estimate.

Want to check out calculations for CavCom's hearing protectors or your own?

The Real World - Individual Fit Testing and the Personal Attenuation Rating (PAR)

First we reviewed methods for utilizing the NRR to estimate hearing protector performance. But now we need to point out that laboratory ratings have historically proved poor predictors of what happens in the real world. Hearing protector fit, training, and proper use vary greatly across individuals.

In 2008, an alliance between OSHA, NIOSH and the National Hearing Conservation Association identified a technology designed to establish individualized hearing protection attenuation ratings for each worker. This group of experts recognized the limitations to relying on laboratory conditions and group statistics to predict an individual user's hearing protector performance in the field. "The consequence of this approach is that an individual user may actually receive more but usually less attenuation than is stated on the hearing protector label." Based on their review of research and emerging trends and technologies, the Alliance identified Individual Fit Testing as a recommended best practice for hearing conservation programs. Individual fit testing of hearing protectors is similar in concept to fit testing for respirators. Preferred methods produce a single number overall estimate of real-world attenuation for each worker; this measure is generally referred to as a Personal Attenuation Rating or PAR.

We recommend you begin with the OSHA NRR calculation to help determine which types of hearing protectors will offer adequate reduction for your workplace noise exposures. However, to find out what is happening in the real world for each worker, conduct an Individual Fit Test to ensure that the chosen hearing protector is actually performing as intended. Similar to NRR calculations, the goal of the PAR calculation is to ensure the worker's protected noise exposure has been reduced to a "safe" level, in most cases considered 85 dBA TWA or below. The difference is that the PAR is specific to the worker, derived from individual testing, not laboratory estimates.

PAR METHOD

Estimate protected noise exposure using the worker's personal attenuation rating (PAR):

1. Determine the employee's workplace noise exposure in dBA TWA
2. Establish the employee's personal attenuation rating (PAR) from individual fit testing (no need for A-scale correction or "de-rating")
3. Subtract PAR from the employee's workplace noise exposure to approximate protected exposure:

Workplace Exposure - PAR = Estimated Protected Exposure
for HEARING CONSERVATION PROGRAM

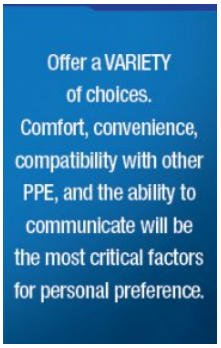
Example

For a noise exposure of 95 dBA TWA and a hearing protector with PAR of 20:

95 - 20 = 75 dBA TWA estimated protected exposure
(COMPLIANCE and ENGINEERING REVIEW)

In this example, the real-world result is well below the target of 85 dBA TWA

Using different methods, you may arrive at different estimates for the same employee and same hearing protector based solely on calculation method. The NRR method might easily overestimate or even underestimate the hearing protector's ability to achieve the target protected goal of 85 dBA TWA. The PAR Method, however, is based on the worker's own field performance. PAR is a better indicator of that individual's protected noise exposure when the hearing protector is worn correctly and consistently throughout a work shift.



Noise Reduction Isn't Everything

It's true that your first step in accomplishing successful hearing protection is to identify a number of quality earplugs and earmuffs with noisereduction capabilities sufficient for the work environment. But there's more to hearing protection than attenuation, whether measured via NRR or PAR. Employees must have the opportunity to select from a suitable variety of devices. Comfort, convenience, compatibility with other PPE, and the ability to communicate are usually the deciding factors in individual choices. Lastly, workers must be individually fitted and thoroughly trained in the proper fit, care and use of the protector. Annual audiometric testing ultimately helps you verify that your efforts have been successful.

Not sure which hearing protectors would be best for your workers? Contact CavCom to discuss the options and to learn more about how our innovative products and systems can improve safety and communication in your workplace.

How Can We Help? Contact Us