Sound Source™

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How Is The SNR Calculated?

When I compare the values in the attenuation charts with the SNR on the package, the SNR is much lower than the average attenuation. How is the SNR calculated?

It is quite an ambitious calculation to take a hearing protector's attenuation measurements at each frequency, input them into a formula, and derive a single-number rating that can be applied universally to all users in all noise settings. If you have studied the attenuation charts on boxes of hearing protectors, you can see the Single Number Rating [SNR] is not simply a mathematical average of the attenuation values. Here are the significant steps used in calculating the SNR[1], and an explanation of why each step is important:

Table 1. **Howard Leight® Max® Single-Use Earplug Attenuation**

Frequency in Hz	63	125	250	500	1000	2000	4000	8000	SNR Value
Mean Attenuation dB	34.6	37.1	37.4	38.8	38.2	37.9	47.3	44.8	37 dB
Standard Deviation dB	3.0	4.5	4.3	3.7	3.5	4.0	3.5	7.2	
Assumed Protection dB	31.6	32.6	33.1	35.1	34.7	33.9	43.8	37.6	

H = 36 dB M = 35 dB L = 34 dB

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Laboratory Testing: Sixteen subjects with normal hearing are tested with properly-fitted hearing protectors [called occluded ear test], and tested again without hearing protectors [called open ear], across a range of sound frequencies. The difference between the open ear and occluded hearing tests gives us the attenuation of the hearing protector. The variability in these attenuation measurements among subjects [the "Standard Deviation"] is calculated and the attenuation values from all subjects are then averaged to give us the "Mean Attenuation in dB" at each frequency. These Mean Attenuation values, as well as the Standard Deviations, appear in the attenuation chart on each box or bulk package of hearing protectors.

Calculate the Assumed Protection Value (APV): To account for individual variation in fitting hearing protectors out in the real world [remember, the laboratory only tested sixteen subjects], a correction factor is subtracted from each attenuation value. This correction factor is based upon the standard deviation, and can be adjusted based upon the desired protection performance [that is, a higher correction will protect a greater percentage of the population]. For example, we subtract one standard deviation from the laboratory attenuation measures to achieve an Assumed Protection Value that can be applied to 84% of the population; but we subtract two standard deviations to achieve an APV that can be applied to 98% of the population. By calculating this Assumed Protection Value, we can generalize the results from a small sample of sixteen subjects to a larger population.

Subtraction from Hypothetical Noise: To account for some differences between the laboratory test sounds and real-world noise, the Assumed Protection Values are subtracted from "hypothetical noise levels" – some standardized noise levels at each frequency band. This step is critical in making the SNR more relevant to a hearing protector user, and not a laboratory microphone which detects sound differently than a human ear.

Logarithmic Addition: Finally, we combine all the adjusted attenuated levels into a single number. Attenuation values are measured in decibels, which are logarithmic numbers. [From math class, you may recall logarithms are related to the exponent of a number, or the power to which a number is raised.] Logarithms cannot just be added mathematically [80 dB plus 80 dB does not equal 160 dB]. They are added in a special way that accounts for the exponents.

The result of this lengthy calculation is the SNR – a single-number rating of a hearing protector's attenuation for a specified percentage of the population. The SNR is significantly lower than the average attenuation across all frequencies because the calculation contains corrections and cushions to make it applicable to a broader population. While it is not a perfect real-world measure of attenuation, the SNR is a very useful standardized method for describing a hearing protector's attenuation in a single number. When subtracted from C-weighted noise measurements in industry, the SNR predicts the A-weighted noise exposures for a given percentage of the population when the hearing protector is worn properly.

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Footnote:

[1] Calculation of the SNR is defined in ISO 4869-2, "Estimation of effective A-weighted sound pressure levels when hearing protectors are worn."