A- and C- Weighted Noise Measurements

Hearing protector literature makes reference to A-weighted and C-weighted noise measurements. What are A-weightings and C-weightings?

A-weighting and C-weighting refer to different scales for loudness perception at various frequencies. At very low sound pressure levels the ear is less sensitive to low frequencies (also to some very high frequencies). In other words, a low-frequency tone, like 100 Hz, needs to be made much louder to be perceived as equally loud as, say, a 1,000 Hz tone, when the tones are presented at a low sound pressure level (like 40 dB). But at higher sound pressure levels—say, 90 dB—the ear perceives the two tones as nearly equal in loudness.

Weighting scales are built into the filters of sound level meters so measurements taken with those meters can mimic this frequency-and-level-dependent behavior of the ear. The A-weighting scale lets the sound level meter "hear" soft sounds approximately the way an average, normal human ear does, by making the meter less sensitive to most low-frequency, and some high-frequency, energy. The C-weighting scale is used to measure loud sounds with approximately equal sensitivity at all frequencies, just like the human ear.

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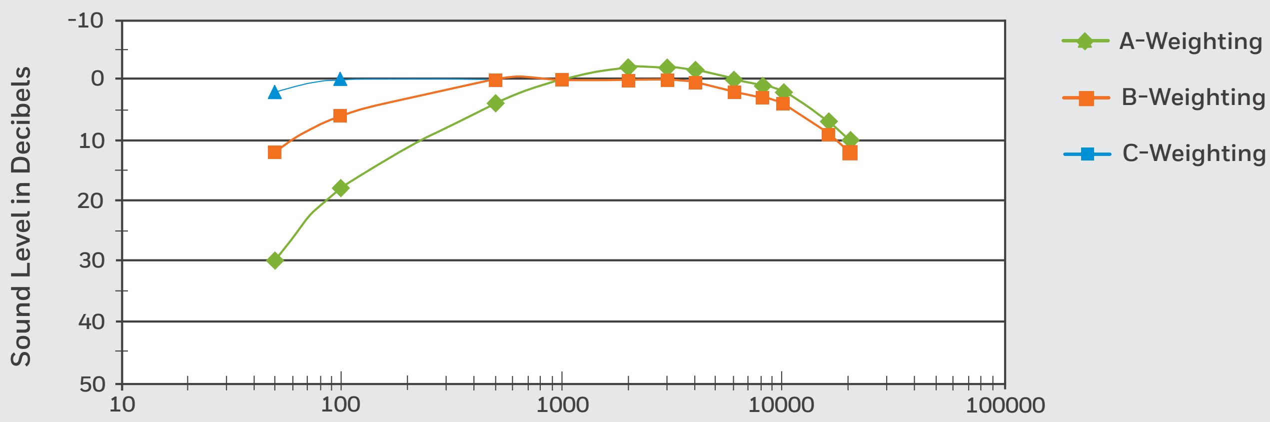
Decibel measurements made with the A-weighting scale are denoted as dBA; those with the C-weighting scale as dBC. There are other weighting scales to account for the range between A-weighting (soft) and C-weighting (loud), but they are not used much anymore. Depending on the weighting scale selected when measuring predominantly-low-frequency sound, a different reading will result. Because the A-weighting scale filters out low-frequency energy, the reading will be several decibels lower than if the measurement were made using the C-weighting scale.

FIGURE 1. A-, B- and C-Weighting Curves



Frequency in Hertz (area under the lines represents sounds that are audible)

A-Weighting

Follows the frequency sensitivity of the human ear at low levels. This is the most commonly used weighting scale, as it also predicts quite well the damage risk of the ear. Sound level meters set to the A-weighting scale will filter out much of the low-frequency noise they measure, similar to the response of the human ear.

B-Weighting

Follows the frequency sensitivity of the human ear at moderate levels, used in the past for predicting performance of loudspeakers and stereos, but not industrial noise. It is no longer used with modern sound level meters.

C-Weighting

Follows the frequency sensitivity of the human ear at high noise levels. The C-weighting scale is quite flat, and therefore includes much more of the low-frequency range of sounds than the A and B scales.

Because hazardous workplace noise is typically loud, it make sense to measure it in dBC. Several of hearing conservation's key documents (including OSHA's Hearing Conservation Amendment, and EPA's labeling requirements for hearing protectors) rely on dBC in determining noise exposures. However, nearly all noise measurements for hearing conservation are measured in dBA. Why is that?

It is because the ears' risk for damage from noise is not the same as the ear's perception of loudness. Early research in hearing conservation concluded that even though the C-weighted scale could predict loudness perception at high sound pressure levels, the A-weighted scale was a better predictor of hearing damage risk from those same levels.

A-weighted measurements of industrial noise can result in misapplications and errors when estimating attenuation from hearing protectors. OSHA has attempted to bridge the difference between C- and A-weightings with the following advice:

- If your industrial noise measurements are in dBC, subtract the NRR of the hearing protector directly from the dBC noise measurement to determine the protected noise level for the worker. Example—Noise Level: 105 dBC, Hearing Protector: 25 dB NRR, Protected Noise Level: 80 dBA.
- If your industrial noise measurements are in dBA, subtract 7 dB from the NRR of the hearing protector for the A-to-C difference, then proceed to subtract the resulting lower NRR from the dBA noise measurement to determine the protected noise level for the worker.
  Example—Noise Level: 100 dBA, Hearing Protector: 25 dB NRR – 7 dB = 18, Protected Noise Level: 82 dBA.

Sound Source is a periodic publication of the Hearing Conservation team of Honeywell Safety Products USA, Inc., addressing questions and topics relating to hearing conservation and hearing protection.

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