

Noise Reduction Rating (NRR)

Guided tours of popular manufacturing facilities/factories, from breweries to aircraft manufacturers, provide visitors with a unique and memorable behind-the-scenes look at the manufacturing process. Some manufacturing facilities, however, can provide a challenge due to their noise level. In these cases, a tour system equipped with noise reduction headphones may be required to both help guests hear the tour guide and to provide guests with adequate hearing protection. This document will provide an overview of how noise reduction rated headphones are rated and how they perform based on their Noise Reduction Rating (NRR).

Noise Levels and Exposure:

Noise reduction headphones are rated in decibels (dB). Before discussing the noise reduction rated values it is important to understand how noise is measured and how to identify, based on those measurements, when hearing protection is required.

Noise is measured in units of sound pressure levels called decibels (dB). Typically, an “A” weighted filter is applied to the measurement, dB(A), because it provides measurements that more accurately represent the sensitivity of the human auditory system by de-emphasizing sound energy in the low and high frequencies in comparison to energy in the mid frequency range. The table below shows common sources of noise and their dB(A) level.

| Typical Sound Pressure Levels, dB(A) | |
|---|--|
|  | Jet aircraft at takeoff, 50 m away 140 |
| | Live Rock Band (Threshold of pain) 130 |
| | Standing beside or near sirens 120 |
| | Chainsaw, 1 m distance 110 |
| | Construction Site 100 |
| | Boiler room 90 |
| | Freight train, 30 m away 80 |
| | Vacuum cleaner, distance 1 m 70 |
| | Conversational speech, 1 m 60 |
|  | Urban residence 50 |
| | Whispering at 2 m 40 |
| | Quiet rural area 30 |
| | Silent study room 20 |
| | Normal breathing 10 |
| | Hearing threshold 0 |

(Note: A 6 dB(A) to 10 dB(A) sound pressure level change is perceived as double or half the volume)

As shown on the previous chart, normal conversation for most of us is about 60 dB(A) at 1 meter. Sound above 85-90 dB(A) can cause hearing damage after extended exposure. The higher the sound level, the shorter the duration of exposure before hearing damage will occur.

In the United States, OSHA, the Occupational Safety and Health Administration sets limits (Permissible Exposure Limits or PEL) of sound based on exposure time (OSHA Standard # 1910.95). When employees are subjected to sound exceeding the limits shown below, OSHA requires that personal protective equipment shall be provided.

The National Institute for Occupational Safety and Health (NIOSH) establishes a more stringent recommendation, Recommended Exposure Limits (REL), for noise based on the best available science and practice. Both the OSHA limits and NIOSH recommendations are shown below.

| Duration per day, hours | Exposure level per NIOSH REL | Exposure level per OSHA PEL |
|-------------------------|------------------------------|-----------------------------|
| 8 hours | 85 dBA | 90 dBA |
| 4 hours | 88 dBA | 95 dBA |
| 2 hours | 91 dBA | 100 dBA |
| 1 hour | 94 dBA | 105 dBA |
| 30 minutes | 97 dBA | 110 dBA |
| 15 minutes | 100 dBA | 115 dBA |

Although tour guests are not employees of the manufacturing facility, equal consideration and precautions should be taken in protecting their hearing and creating a safe and comfortable environment.

NRR (Noise Reduction Rating)

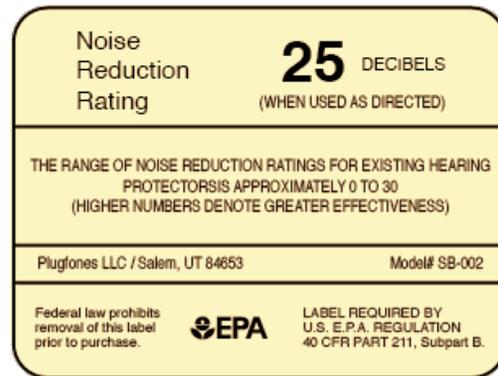
To determine if a particular Noise Reduction Rated headphone will be sufficient to provide the necessary hearing protection for a given environment, as discussed above, we first need to determine how noisy the tour environment is and understand how to interpret the NRR value into real world conditions.



First, use a Sound Pressure Level meter to measure the dB(A) noise level of the tour environment.

Set the meter to "slow" response and "A" weighting. Measure the noise in the tour area as the conditions will be during the tour(s). The average in the noisiest area that guests will be exposed to should be measured.

Next, we need to understand how the NRR value is derived so we can use that information and the measured noise level to reliably predict levels of protection achieved by a given individual. Noise Reduction Rating (NRR) is a measure of the effectiveness of a hearing protection device to reduce noise levels. Higher values indicate greater noise reduction. NRR values range up to approximately 30 dB. To the right is an example of the EPA label for a headset with an NRR of 25 dB.



If the constant noise measured in the tour environment is 90 dB(A), the actual exposure by someone wearing noise reduction headphones with an NRR of 25 dB is calculated as follows:

1. Subtract 7 from the NRR (if noise was measured "A" weighted). $25-7 = 18$ dB
2. Subtract the value above from the measured average noise. $90-18 = 72$ dB

Based on this calculation the actual noise level heard by the tour guest should be **72 dB(A)**.

However, the above calculation will only give you best case under ideal circumstances. The NRR rating is based on a laboratory test where the hearing protection device is properly fit. OSHA's experience has shown that the hearing protection device seldom reduces the decibels by the NRR value indicated, in real world use. OSHA recommends applying a 50% correction factor. Using OSHA's recommendation, the protected exposure level for the same headset is calculated as follows:

1. Subtract 7 from the NRR (if noise was measured "A" weighted). $25-7 = 18$ dB
2. Divide that value by 2 (50% correction factor) $18/2 = 9$ dB
3. Subtract the value above from the measured average noise. $90-9 = 81$ dB

Based on OSHA's calculation, applying their recommended 50% correction factor, the actual noise level heard by the tour guest is **81 dB(A)**.

Reality is, in this example, the noise exposure level experienced by the tour guests will be somewhere between 72 dB(A), best case, and 81 dB(A).

-Proper fit of the headphone is key to achieving the best performance-

There are two basic styles of noise reduction headphones, over-the-ear/earmuffs and in-ear/earplugs.

- Earmuffs surround the ear. For proper fit, the earmuff must completely surround the ear and be sealed firmly against the skin. The size and shape of the head, how tight the headset is over the head/ears, hair and/or glasses preventing the headset from sealing tightly against the skin are all factors in achieving a proper fit.
- Earplugs are placed inside the ear canal. For proper fit, the foam or silicone tip needs to be properly inserted to seal the ear canal. Follow the manufacturers instructions to achieve best results. Often earplugs come with a variety of tips to accommodate the fit and personal preference of the individual. Note that the headphones NRR rating may vary depending on the type of tip used.



Tour guides that provide guests with qualified instruction, and assistance when needed, with proper fit of their headphones will typically achieve better results.

In cases of extremely high noise environments it may be necessary to combine hearing protection devices to achieve OSHA requirements. Earmuffs can be worn over an in-ear audio headset.



Be aware that noise reduction headphones such as those discussed above reduce all sounds equally and may prevent individuals from hearing their surrounding and anticipating hazards. It's up to the tour facility to anticipate and mitigate any risks.

Conclusion:

The information above is intended as a guideline to help you better understand the effectiveness of a noise reduction headphone based on the headphone's Noise Reduction Rating (NRR). Listen Technologies recommends consulting with your facilities Health and Safety Coordinator when determining the appropriate level of hearing protection for your facility's tour guests.

Additional information about hearing protection devices and noise exposure can be found on OSHA's and NIOSH's websites.

Questions? Please contact Listen's Technical Services team at support@listentech.com