

## Hearing Protection



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## How Much Protection is Really Needed?

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## Few Jobs Call for High Noise Reduction

- 9 out of 10 workers are exposed to 95 dBA or less

Most workers need less than 10 dB of attenuation

- Virtually any hearing protector can provide this much noise reduction!

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# How Much Protection do HPDs Provide?

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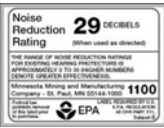
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## Noise Reduction Rating NRR

- Average attenuation in laboratory for a group of subjects
  - "Best Fit"
- In the workplace, most people get much less protection
  - Protectors not worn perfectly
  - Protectors not worn during all noise exposures



The image shows a rectangular label for a Noise Reduction Rating (NRR) of 29 dB. The text on the label includes: 'Noise Reduction Rating 29 dB (NRR) (Other uses as directed)', 'The range of noise reduction ratings for existing hearing protectors is approximately 2 to 30 decibels.', 'General Industrial Use - 1100', 'Company - St. Paul, MN 55144-1000', and the EPA logo.

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## Comparing NRR of 2 Devices

- Differences between NRRs of 3 dB or less are not important
  - Statistically no difference
- An HPD with an NRR of 28 dB provides essentially the same noise reduction, on average, as one with an NRR of 25 or 30 dB

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## Using the NRR

$$\text{dBA} - \text{NRR} - 7 \text{ dB} = \text{dBA}$$

workplace noise      effective employee exposure

Apply 50% "de-rating"  
when HPDs are used  
in place of noise controls



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## De-rating the NRR

- Reducing the value of HPD ratings
  - To better predict workplace attenuation
- NIOSH recommends de-rating ear plugs more than ear muffs

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## Dual Protection

- Adding muffs over plugs boosts average attenuation 5-10 dB
- Greatest improvement in low frequencies



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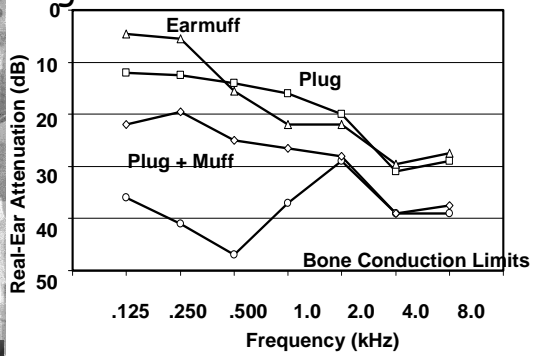
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### Single vs. Dual Protection




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*Any hearing protector that can be worn wrong, will be worn wrong*




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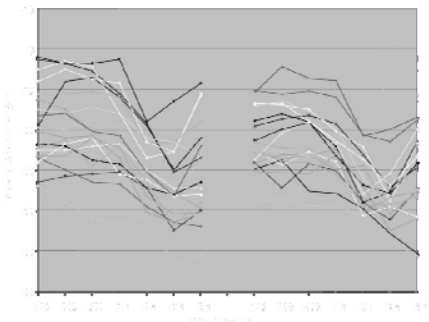
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### HPD Attenuation Varies Widely




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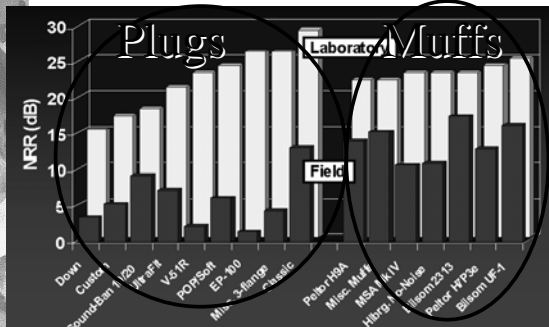
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## Real-World vs. Laboratory NRR



Berger (2000)

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## Higher NRR ≠ More Protection

- Many employers buy the HPD with the highest NRR
- Is the HPD with the highest NRR more likely to:
  - Be worn correctly? No
  - Fit the best? No
  - Be worn more of the time? No

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## Human Factors

- The best hearing protector is the one that is:
  - *Worn correctly (fit)*
  - *Worn consistently (wear time)*

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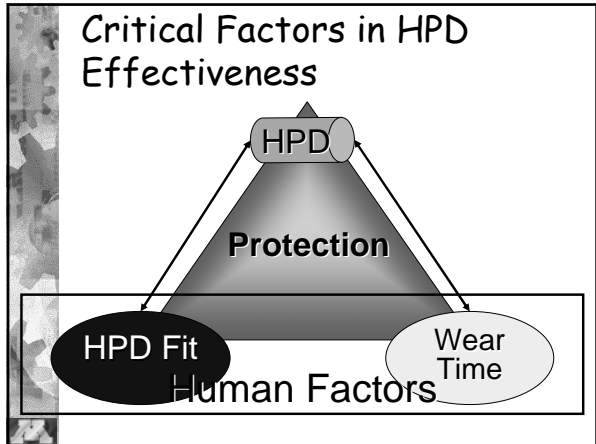
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- ### The Risks of Overprotection
- Communication may be impaired
    - Conversation
    - Warning sounds
  - Workers may fit HPDs incorrectly to enhance hearing
    - Lower attenuation
  - Workers may remove HPDs more often
    - Reduced wear time

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- ### Communication Needs
- What must the worker hear?
    - Detection of machine failure or warning
    - Identification of specific signals
    - Detailed conversation
      - Radio conversation more difficult than face-to-face communication in noise
  - Ideal hearing level varies by job
    - Firefighter
    - Crane operator
    - Forklift driver

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## The Importance of Wear Time

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## HPD Wear Time

- Even a few minutes of non-wear time dramatically decreases the effective noise reduction
  - The effect is more profound at very high noise levels
- A high NRR protector is no better than a low NRR device when wear time is reduced

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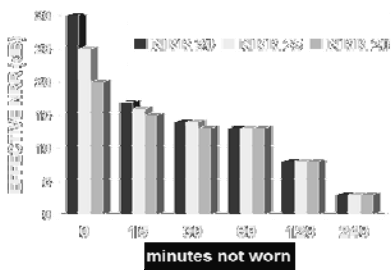
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## Wear Time & Effective NRR

- Can NRR 20 earplugs provide more protection than NRR 30 plugs?
  - YES! When they are worn 15 minutes longer



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**Factors Affecting Wear Time**

- The most important factor in determining wear time is:

**COMFORT**

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**Factors Affecting Wear Time**

- Arezes and Miguel (2002)
  - Studied relationship between HPD *comfort* and *wear time*

**Key finding**

**HPDs with lower attenuation ratings but high comfort ratings were more effective than HPDs with high attenuation but low comfort ratings**

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**Hearing Protector Choices**

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## Hearing Protector Categories

- Foam earplugs
- Pre-molded, reusable earplugs
- Banded HPDs
- Earmuffs
- Special purpose HPDs
  - Level-dependent
  - HPDs with electronic communication
  - HPDs with entertainment functions

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## Attributes of Hearing Protectors

- Performance
  - Noise reduction (attenuation)
  - Effect on communication
- Comfort
- Ease-of-use
  - Convenience
  - Compatibility with other PPE
- Physical properties
  - Electrical conductivity
  - Durability

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## Types of Earplugs

- Moldable
- Pre-molded
- Foam
- Custom-made
- Custom-fit

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## Moldable Earplugs

- User molds material into a ball-shaped plug then inserts plug into ear canal opening
  - Silicone
  - Wax
- Advantage
  - Comfort
- Disadvantages
  - Poor acoustic seal
  - Tendency to loosen as they are worn



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## Pre-Molded Earplugs

- Reusable
- Various materials
  - Silicon
  - Vinyl
  - Thermoplastic



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## Pre-Molded Earplugs

- Advantages
  - Easy to use
    - No need to roll down like foam ear plugs
  - Communication
    - Moderate noise reduction helps prevent overprotection
  - High worker acceptance
    - Washable plugs stay clean
- Disadvantages
  - Less comfortable
    - Plug doesn't conform to ear shape easily

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## Custom-Made Earplugs



- Fit shape of each ear individually
- Made from ear impressions taken by audiologist or trained technician

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## Custom-Made Earplugs

### • Advantages

- Very comfortable when fit properly
- Can be acoustically tuned to provide more or less protection

### • Disadvantages

- Don't conform to changes in ear shape over time
- Modifications are often necessary to get comfortable fit

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## Foam Earplugs

### • Advantages

- Comfort
  - Soft foam conforms to shape of each ear
  - Tapered shape fits ear canal
- High Attenuation
  - High attenuation when worn correctly
- Inexpensive



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## Foam Earplugs

### • Disadvantages

- Fit
  - Few people fit them well
- Ease-of-use
  - More difficult to fit than other devices
- Too much attenuation
  - When worn properly, may lead to overprotection



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## Banded Hearing Protectors

### • Advantages

- Convenience
  - Ideal for people who take hearing protectors on/off
- Communication
  - Moderate attenuation
- Easy to use
  - No need to roll down plugs
- Economical
  - Reuse the band; replace the ear pads
- Fits wide range of ear sizes



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## Banded Hearing Protectors

### • Disadvantages

- Comfort
  - Pressure against outer ear
- Band noise
  - Rigid bands transmit noise into ear when bumped
- "Occlusion Effect"
  - Wearer's hears echo when speaking



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# Earmuffs

## \* Advantages

- Consistency
  - Muffs provide better noise reduction in workplace
- Convenience
  - Ideal for people who take HPDs on & off frequently
- Comfort
  - Nothing inserted into ear



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# Earmuffs

## \* Advantages

- Easy to use
  - Few instructions needed
  - Easy to clean
- Fit
  - Muffs fit nearly everyone
- Economical
  - Long lasting
  - Replacement cushions and inserts



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# Earmuffs

## \* Advantages

- Wide variety of styles
  - Headband
  - Helmet mount
  - Foldable
- Versatile
  - Wear head band or neck band behind neck or under chin



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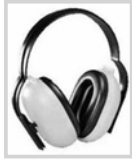
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## Earmuffs



- Disadvantages
  - Comfort
    - Can be hot & cause perspiration
    - Can be heavy
    - Head band pressure
  - Compatibility
    - May interfere with helmet, hood, or other equipment

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## Wearers Must be Able to Choose From Several HPDs

- Every wearer is different
  - Different ears
  - Different jobs
  - Different ability to fit HPDs
  - Different motivation
  - Different reaction to style
  - Different communication needs
  - Different noise exposure

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## Myth #1:

"Hearing protectors prevent me from hearing important sounds."

- Without hearing protectors, your hearing gets worse during the day.
- You can still see with sunglasses and you can still hear with hearing protectors
  - Hearing protectors allow you to hear sounds at a more comfortable level

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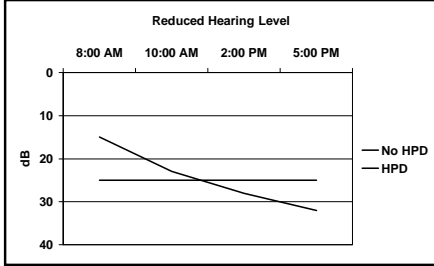
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# HPD Keeps Hearing Constant

With no protection, hearing gets worse during the work shift



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**Myth # 2:**  
"I'm used to loud noise, it doesn't bother me."

- Your hearing may be damaged already
  - It's not too late to start wearing hearing protection
- The risk of damaging your hearing is unrelated to how sensitive you are to loud sounds
  - You can't "toughen up" your ears

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**More Choices Mean Better Protection**

- When wearers are allowed to choose the HPD that best meets his/her needs, wear time will be longer

*Longer wear time means better protection, regardless of the NRR*

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**Selecting Hearing Protectors**

The best hearing protector is the one that is worn

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