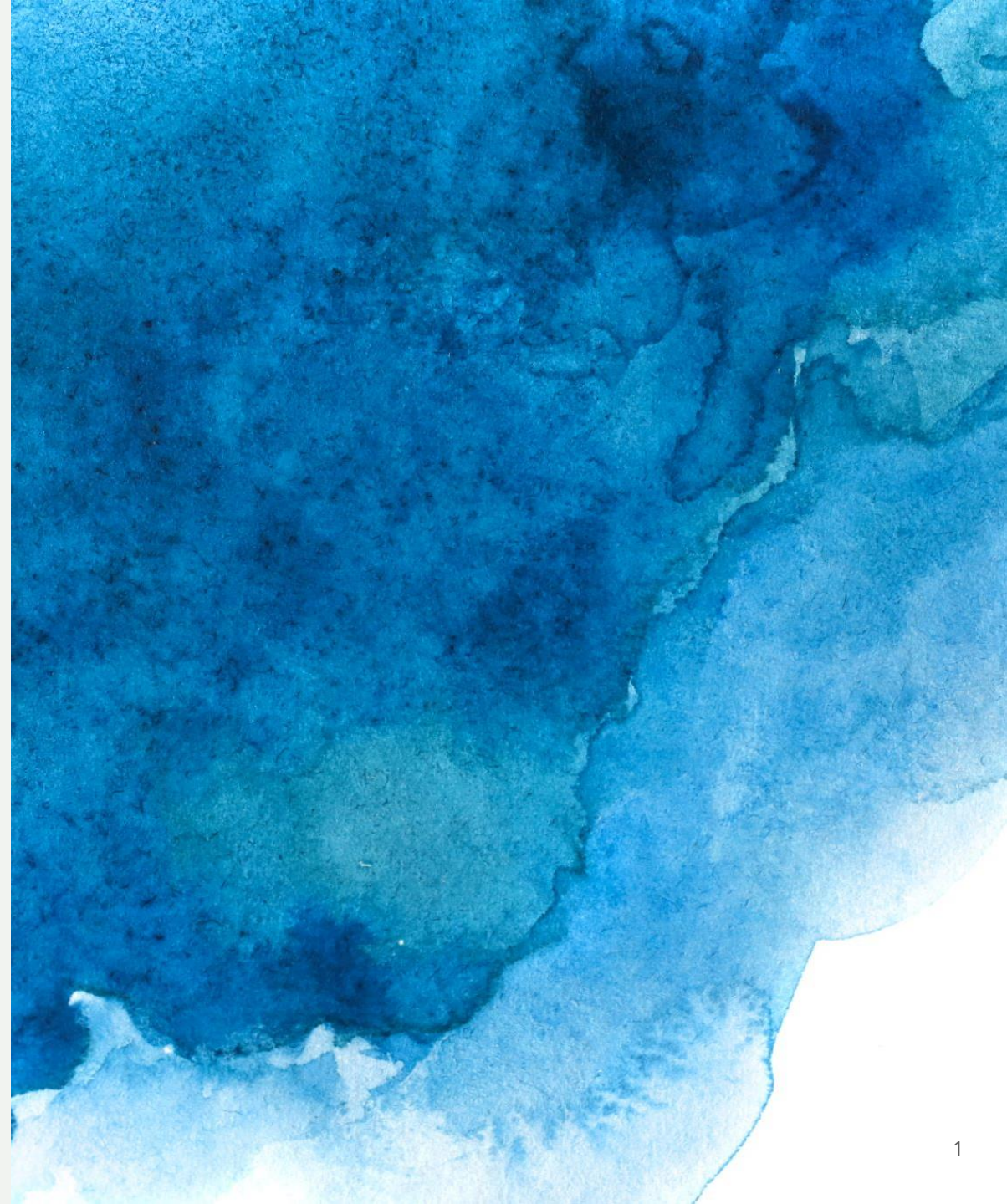




Hearing Protection Device (HPD) Fit Testing

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Objectives

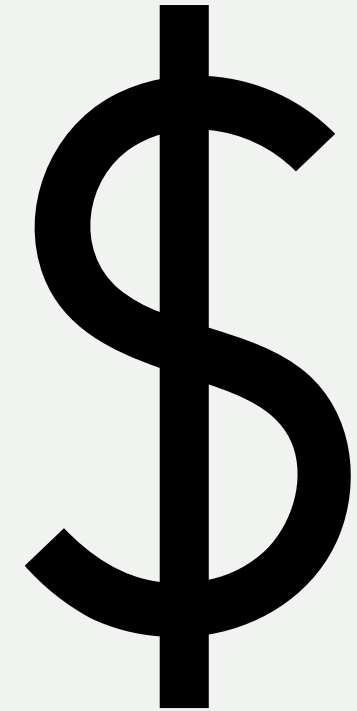
- Identify at least two types of hearing protector device fit test (HPDFT) systems
- Explain methods for incorporating HPDFT into an employer's hearing conservation programs (HCP)
- Discuss how OSHA Letters of Interpretation regarding HPDFT and the Occupational Noise Exposure Standard (29 CFR 1910.95)

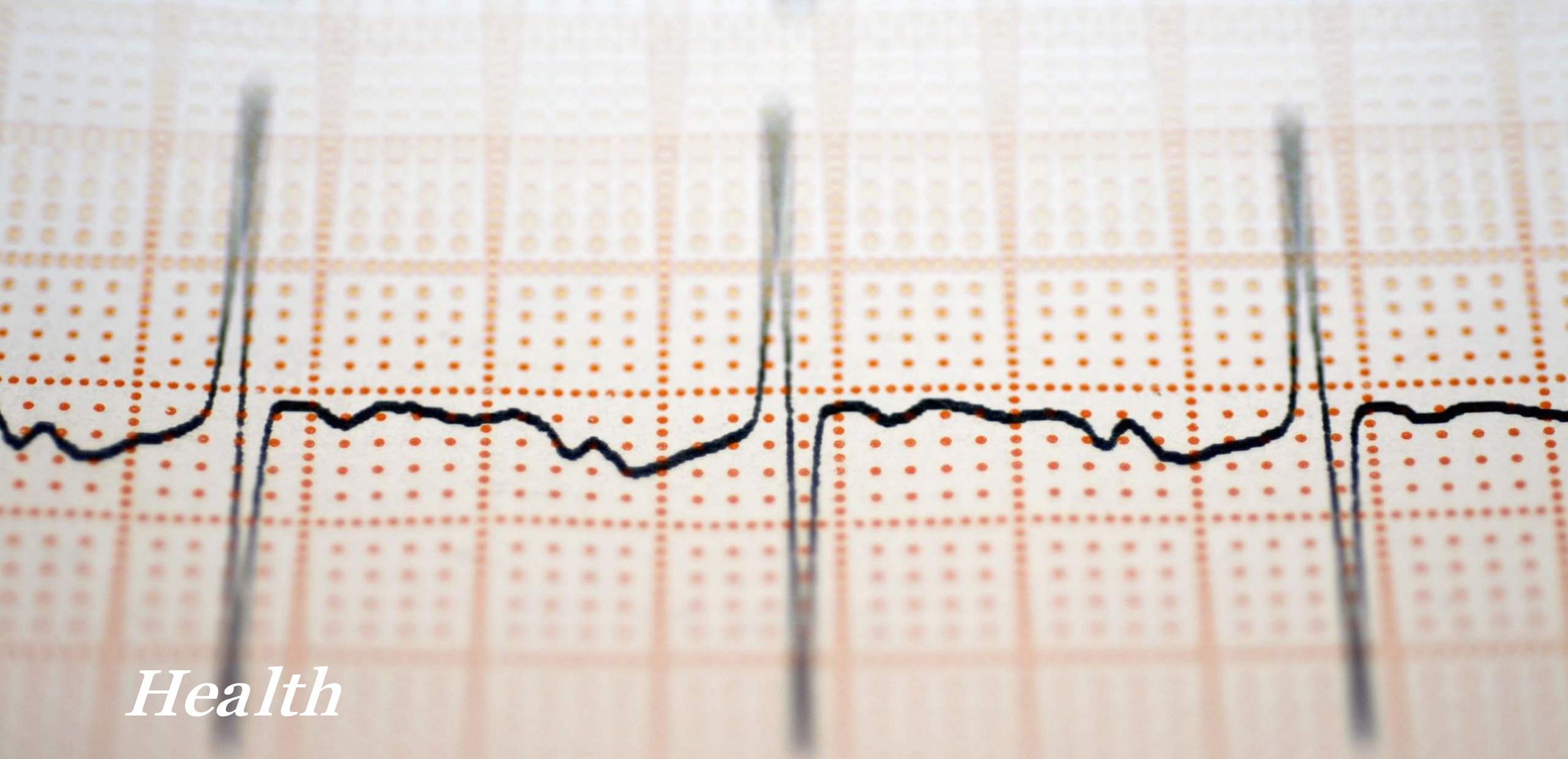
Disclaimer

- This presentation is intended as a general overview and is for informational purposes only.
- I am presenting today as a private citizen, not as a representative of my employer. The views expressed in this presentation are my own and do not reflect the official policy or position of my employer. The presentation does not represent official interpretation of OSHA standards and does not add to or subtract from the regulatory requirements in The OSH Act of 1970.
- The information is derived from publicly available websites and from my personal experience working as a nurse practitioner in occupational health for the past ten years.
- Mention of commercial products or programs does not imply endorsement.
- This presentation should not be relied upon in isolation as content is often accompanied by additional and/or clarifying information or discussion. Information is current as of the time of this presentation.
- Stock images from MS Office 365 are used in this presentation unless otherwise noted.
- I have no financial interests to disclose.



*Impact of Occupational
Noise Induced Hearing
Loss (NIHL)*





Health



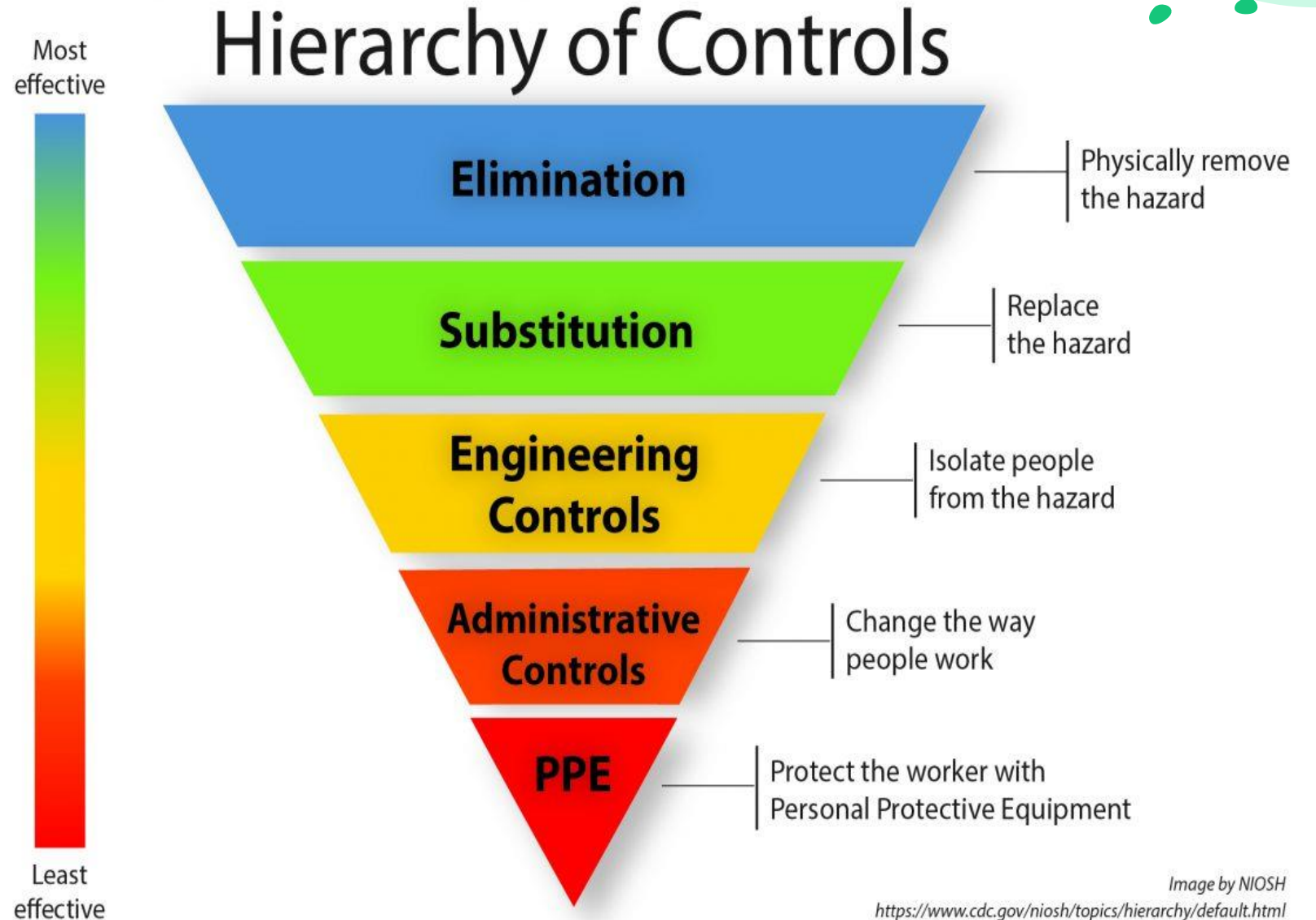
Quality of Life



INJURY PREVENTION



Occupational Noise Induced Hearing Loss Prevention



Noise Reduction Rating (NRR)

Laboratory Derived
from experienced
users

Experimenter fit HPD
into user's ear prior to
measuring
attenuation

Wide variability
between NRR and the
actual attenuation
achieved by workers
in the field

Methods for Derating the NRR

One method:

- Subtract 50% from the labeled NRR

Another Option:

- Earmuff: Subtract 25% from NRR
- Moldable earplugs: Subtract 50% from NRR
- Pre-formed earplugs: Subtract 70% from NRR

Effective A-weighted noise level
ENL = exposure dBA – (derated
NRR – 7)

Estimate Examples

NRR labeled as 22dB (formable)

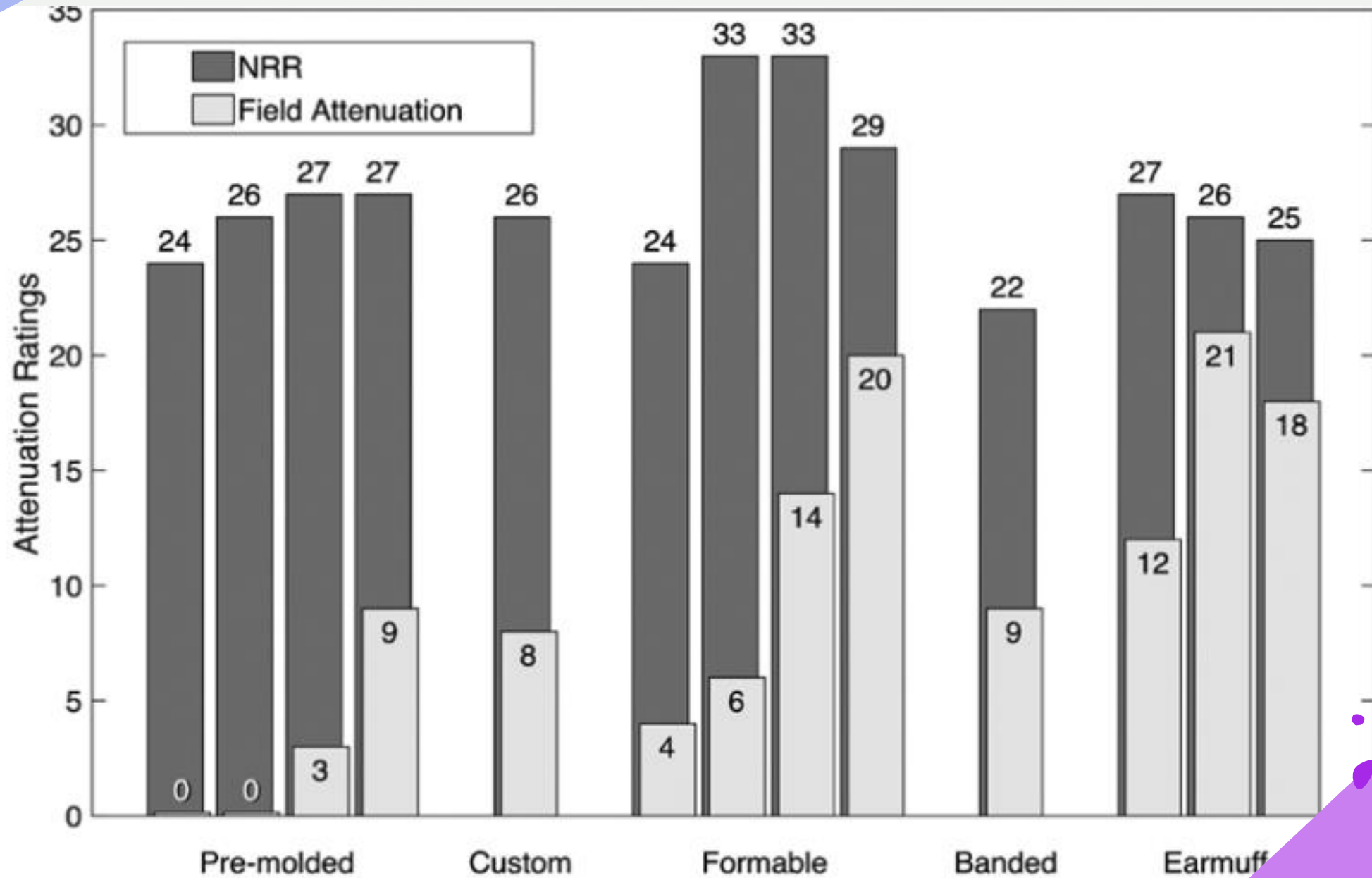
$$\text{ENL} = 100\text{dBA} - (11 - 7)$$

$$\text{ENL} = 96 \text{ dBA}$$

NRR labeled as 33dB (premolded)

$$\text{ENL} = 100 \text{ dBA} - (10 - 7)$$

$$\text{ENL} = 97 \text{ dBA}$$



How much noise is reaching the worker's ears?

100 dBA; NRR 22 dB



Image credit: <https://www.optimumsafetymanagement.com/wp-content/uploads/2016/09/osha-hearing-protection.jpg>



Image credit: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSjs86LuNP_HGUnrTd5UpUC6NQiGfTWri-sZw&usqp=CAU



Image credit: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSGI8M-BbqYtbEbfMcaZm-3mkO3y6ocTyUJ1QHTWDqe12s72Jk_8CQA7tW85IlosEDAoV4&usqp=CAU

Answer:
We have no idea!



Hearing Protector Device Fit Testing

Personal Attenuation Rating (PAR)

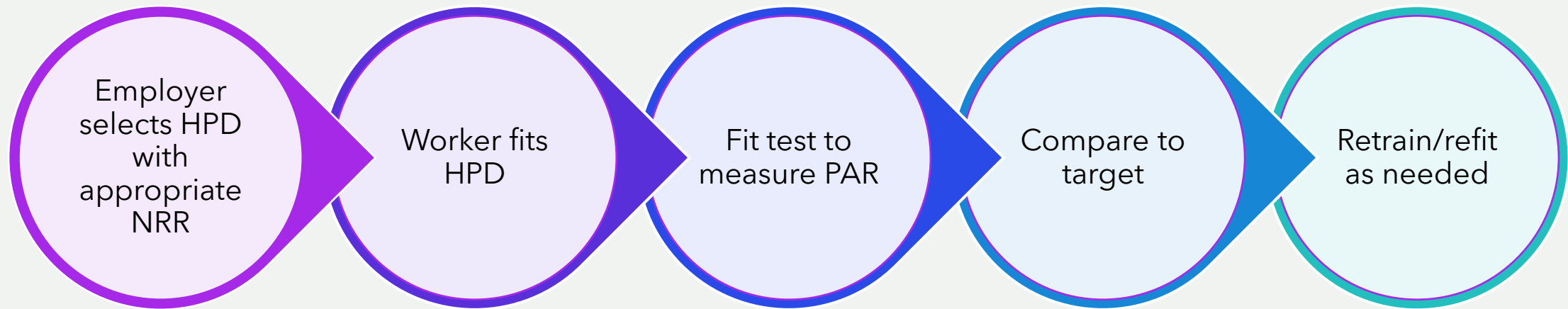
Field test (may be at or near worksite)

Individual measure of noise attenuation based on how an employee “usually” inserts HPDs

Can test employees on a variety of earplugs available in workplace

PAR has been validated as comparable to NRR in estimating actual attenuation of HPD - worker learns the “feel” of proper fit

HPD Fit Test Process Map



Which Type of Hearing Protector Fit Test System?

It Depends...



Types of HPDFT Systems – Response-based

Real Ear Attenuation at Threshold (REAT)

- Michael and Associates FitCheck Solo™ and FitCheck Muffs™
- Benson Medical Instruments CCF-200 Fit-test™
- Workplace Integra IntegraFit™
- Edare Incorporated WAHTS™ Wireless Audiometric Hearing Test Systems

Loudness Balance System

- Honeywell Veripro™

FitCheck Solo TM



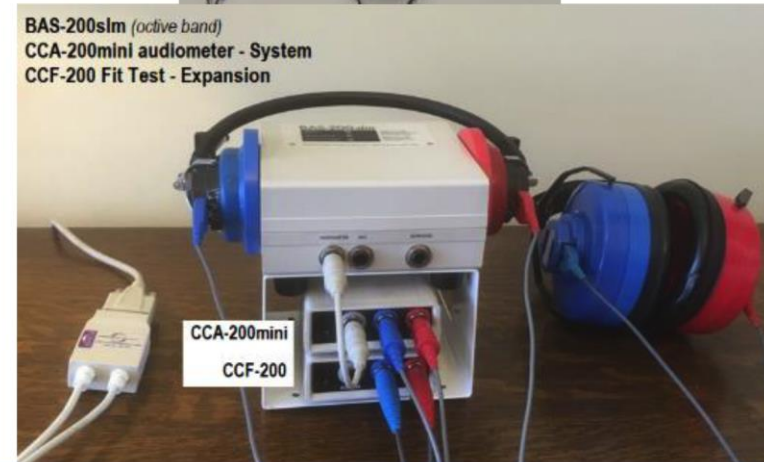
*FitCheck Solo*TM

Features	FitCheck Solo
Test method	REAT Headphone, Method of Adjustment
System Cost	~\$3200
Equipment	Isolating headphones, mouse
Applicability	Earplugs
Test Learning Time	~ 3-5 minutes
Testing time	~ 5-7 minutes
Fit-Test Output	A-weighted attenuation/PAR
Listener Requirements	Thresholds < 45 dB HL
Tester Training Level	CAOHC certification recommended
Background noise	58 dBA
Binaural/monaural	Binaural (Monoaural possible)
Uncertainty	3 to 5 dB

Benson Medical Instruments: CCF-200 Fit Test™

Image credit: Benson Medical Instruments

- REAT under Headphones
- Multiple languages for automatic voice instructions and error coaching
- Integrates with CCA-100mini or CCA-200mini. Can be used as stand-alone unit
- Optional Sound Level Meter capabilities to allow for quiet room testing
- Test any number of frequencies. Allowing a faster test or more comprehensive test. (default 500 & 1k)
- Match testing to sound survey to comply with OSHA and NIOSH PEL - permission to work
- Annual calibration and daily calibration check
- Works with a wide range of earplugs



Workplace Integra INTEGRAfit™

Testing Frequency

INTEGRAfit

- 500 Hz is a conservative, efficient test
 - PAR @ 500 Hz takes ~3 mins
 - the test yields a PAR value of ~3 db less than a multiple frequency value
- 500 Hz has a low hearing loss rate
 - higher frequencies have high hearing loss rates which impacts tests results
- 500 Hz has superior air leak detection versus higher frequencies
 - air leaks allow noise to bypass the ear plug yielding poor noise reduction

workplace
INTEGRA

Image credit: Workplace Integra, Inc.

Edare/WAHTS System Components

- Computer-based Real-Ear Attenuation at Threshold (REAT) under headphones
- $\frac{1}{3}$ Octave noise band stimuli
- Monaural and binaural
- Sound isolation headphones: > 45 dB
- Capacity to integrate fit testing with monitoring audiometry
- Mobile app
- Export to electronic record systems possible





Features	WAHTS Fit-test System
Test Method	REAT Headphone
System Cost	~\$7350 (hearing testing and fit testing)
Equipment	WAHTS Headset, Tablet and Carrying Case
Applicability	In-ear hearing protectors, e.g. foam, flange, custom etc.
Test Learning Time	~30 sec
Testing Time	~3 min
Fit-Test Output	Personal Attenuation Rating (PAR)
Listener Requirements	Thresholds < 55 dB HL
Tester Training Level	CAOHC Recommended
Background noise	Below 55 dB
Binaural/monaural	Binaural and Monaural
Uncertainty	2-4 dB

Objective
measurement

No worker
response
required

Earplug
surrogate
must be
utilized

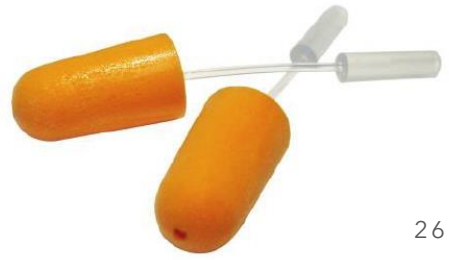
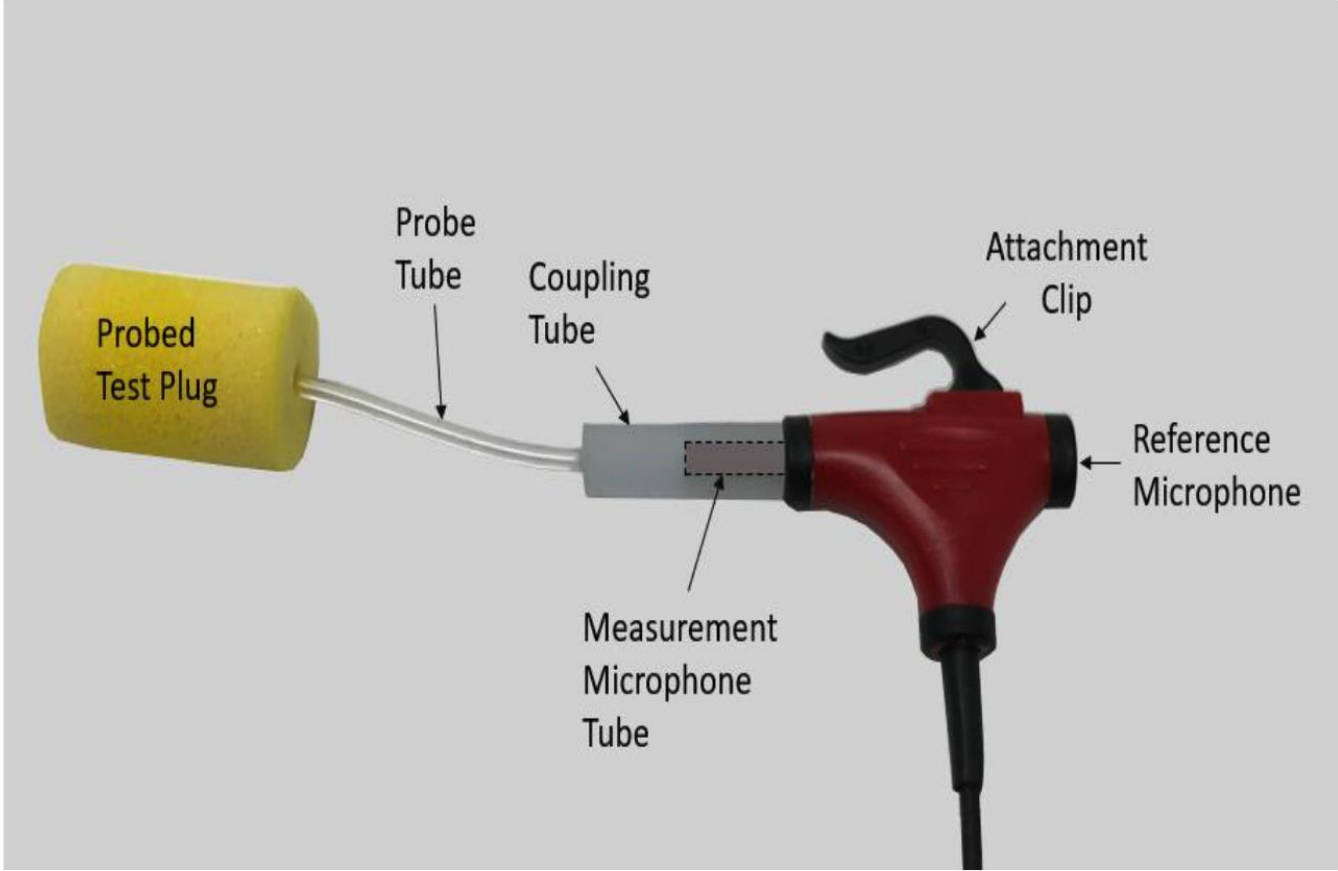
Can test muffs
or earplugs
(specific
brands)

Microphone in Real Ear (MIRE)

3M Company

- **3M™ E-A-Rfit™ Dual-Ear Validation System**
- **3M™ Peltor™ PIC-100 Integrated System**

3M™ E-A-Rfit™ Dual-Ear Validation System



Performance Requirements	3M™ E-A-Rfit™ Dual-Ear Validation System
Test Method	Field-Microphone in Real Ear (F-MIRE) using a surrogate hearing protector device
Duration of Test	3 seconds
Objective	No listener response is required
Listener Requirements	None
Hearing Protectors	Measures earplugs, earmuffs and electronic hearing protectors
Test site noise requirements	The maximum allowable ambient noise level limit is 85 dBA or 91 dBC
Reports PAR	Yes: L, R and Binaural measured simultaneously
Typical PAR Uncertainty	~ 5-7 dB. The combined variability of the attenuation estimate consists of three primary components: measurement, fit, and spectral.

3M™ E-A-Rfit™ Dual-Ear Validation System

- F-MIRE provides an objective measure of noise reduction
- F-MIRE measures the difference between the sound levels inside and outside the hearing protector at the same time.
- Personal Attenuation Rating (PAR) is calculated from attenuation measured at seven frequencies per ear simultaneously
- E-A-Rfit tests earplugs, earmuffs and electronic hearing protectors (both in-ear and over-the-ear)
- E-A-Rfit is compliant to ASA/ANSI S12.71-2018 (R2022)



3M™ PELTOR™
Professional In-Ear
Communication
Headset, PIC-100

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Key Features

On-Demand Fit Test

helps assess proper fit in real time

Hearing Protection

with replaceable eartips in multiple types & sizes

Close-Connect Wireless Technology

enables group communication and allows for simultaneous speakers

Bluetooth® Technology

allows for connection to smart devices and/or two-way radios

Environmental Listening

helps promote auditory situational awareness

In-Ear Speech Microphone

enables clear communication in noise

Take-Aways for HPD fit testing

- NRR = *capability* of a given HPD to attenuate noise
- PAR is individualized measure of attenuation of a given earplug
- Feasible
- Efficient
- Quick (less than 10 minutes)

Implementation Considerations

- Effective training tool for workers
- Identify a champion for hearing protection who knows how to insert HPDs and troubleshoot
- Know the noise exposure level in the workplace
- Test using the HPDs available in the workplace
- Encourage workers to replicate the “feel” of properly inserted HPD

Standards and Guidance

Occupational Safety and
Health Administration
(OSHA)

Mining Safety and Health
Administration (MSHA)

Federal Railroad
Administration
(FRA)

National Institute for
Occupational Safety and
Health
(NIOSH)

Local
State
National
International

ANSI/ASA S12.71-2018
Performance Criteria
for HPD Fit Testing

OSHA's General Industry Occupational Noise Exposure Standard

29 CFR 1910.95

Employers shall:

- **Train workers in the use and care of all HPs provided to employees
1910.95(i)(4)**
- **Ensure proper initial fitting and**
- **Supervise the correct use of all HPs
1910.95(i)(5)**



OSHA's General Industry Occupational Noise Exposure Standard

29 CFR 1910.95

-
- The employer shall evaluate HPD attenuation for the specific noise environments in which the HPD will be used
 - The employee shall use one of the evaluation methods described in Appendix B: *Methods for Estimating the Adequacy of Hearing Protection Attenuation* 1910.95(j)(1)

OSHA's General Industry Occupational Noise Exposure Standard

29 CFR 1910.95

HPDs must attenuate employee exposure to at least an 8-hour time-weighted average (TWA) of 90 decibels (dB) 1910.95(j)(2) - *EXCEPT*

For employee with significant threshold shift, HPD must attenuate exposure to 8-hour TWA of 85 dB or below 1910.95(j)(3)

OSHA's General Industry Occupational Noise Exposure Standard

29 CFR 1910.95

Employer shall train each employee who is exposed to noise at or above an 8-hour TWA of 85 dB in accordance with the standard

Training will include:

- Purpose of HPDs
- Advantages, disadvantages and attenuation of various types of HPDs
- Instruction on selection, fitting, use and care

Employees with standard threshold shift (STS)

29 CFR 1910.95(g)(8)(ii)(A) and 1910.95(g)(8)(ii)(B)

Mandatory fitting
or refitting of
HPDs

Mandatory
training or
retraining on HPD
use and care

***NHCA-OSHA-NIOSH
Alliance:***

***Best Practice Bulletin
Hearing Protector Fit
Testing (2008)***



Valuable training tool:
Proper use of HPDs



Selection/fitting of HPDs
Train the trainer



STS follow-up: fit/refit/ and train/retrain
worker to select/fit HPD with
appropriate attenuation)



Provides documentation of HPD
adequacy and training

NHCA-OSHA-NIOSH Alliance: Best Practice Bulletin Hearing Protector Fit Testing (2008)

A tool to assess overall effectiveness of employer's hearing conservation program

Enables matching employee's HPD attenuation to their noise exposure level (especially critical for safety sensitive positions or those with hearing loss)

Aids in selecting the best HPD from available options

OSHA Letters of Interpretation

"This letter constitutes OSHA's interpretation of the requirements discussed."

OSHA's requirements are set by statute, standards and regulations.

Letters of interpretation do not create new or additional requirements but rather explain these requirements and how they apply to particular circumstances.

Will OSHA accept a personal attenuation rating (PAR) instead of the NRR/NRR(SF) de-rating?



RESPONSE: THE OSHA NOISE STANDARD REQUIRES EMPLOYERS TO USE A NOISE REDUCTION RATING (NRR) METHOD DESCRIBED IN APPENDIX B.



AN EMPLOYER WOULD BE IN VIOLATION OF PARAGRAPH 1910.95(J)(I) IF A METHOD CONSISTENT WITH APPENDIX B WAS NOT USED.



SEE 2017 LETTER OF INTERPRETATION

Letter of Interpretation *10/20/2017*

Appendix B must be utilized to select options for HPDs; Employee chooses one from a variety of adequate options

Paragraph 1910.95(i)(5) requires the employer to ensure proper initial fitting and correct use of all HPDs

OSHA has always embraced newer technology that enhances workplace safety, but is prohibited from formally testing, evaluating, certifying, or approving of products, processes or programs.

Can employers use a personal fit-testing system to provide training to employees in the use and care of hearing protectors?

"Yes. OSHA's Noise Standard requires employers to provide training in the use and care of all HPDs provided to employees, per paragraph 29 CFR 1910.95(i)(4).

Paragraph (k)(3)(ii) is the requirement to inform employees on the purpose of HPDs, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care..."

Can employers use a personal fit-testing system to provide training to employees in the use and care of hearing protectors?

“The means and methods that employers use to provide this training is a performance-based requirement, so

Employers may use any means that are most suitable and effective, which may include the use of a personal fit-testing system.”



Example

01

Employer used Appendix B as mandated in the OSHA Noise Standard

02

Employee chooses one of the available protectors

03

Personal fit-testing indicates that a proper initial fit is not possible for an employee using the selected adequate HPD (i.e., has an adequate NRR)

04

The employer and employee should select another adequate HPD from the variety of options selected IAW the standard

OSHA Technical Manual (OTM) – HPD Fit Testing

HPDFT enables employers to determine how well individual HPDs protect workers



Especially useful when workers have experienced an STS



“HPD fit-testing could be utilized to determine the appropriate attenuation for a given environment, by identifying an HPD that would provide necessary attenuation to protect the hearing, but not so much that it would interfere with the ability to hear warning alarms.” (Section 4. Personal Protective Equipment)

OSHA Technical Manual (OTM) – HPD Fit Testing

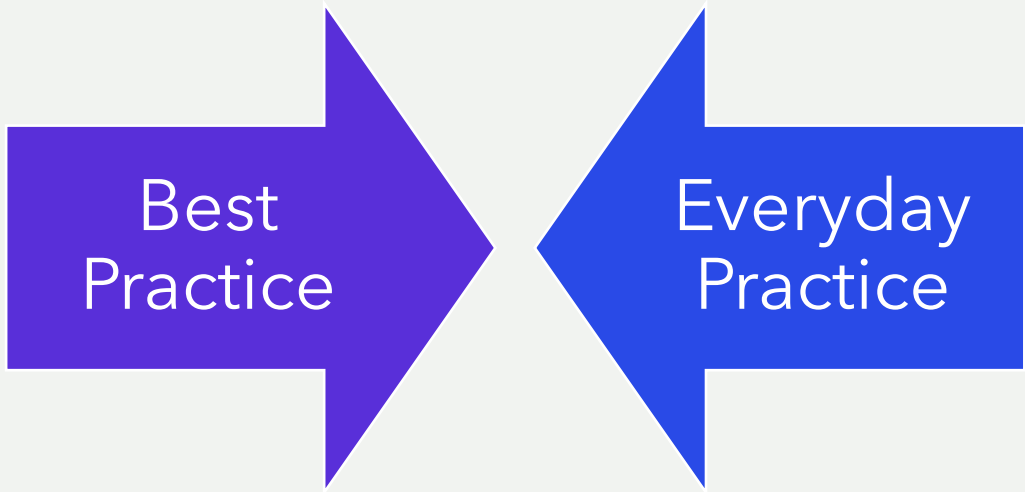
“HPD fit-testing cannot be substituted for the NRR when assessing the adequacy of a given protector to reduce noise exposure; however HPD fit-testing can be used in addition to NRR.

The OSHA/National Hearing Conservation Association (NHCA) Alliance has recommended HPD fit-testing as a best practice and valuable training tool that can help in training the worker to achieve an optimal fit.” (Section M. Training)

Summary

- HPD Fit Testing is recognized as a best practice by OSHA since 2008
- OSHA's letters of interpretation support the use of HPDFT for training workers to effectively use HPDs
- While no US regulatory agencies currently require HPDFT, some other nations have incorporated it in their policies

HPD Fit Testing



References

- McDaid, D., Park, A-I., & Chadha, S. (2021). Estimating the global costs of hearing loss. *International Journal of Audiology*, 60(3), 162-170. <https://doi.org/10.1080/14992027/1883197>
- Huddle, M. G., Goman, A. M., Kernizan, F. C., Foley, D. M., Price, C., Frick, K. D., & Lin, F. R. (2017). The economic impact of adult hearing loss: A systematic review. *JAMA Otolaryngology-Head & Neck Surgery*, 143(10), 1040-1048. <https://doi.org/10.1001/jamaoto.2017.1243>
- Alamgir, H., Tucker, D. L., Sun-Young Kim Betancourt, J. A., Turner, C. A., Gorrell, N. S., Won, N. J., ... Packer, M.D. (2016). Economic burden of hearing loss for the U. S. military: A proposed framework for estimation. *Military Medicine*, 181(4), 301-306. <https://doi.org/10.7205/MILMED-D-14-00612>
- U.S. Department of Veteran Affairs. (2020). *Veterans benefits administration: Annual benefits report fiscal year 2019*. <https://www.benefits.va.gov/REPORTS/abr/docs/2019-abr-v2.pdf#>
- Centers for Disease Control and Prevention (2019). *The National Institute of Occupational Safety and Health (NIOSH): Occupational hearing loss (OHL) surveillance*. <https://www.cdc.gov/niosh/topics/ohl>
- Reed, N. S., Altan, Al Deal., J. A., Yeh, C., Alexander, D. K., Wallhagan, M., & Lin, F. R. (2018). Trends in health care costs and utilization associated with untreated hearing loss over 10 years. *JAMA Otolaryngology-Head & Neck Surgery*, 145(1), 27-34. <https://doi.org/10.1001/jamaoto.2018.2875>
- Yankaskas, K. (2013). Prelude: Noise-induced tinnitus and hearing loss in the military. *Hearing Research*, 295, 3-8. <https://doi.org/10.106/j.heares.2012.04.016>
- Center for Disease Control and Prevention (2018). *National Institute of Occupational Safety and Health (NIOSH): Noise and hearing loss prevention: Guidance and regulations*. <https://www.cdc.gov/niosh/topics/noise/reducenoiseexposure/regsguidance.html#:~:text=The%20NIOSH%20REL%20noise%20is%2085%20decibels%2C,legal%20limits%20on%20noise%20exposure%20in%20the%20workplace>
- Chan, Henry S. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to noise. (1998) DHHS publication; no. (NIOSH) 98-126. <https://stacks.cdc.gov/view/cdc/6376>
- Nelson, J. T., Swan, A. A., Swiger, B., Packer, M., & Pugh, M. J. (2016). Hearing tests in the U.S. Department of Defense: Potential impact on Veterans Affairs hearing loss disability awards. *Hearing Research*, 349(2017), 13-20. <https://doi.org/10.1016/j.heares.2016.10.005>
- Occupational Safety and Health Administration (1983a). *The Occupational Safety and Health (OSH) Act of 1970. 29 CFR 1910.95, Appendix B. Methods for estimating the adequacy of hearing protector attenuation*. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9737&p_table=STANDARDS
- Occupational Safety and Health Administration (1983b). *The Occupational Safety and Health (OSH) Act of 1970. 20 CFR 1910.95. Occupational Noise Exposure*. <https://www.osha.gov/laws-reg/regulations/standardnumber/1910/1910.95>

Department of Defense instruction (DoDI) 6055.01. (2014, Oct 14), *DoD safety and occupational health (SOH) Program*.

OPNAV Instruction 5100.19F (2019, May 5). *Navy safety and occupational program manual for forces afloat*.

OPNAV Instruction 5100.23H. (2020, June 5). *Safety and occupational health program*.

Federman, J., & Duhon, C. (2016). The viability of hearing protection device fit-testing at navy and marine corps accession points. *Noise and Health*, 18(85), 303-311. <https://doi.org/10.4103/1463-1741.195806>

Federman, J., Karch, S. J., & Duhon, C. (2021). How hearing conservation training format impact personal attenuation ratings in U.S. Marine Corps training recruits. *International Journal of Audiology*, 60(2), 151-159. <https://doi.org/10.1080/14992027.2020.1811407>

Ahroon, W. A. & Stefanson, J. R. (2021). Evaluation of hearing protector fit test systems. Unites States Army Aeromedical Research Laboratory. USAARL-TECH-TR-2021-34. <https://apps.dtic.mil/sti/trecms/pdf/AD1146507.pdf>

Shkemi A, Smith L, Roberts B et al Fraction of acute work-related injuries attributable to hazardous occupational noise across the USA in 2019. *Occupational and Environmental Medicine* 2022; **79**:304-307. doi: 10.1136/oemed-2021-107906

Murphy, William J., et al. Effects of training on hearing protector attenuation. *Noise & Health*, vol. 13, no. 51, 2011, pp 132-41, <https://doi.org/10.4103/1463-1741.77215>.

Murata, Thais, et al. Effects of hearing protection field attenuation estimation systems and associated training on the level of noise attenuation in workers exposed to noise. *Cochrane Database of Systematic Reviews*, vol. 2021, no. 10, 2021, <https://doi.org/10.1002/14651858.CD015066>

Byrne, David C. et al. Interlaboratory comparison of three earplug fit-test systems. *Journal of Occupational and Environmental Hygiene*, vol. 14, no 4, 2017, pp 294-305, <https://doi.org/10.1080/15459624.2016.125002>.

Murphy, William J., et al. Personal attenuation ratings versus derated noise reduction ratings for hearing protection devices. *The Journal of Acoustical Society of America*, vol. 152, no.2, 2022, pp 1074-89. <https://doi.org/10.1121.10.0013418>

Murphy, William J. et al. Hearing protector fit testing with off-shore oil-rig inspectors in Louisiana and Texas. *International Journal of Audiology*, vol. 55, no. 11, 2016, pp. 688-98, <https://doi.org/10.1080/14992027.2016.1204470>

Gong W, Murphy WJ, Meinke DK, Feng HA, Stephenson MR,. Evaluating earplug performance over a 2-hour work period with a fit-test system. *Seminars in Hearing*, 2023 Jun 1; 44(4):470-484.doi:10.1055/s-0043-1769586.

Themann CL, Masterson EA, Peterson JS, Murphy WJ. Preventing occupational hearing loss: 50 years of research and recommendations from the National Institute for Occupational Safety and Health. *Semin Hear*.2023 Aug 3; 44(4):351-393.doi:10.1055/s-0043-1769499

Liu, Yufei, et al. Evaluating the effect of training along with fit testing on premolded earplug users in a Chinese petrochemical plant. *Ear and Hearing*, vol. 41, no. 4, 2020, pp 838-46, <https://doi.org/10.1097/AUD.0000000000000803>

Hayes, M. E., Hammond, S., Montgomery, A. P., Stephenson, L. (2022). Improving Hearing Protection Device Noise Attenuation through Fit-Testing in an Occupational Health Clinic. *Workplace Health & Safety* 70 (4), 196-204. doi: 10.1177/21650799211067927