Hearing Protection Devices and Fit Testing

EHS Partnerships Ltd.

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Review

- 1. Hearing Protection Device Requirements
- 2. Fit Testing Requirements
- 3. Exploring Limitations to HPD

Chapter 1: HPD Requirements

Part 16 of the Code

222 An employer must ensure that hearing protection devices used and worn by workers at a work site or work area

(a) meet the requirements of CSA Standard Z94.2-14 (R2019), *Hearing protection devices — Performance, selection, care, and use*, and

(b) are fit tested in accordance with CSA Standard Z94.2-14 (R2019), *Hearing protection devices — Performance, selection, care, and use*.

CSA GROUP™

Z94.2-14
(reaffirmed 2019)

Hearing protection devices — Performance, selection, care, and use

Selection of HPD Based on Noise Levels

- 1. Use of **Classes**, which pre-assigns the HPDs according to their defined attenuation ranges;
- 2. Use of a **Single Number** like NRR or SNR (SF 84); and
- 3. Use of **Octave-Band Approach**

Changes to Classification of HPD

Pre March 31, 2023 (OHS 2021)

Maximum Equivalent Noise Level (dBA L_{ex})	CSA Class of Hearing Protection	CSA Grade of Hearing Protection
≤ 90	C, B, or A	1, 2, 3, or 4
≤ 95	B or A	2, 3, or 4
≤ 100	A	3 or 4
≤ 105	A	4
≤ 110	A earplug + A or B earmuff	3 or 4 earplug + 2, 3, or 4 earmuff
>110	A earplug + A or B earmuff and limited exposure time to keep sound reaching the worker's ear drum below 85 dBA L_{ex}	3 or 4 earplug + 2, 3, or 4 earmuff and limited exposure time to keep sound reaching the worker's ear drum below 85 dBA L_{ex}

Post March 31, 2023 (CSA)

Maximum Equivalent Noise Level (dBA L_{ex})	Recommended Class of Hearing Protection*
≤ 90	C, B/BL, or A/AL
≤ 95	B/BL or A/AL
≤ 105	A/AL
>105	A/AL earplug + A/AL or B/BL earmuff, and limited exposure time to keep sound reaching the worker's ear drum below 85 dBA L_{ex}

Classes of Hearing Protection

Table 3
Assignment of class based on the octave band attenuation values measured according to ANSI S3.19
(See Clauses 3, 6.1.3, 7.1, 9.6.4.1, and 9.6.4.3.)

	Minimum attenuation, dB		
Frequency, Hz	**Class A**	**Class B**	**Class C**
125	10(1)	5(1)	None
250	18	12	None
500	26	16	None
1000	31	21	11
2000	33	23	13
3150	33	23	13
4000	31	21	11
6300	33	23	13
8000	33	23	13

- L Designation – Hearing protectors that meet the requirements for either Class A or B and have a minimum attenuation of 20 d B at 125 Hz are designated as AL or BL, respectively.

Limitations of Classes

- Small difference of even tenths of a decibel at one or more test bands can shift an HPD from one class to an adjacent one
- Values computed from experimenter-fit ANSI S3.19 data. Derating therefore required, approximately 10 dB

SNR - SF 84

- Theoretically run value for 84% of the worker population

Example for use with A-weighted sound measurements:

The measured L_{eq} is 95 dBA. For a device with an SNR(SF_{84}) of 21 dB, the predicted A-weighted effective L_{eq} when the hearing protector is worn is

95 dBA – (21 – 3) dB = 77 dBA

Note: *See Note 3) to Table 2 for an explanation of the* 3-dB *adjustment.*

SNR – SF 84

Table A.1
Sample calculation of SNR(SF_{84})
[All values in dB]
(See Clauses A.1 and B.3.)

Octave-band centre frequency, Hz	125	250	500	1000	2000	4000	8000	Overall levels
Pink noise with a level of 100 dBC	92.0	92.0	92.0	92.0	92.0	92.0	92.0	100.0 dBC*
A-weighting	−16.1	−8.6	−3.2	0.0	1.2	1.0	−1.1	
A-weighted pink noise	75.9	83.4	88.8	92.0	93.2	93.0	90.9	
Mean attenuation (ANSI/ASA S12.6, Method B)	10.0	14.4	19.6	22.8	29.6	38.8	34.1	
Standard deviation	3.0	3.0	3.9	3.4	5.2	6.2	4.4	
Assumed protection values (APV)	7.0	11.4	15.7	19.4	24.4	32.6	29.7	
A-weighted pink noise — APV	68.9	72.0	73.1	72.6	68.8	60.4	61.2	78.6 dBA*

* *For details on computing overall levels from octave data, see Annex B.*

SNR(SF_{84}) is computed as follows.

SNR(SF_{84}) = 100.0 dBC – 78.6 dBA = 21.4 dB, which rounds to 21 dB

SNR - NRR

- The NRR is determined in a laboratory setting, and is the difference between the measured C-weighted sound level of a noise and the A-weighted noise level measured under a hearing protector.

SNR - NRR

Table 2
Effective rating calculations for the NRR
(See Clauses 9.3.3, 9.6.5.2, and 9.7.1, and A.2.)

Device type	Percentage of NRR achieved	For use with dBA	For use with dBC
Earplugs	50%	$L_{eq} - [NRR(0.5) - 3] = XX$ dBA	$L_{Ceq} - NRR(0.5) = XX$ dBA
Earmuffs	70%	$L_{eq} - [NRR(0.7) - 3] = XX$ dBA	$L_{Ceq} - NRR(0.7) = XX$ dBA
Dual protection	65%	$L_{eq} - [(NRR + 5)(0.65) - 3] = XX$ dBA	$L_{Ceq} - (NRR + 5)(0.65) = XX$ dBA

Notes:

1) *Use of the deratings shown in this Table might be helpful in estimating average protection for groups of users, but the deratings cannot be used to estimate protection for individual users.*
2) *Predicted values should be rounded to integer values.*
3) *The NRR that is used for the dual-protection calculations in row 4, columns 3 and 4, is the higher of the individual NRRs of the two devices.*

Limitations of NRR

- cannot be used reliably to determine the classification of a hearing protector.
- NRR values are calculated on a different basis than that used for determining the class definitions given in Table 3
- overlap in values of NRR between Classes A and B. Generally, however, a hearing protector with an NRR of at least 24 and with mean-attenuation values of at least 26, 31, and 33 dB at 500, 1000, and 2000 Hz, respectively, meets the Class A requirements.
- A protector that does not meet the Class A mean-attenuation requirements at 500, 1000, and 2000 Hz, but has an NRR of at least 17, falls generally into Class B.
- A protector with an NRR of less than 17 falls generally into Class C.

Table 3
Assignment of class based on the octave band attenuation values measured according to ANSI S3.19
(See Clauses 3, 6.1.3, 7.1, 9.6.4.1, and 9.6.4.3.)

	Minimum attenuation, dB		
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Octave Band Computation

- Most complex, but most accurate
- Uses octave band noise data to calculate effective noise level when HPD is worn
- Effective when levels are above 105 dBA

Overall level = $10 \cdot \log_{10} \sum_{i=125}^{8000} (10^{L_i/10})$, where L is the octave-band level in decibels for bands i = 125 to 8000 Hz.

Octave Band Computation

Table B.1
Sample calculation of weighted equivalent overall levels
(See Clauses B.2 and B.3.)

Octave-band centre frequency, Hz	125	250	500	1000	2000	4000	8000	Overall levels
Example noise spectrum	87.0	89.0	86.0	88.0	84.0	84.0	73.0	94.5
C-weighting coefficients	–0.2	0.0	0.0	0.0	–0.2	–0.8	–3.0	—
C-weighted spectrum	86.8	89.0	86.0	88.0	83.8	83.2	70.0	94.4
A-weighting coefficients	–16.1	–8.6	–3.2	0	1.2	1	–1.1	—
A-weighted spectrum	70.9	80.4	82.8	88.0	85.2	85.0	71.9	92.1

Note: *All values in dB.*

Limitations

- Complex and not commercially documented

Goal - Theoretically Preferred Matching HPD Attenuation to Noise Exposure

Sound Level Resulting from use of HPD - db (A)	Protection Outcome
85+	Insufficient
80 – 85	Acceptable
75 - 80	Optimal or Ideal
70 - 75	Acceptable
Less than 70	Possible Overprotection

Implications in the Industry

- Not a clear understanding of HPD rating systems and their use
- Each rating system calculated on a different basis
- No specific outline of which system should be used
- Each system has its own limitations and users should understand what each of them mean
- Risk of Over or Under Protection

Chapter 2: Fit Testing Requirements

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Z94.2-14
(reaffirmed 2019)

Hearing protection devices — Performance, selection, care, and use

Field Attenuation Estimation Systems

- Some are classified as subjective, where they rely on worker responses to test signals
- Others are objective, solely relying on measurements
- Technologies used to generate PARs differ and results aren’t comparable
- ANSI S12.71 classifies fit testing systems and make results more comparable

Fit Testing (Field Attention Estimation Systems)

- Not based on in-situ measurements for actual users undergoing exposures
- Reflects what users can achieve and have been shown to achieve

Qualitative Fit Testing

- Uses a pass or fail screening to decide if an individual's hearing protection is working effectively
- Depends on the users response
- Less accurate
- Lean toward overcompensating rather than under compensating

Quantitative Fit Testing

- Uses specialized equipment to measure amount of sound getting through an individual's hearing protection

Preparing for a Fit Test

- Visually inspect ear canal for impacted wax, infection, discharge, or unusually small ear canal (refer to a medical specialist)
- Fitting technique should be first demonstrated and practiced by fit tester subject
- Information on fit, care and maintenance shall be given to the personnel

VeriPro - subjective

- Software – designed to be easy to use
- Audio Processor – coverts digital signal from software, calibrates it to the headphones and amplifies the sound
- Headphones – audiometrically optimized and calibrated to signals used in the VeriPro test

How Does it Work - subjective

- user balances sound levels between the right and left ears to measure

loudness differences with and without the earplugs normally worn by the user.

- This process, called “Loudness-Balance”, determines the Personal Attenuation Rating (PAR) achieved in each ear.

Complete Check vs. Quick Check

Complete

- Calculates Personal Attenuation Rating across five frequencies

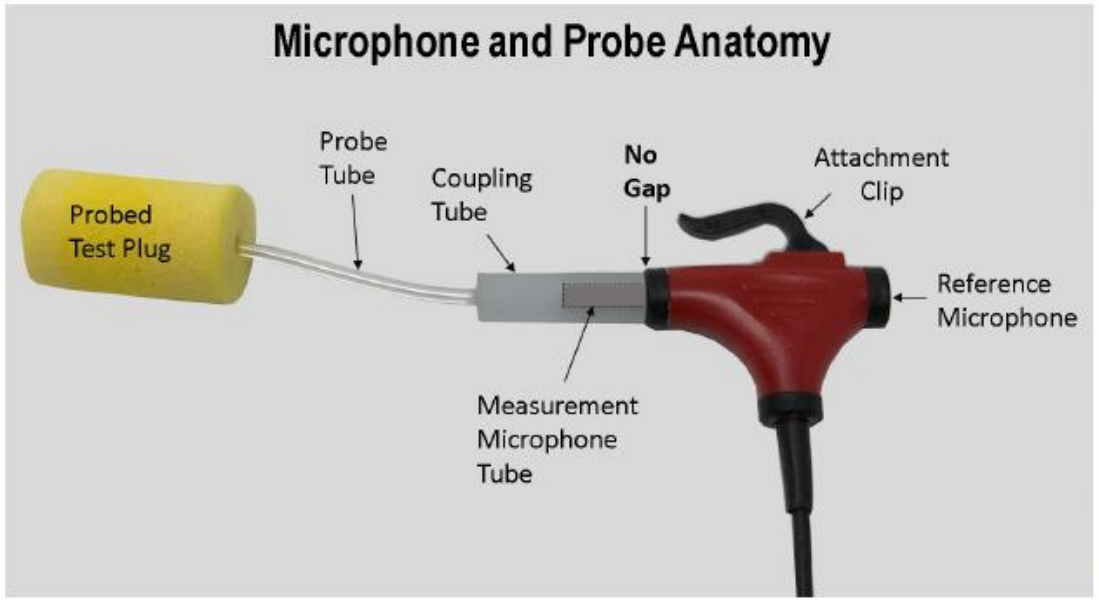
(250, 500, 1000, 2000 and 4000 Hz)

Quick

- Ideal for initial and annual training,
- short duration, tests one frequency (500 Hz)

Fit-testing – Quantitative - Objective

Fit-testing – Quantitative

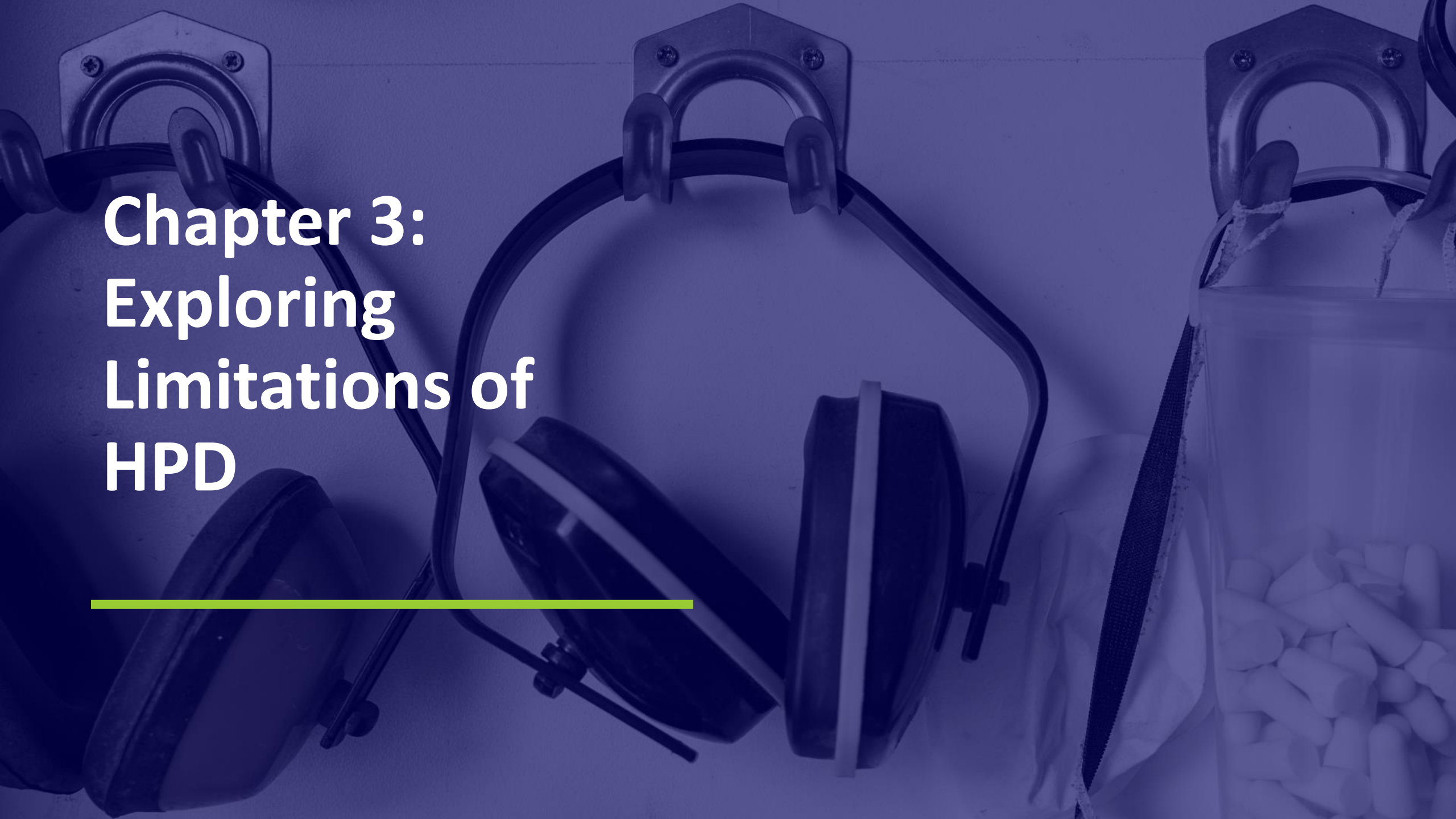


Implications

- No specific outline of fit testing technology in CSA standard
- Various fit testing systems have various technologies so results are not comparable – measurement uncertainty depends on skill of user
- No stipulation in CSA standard relating to whether employees require qualitative or quantitative fit testing

Factors to Consider – ANSI S12.71-2018

- Ambient Noise in Test Environment
- Hearing ability of subjects must be sufficient to assure they hear the signals after attenuation by HPD
- Subjective vs Objective
- Use of Octave Band or testing at various frequencies



Chapter 3: Exploring Limitations of HPD

Hearing Protection Devices

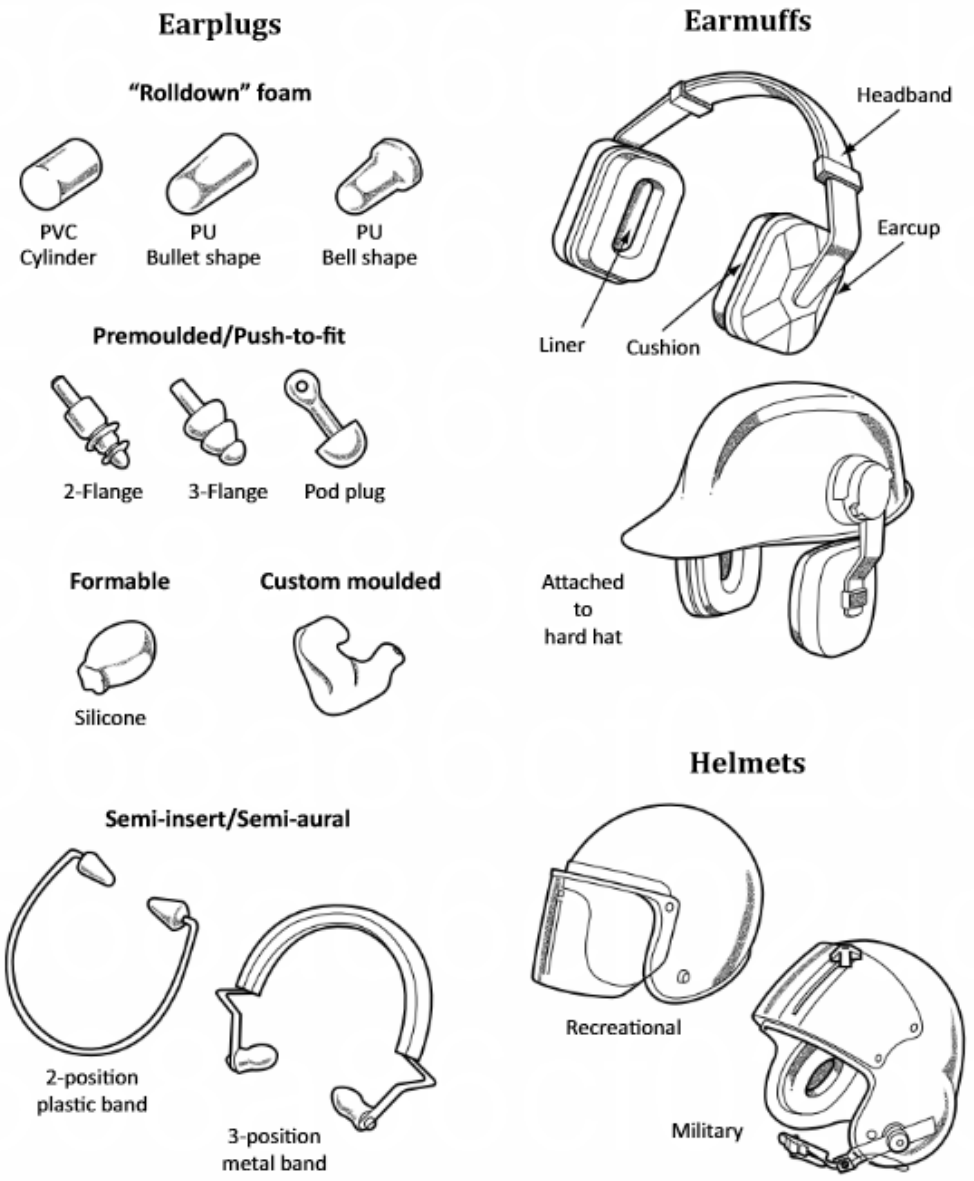
- Reduce noise exposures and the risk of hearing loss **WHEN** worn correctly
- If hearing protection is required, then a complete hearing conservation program should be implemented.
- A hearing conservation program includes noise assessment, methods for controlling noise, hearing protector selection, employee training and education, audiometric testing, maintenance, inspection, record keeping, and program evaluation.

Hearing Protection

- Hearing Protection must:
  - be used properly;
  - be comfortable;
  - not create other safety problems; and
  - be adequate to control the noise hazard.
- To get the most effective hearing protection from earplugs and muffs, employees must be adequately trained in their correct use and care.

Earplugs and Earcaps

- There are several types:
  - reusable plugs ;
    - custom-molded
    - flanged
  - disposable plugs;
    - Roll down foam and
  - reusable canal cap earplugs.



DISPOSABLE

An economical and convenient choice for work situations that demand a high degree of comfort, or where hygiene presents a problem for reuse. Formable foam is also THE material of choice when highest attenuation is required.

MAX®		
Highest NRR in disposable.		
NRR 33	MAX-1	MAX-30
CAN A(L)	Uncorded	Corded

MAX LITE®		
Low pressure foam for comfort.		
NRR 30	LPF-1	LPF-30
CAN A(L)	Uncorded	Corded

LASER LITE®		
Highly visible protection.		
NRR 32	LL-1	LL-30
CAN A(L)	Uncorded	Corded

X-TREME®		
Tapered design for comfort.		
NRR 32	XTR-1	XTR-30
CAN A(L)	Uncorded	Corded

FIRMFIT®		
Firm foam reinvented.		
NRR 30	FF-1	FF-30
CAN A(L)	Uncorded	Corded

FOR DISPOSABLE FOAM EARPLUGS

Inspect: Prior to fitting, examine your earplugs.

Discard: Discard disposable earplugs after each use, or ifearplugs are compromised.

Hygiene: To maintain hygiene standards, disposable earplugs should be discarded at the end of every shift.

*Uncorded Plugs are also available in LS-500 Refills, HL400 Cannisters, and Zip Top Bag Refills

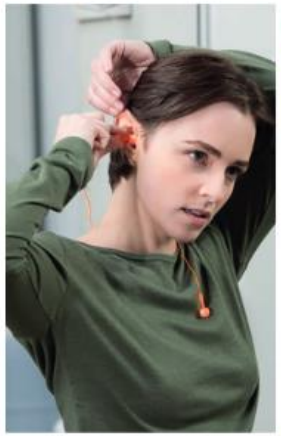
PUSH-IN FOAM

Designed so they're easy to fully insert and remove without picking up dirt from workers' fingers, and comfortable to wear during the work day. Give workers confidence — with TrustFit® push-in foam earplugs.

TRUSTFIT® POD		
Reusable, no-roll down, push-in foam, pod-shaped earplu		
NRR 28	TRUSTFITPOD-1	TRUSTFITPOD-
CAN A(L)	Uncorded	Corded

TRUSTFIT® PLUS		
Reusable, no-roll down, push-in foam, bell-shaped earplug		
NRR 31	TF-PLUS-1	TF-PLUS-30
CAN A(L)	Uncorded	Corded

TRUSTFIT® TRAK	
Reusable, no-roll down, push-in foam, pod-shaped metal detectable earplug.	
NRR 29	TFT-POD-30
	Corded



IT'S ALL ABOUT CHOICE FOR PUSH-IN FOAM EARPLUGS

Inspect: Prior to fitting, examine earplugs for dirt, damage or hardness — discard immediately if compromised.

Clean: Earplugs should be cleaned between each use andprior to re-insertion. To wash use mild soap and warm water, pat dry then store in protected area when not in use.

Chemicals, disinfectants, and solutions should not be used on foam earplugs.

Hygiene: Earplugs can be used a full work-week. Replace after 5 days or if foam tip is damaged or hardened.

REUSABLE

Ideal for environments where employees can retain and store earplugs for reuse over time, reducing waste and saving money.

QUIET®				
Easy handling, better fit.				
NRR 26	QD-1	QD-1-DS	QD-30	QD30-RC
CAN A(L)	Uncorded	LS500 Refill	Corded	Reusable Case

FUSION®		
All-day comfort, easy handling.		
NRR 27		FUS30-HP
CAN A(L)		Corded

FUSION® SMALL		
For smaller ear canals.		
NRR 27		FUS30S-HP
CAN A(L)		Corded

SMARTFIT®			
Personalized fit.			
NRR 25	SMF-30	SMF-30W-P	SMF-30BU
CAN A(L)	Detachable cord	Cotton Cord/ Paper Bag	Corded/ Blue Nylon

AIRSOFT®		
Optimized for comfort.		
NRR 27	DPAS-1	DPAS-30R
CAN A(L)	Uncorded	Corded/Red Polycord

FOR ALL MOLDED REUSABLE EARPLUGS

Inspect: Prior to fitting, examine your earplugs for dirt, damage, deformation or extreme hardness — discard immediately if compromised.

Clean: Wash reusable earplugs with mild soap and warmwater only. Pat dry with a towel and store when not in use. Do not treat with any other substances, as the earplugs may degrade and compromise effectiveness.

Hygiene: With proper maintenance, reusable earplugs can be used daily for 2-4 weeks.

*Airsoft also available in White Nylon Cord & Reusable Case

DETECTABLE

Specially created for environments where contamination from foreign objects is unacceptable. Available in both disposable and reuseable options. Detectable features (metal, visual, optical, x-ray).

LASER TRAK®	
Disposable, visual and metal detectable features.	
NRR 33	LT-30
CAN A(L)	Corded

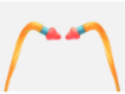
TRUSTFIT® TRAK	
Reusable, metal detectable push-in foam earplug.	
NRR 29	TFT-POD-30
CAN A(L)	Corded

SMARTFIT® DETECTABLE	
Personalized fit and detectability.	
NRR 25	SDT-30
CAN A(L)	Corded

FUSION® DETECTABLE	
All-day comfort, easy handling and detectability.	
NRR 25	FDT-30
CAN A(L)	Corded

FUSION® DETECTABLE SMALL	
All-day comfort for smaller ear canals and detectability.	
NRR 25	FDT-30-SM
CAN A(L)	Corded

BANDED



An alternative for those who work in intermittent noise or for managers and visitors who move in and out of noisy areas.

QB2® HYG	
Supra-aural protection.	
NRR 25	QB2HYG
CAN B(L)	

FOR ALL BANDED EARPLUGS

Inspect: Inspect band and earpods prior to fitting. Replace earpods if they are dirty, damaged, hard or stiff. Replace the band if it becomes brittle or deformed.

Clean: Clean the band and earpods with mild soap and warmwater only, and dry thoroughly. Use of cleaners other than mild soap and water may damage the materials.

Replace: Replace pods every 2-4 weeks to ensure optimal protection and performance.

Earmuffs

- Moulded plastic earcups with foam, fluid or gel cushioned seal
- Cap-mounted muffs

Fitting Earmuffs

- Cuffs must fit snugly over entire ear.
- Headband must be adjustable to keep muffs comfortably in place.
- Cuffs must not rest on anything that could break the seal and let noise in:
  - hair;
  - eyeglass arms; or
  - other PPE.

Caring for Earmuffs

- Replace cuffs if they become hard or cracked - usually every six months, entire muff every 2 years
- Replace earmuffs if straps lose tension.
- Wash with mild soap and water - do not use alcohol or solvents.
- Never modify equipment, like drilling holes to reduce pressure.

Fit-testing – Quantitative and Qualitative

Figure 1

Figure 2

Figure 3

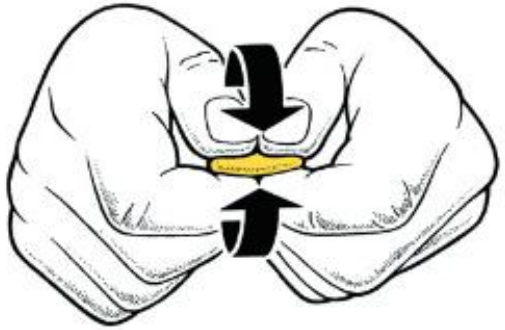


Figure 4

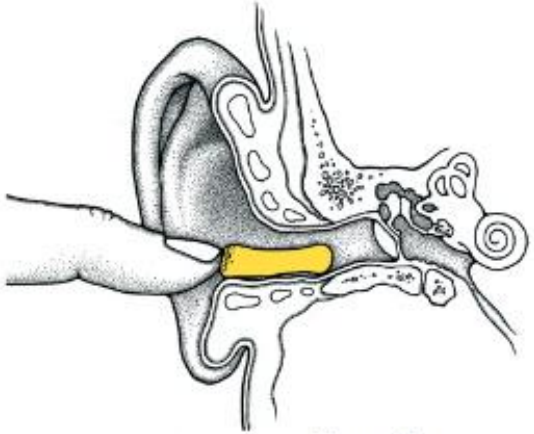
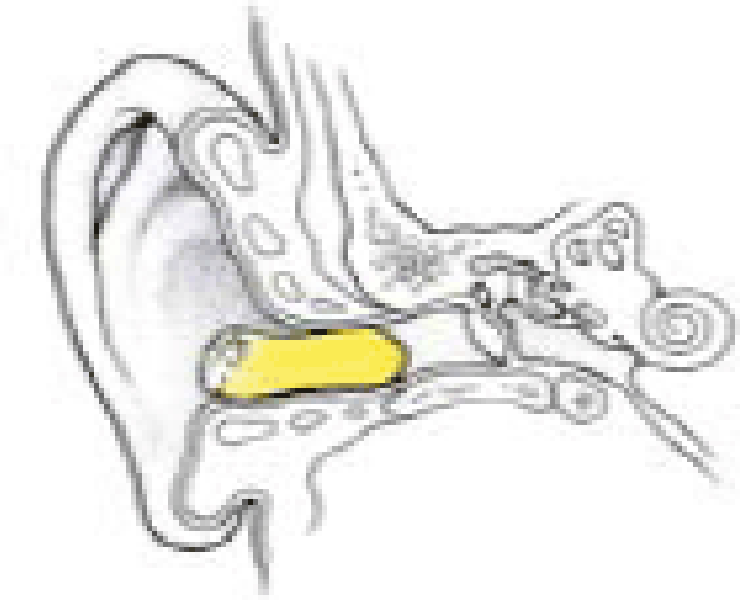
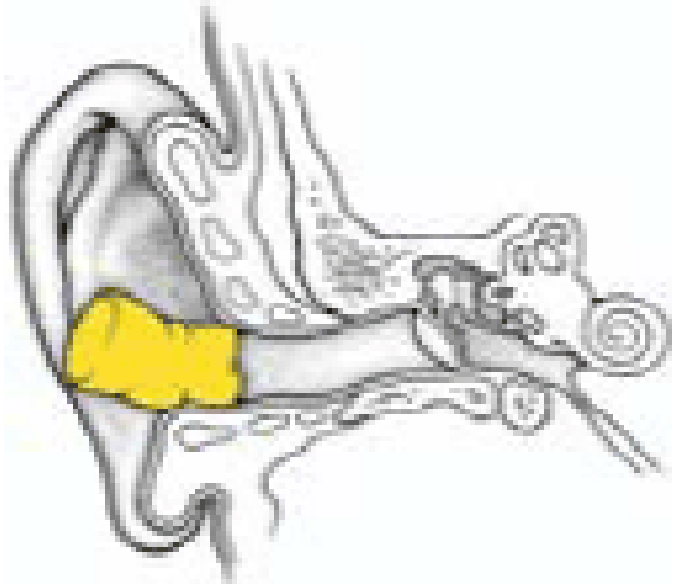


Figure 5

Fit-testing – Qualitative



Good



Poor

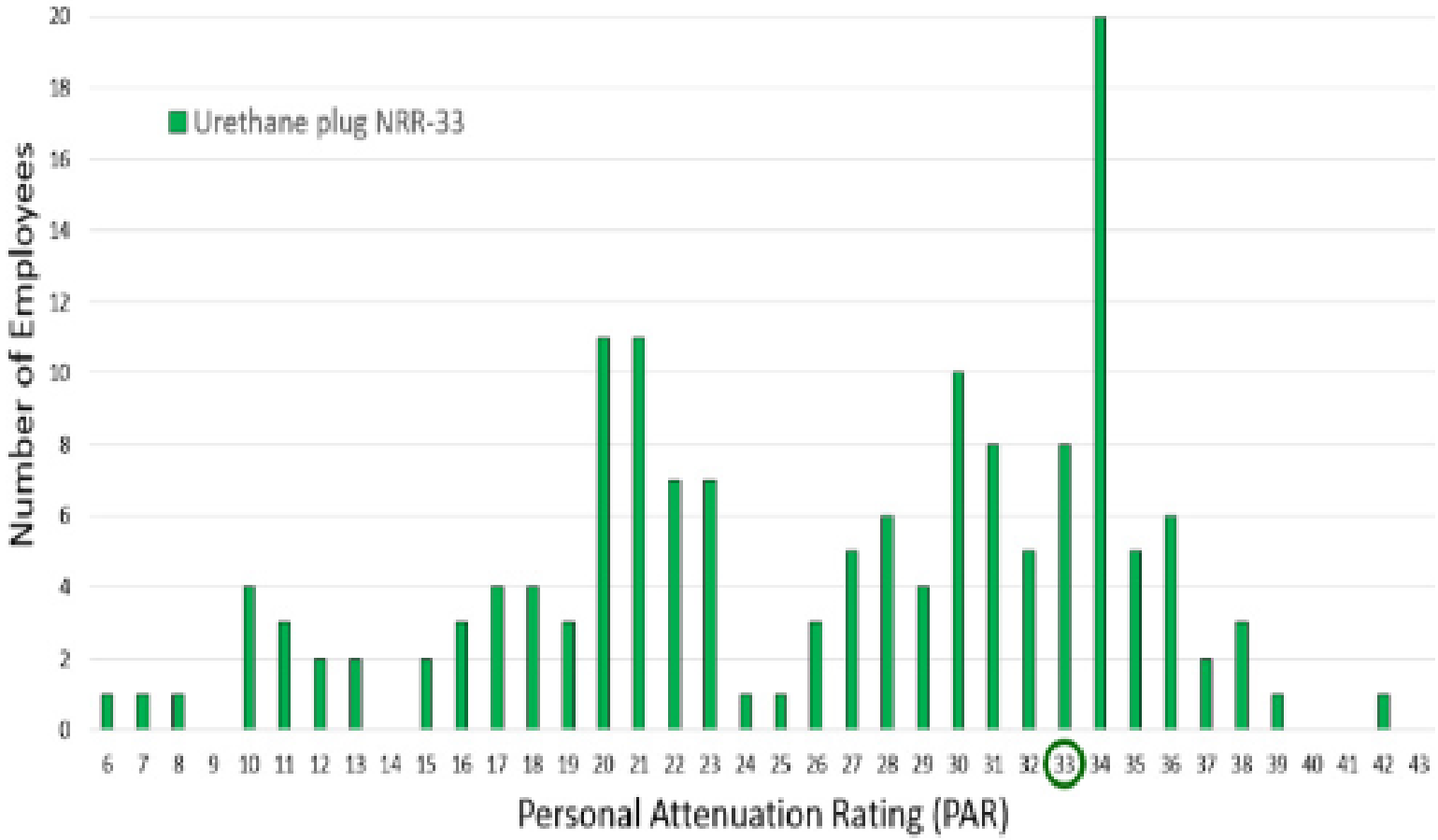
Fit-testing – Qualitative

Improper

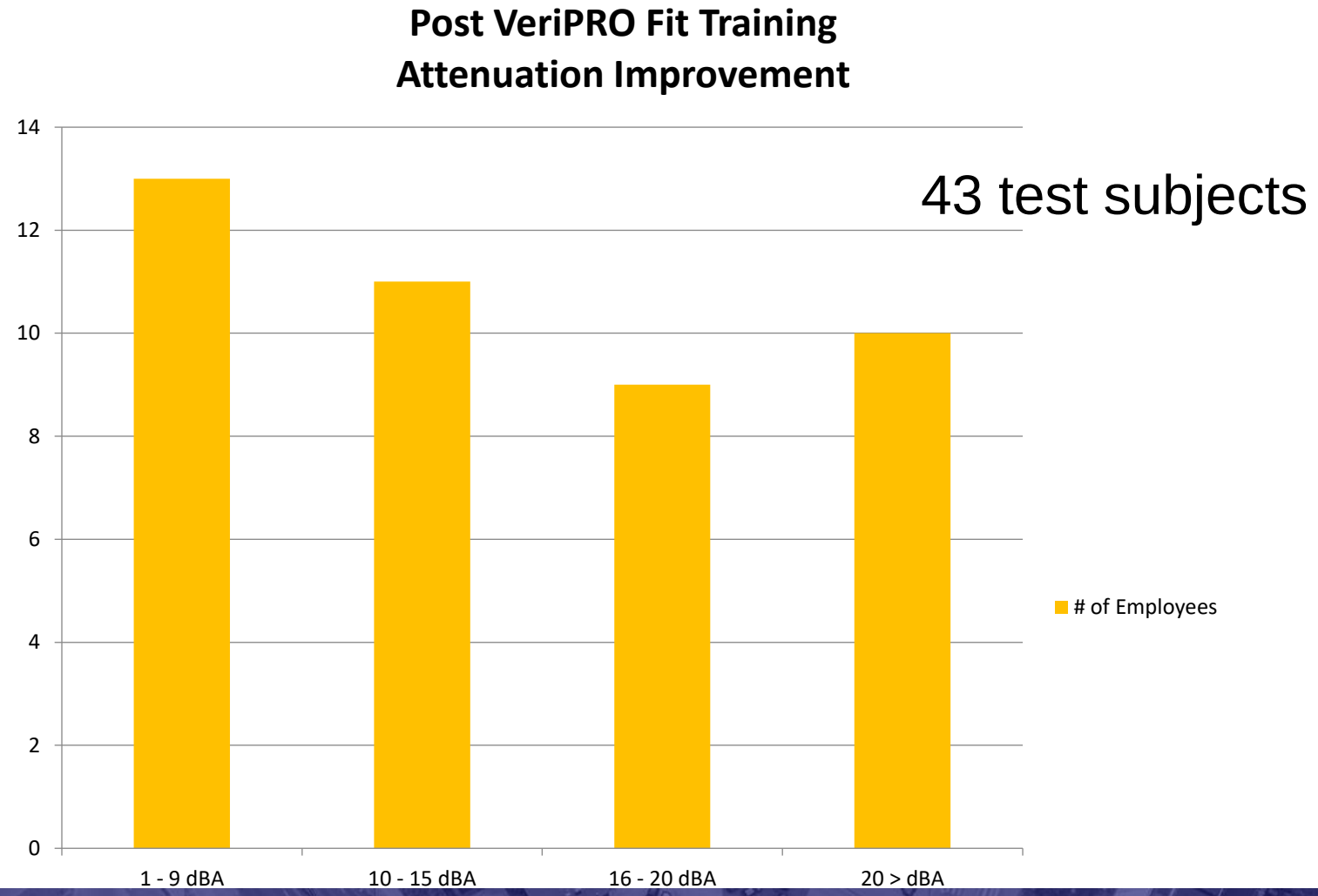
Poor

Correct

Variability in PARs in Workers – 3M Ear Fit



Does qualitative fit-testing work?



43 test subjects

Limitations

- Follow consistent **Classification System**
- **Comfort** – more comfortably HPD is more likely to be worn
- **Compatibility** – ensure it does not interfere with other equipment
- Introduces other hazards in environment – **communication**, auditory signals – HPDs should account for need to hear alarms, warnings or call signals in the noisy environment
- Watch out for **Overprotection**
- Persons with hearing loss can have further difficulties with hearing

Final Thoughts

- ANSI S12.71-2018 Performance Criteria is not easily understandable for employers and industry
- Until specific requirements are outlined for fit testing, there will be inconsistencies with fit testing data, however, the training on the selection, fit and care maintains to be the most critical component
- Qualitative fit testing standards are not outlined with industry accepted criteria which leaves room for misdiagnosis
- Audiometric testing results need to be incorporated into the fit testing evaluation

QUESTIONS?

ehs[p]

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