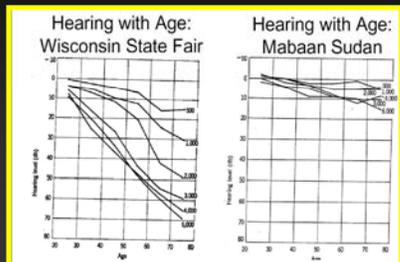


"Hearing Loss is inevitable"

Mabaan tribesmen (never exposed to industrial or urban noise in Sudan desert) still had, at age 70, same average hearing levels as American 20-year-olds!



7 Rosen et al. (1962) Ann Otol Rhinol Laryngol, 71: 727-742. Presbycusis study of a relatively noise-free population in the Sudan

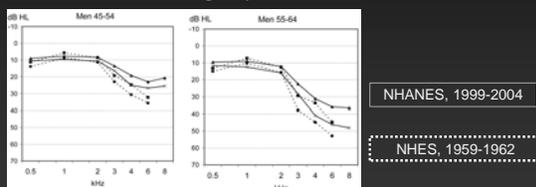
Our goal is "hearing conservation"

NO

Aim for "Hearing Loss Prevention"

Americans Hear as Well or Better Today Compared With 40 Years Ago

Comparing 1999-2004 NHANES to 1959- 1962: High-frequency hearing thresholds were lower (better) Prevalences of hearing impairment were also lower



9 Hoffman et al.(2010) Ear & Hearing 2010;31:725-734

"Noise damage risk criteria, based on level and duration of exposure are always effective..."

"NOISEburn"

LEFT EAR

Frequency (Hz)

Hearing Level (dB)

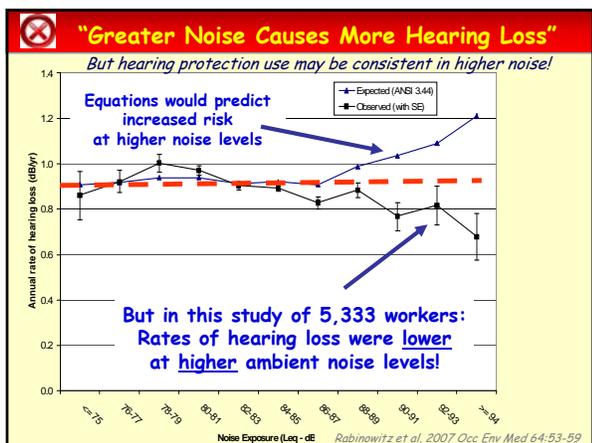
... Not all humans respond to noise similarly...

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... individuals may be exposed to similar noise levels over a lifetime, they show as much as 50-70dB difference in hearing loss

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Passchier-Vermier, 1973, EPA Report No. 550/9-73-008



Use of hearing protection use may be more consistent in higher noise!

Davies, et al. (2009) surveyed 4 Canadian lumber mills (52 job series)

Hearing protector use was greatest among those exposed above 95 dBA... and less among those exposed between 85-95 dBA

14 Davies, et al. (2009) J Occup Environ Hyg. 2009 Jan;6(1):32-41. Occupational noise exposure and hearing protector use in Canadian lumber mills.

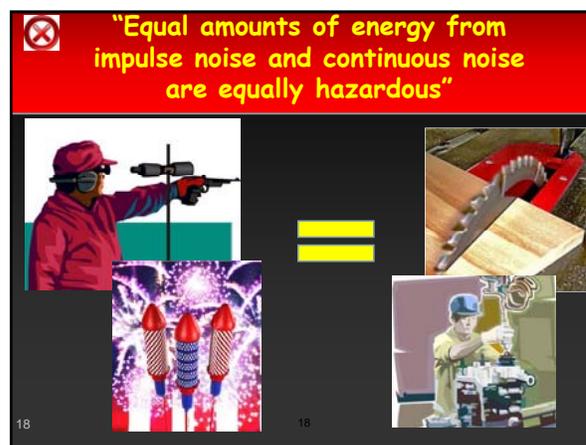
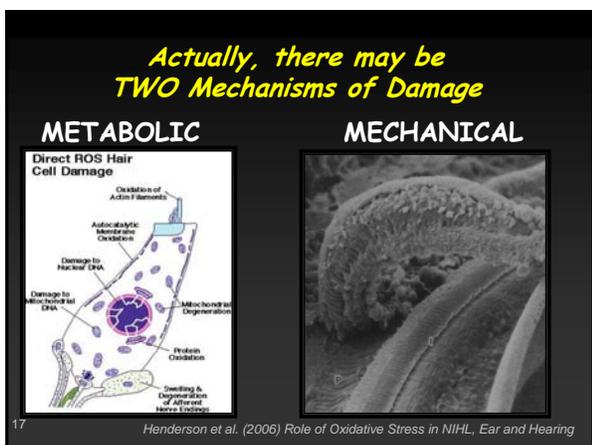
Comply with OSHA, prevent all NIHL
But as many as 22% of employees could incur material hearing loss at the end of a 40-year career

Risk of Exceeding a "Low Fence" of 25dB Hearing Loss (ave. 500, 1000, and 2000 Hz) after 40 years of Exposure (from OSHA 1981)

As estimated by:	ISO	EPA	NIOSH
90 dBA TWA, 8hrs	21%	22%	29%

85dBA/3dB exchange rate recommendations re: noise measurement have been adopted by NIOSH, ACGIH, Dept of Defense, NASA, others

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But impulse noise peak pressure may exceed a critical level that's not achieved by typical "steady" noise

Nearly instantaneous rise time

Very brief duration of overpressure ($\pm 50-150$ microsec)

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Cochlear damage may even increase in first few hours after high-level impulses

Greater hearing loss seen 2-8 hours after impulse noise exposure than seen immediately post-exposure
(Demonstrated with auditory evoked potentials in exposed chinchillas)

Danielson et al. Jour. Acoust Soc America (1991)

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Temporary Threshold Shifts are Harmless

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Temporary Threshold Shifts are Harmless

In mice, TTS (of 40dB) recovers (audiometrically) within a few days, but subsequent anatomical exams showed progressive, delayed degeneration of cochlear nerve and ganglion cells (for as long as 64 weeks postexposure)

Kujawa SG, Liberman MC. (2009) Adding insult to injury: cochlear nerve degeneration after "temporary" noise-induced hearing loss. J Neurosci 29:14077-14085.

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Employers record all hearing loss cases, per CFR 1904.10

Wells (2006) survey asked:

Do you believe that STS's (identified as recordable) are being "lined out" or "denied" inappropriately, with intention to reduce the recordable rate?

	NO	YES
All surveyed	64%	36%
Prof reviewers	57%	43%

Wells (2006) CAOHC Update, Vol 18

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Although "recordable determination" process is tool for OSHA and NIOSH, and should be unrelated to hearing loss prevention strategies... NHCA (2011) reports that professional reviewers feel pressured by clients to make a determination that STS is not recordable, e.g.,

- Threatening employees with outsourcing jobs if hearing losses are recorded.
- Threatening health professionals with breaking of a contract if hearing losses are recorded.
- Insisting on multiple retests to make the STS "go away."

NHCA Position Statement, Spectrum (2011) 28(1):1,11-14

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Log of Work-Related Injuries and Illnesses

Recording of a hearing impairment

- is not necessarily a "black mark"
- does not encourage OSHA inspections or citation

The failure to record hearing losses in noisy occupations gives rise to suspicion

NHCA Position Statement, Spectrum (2011) 28(1):1, 11-14

NEW NHCA POSITION STATEMENT
Guidelines for Recording Hearing Loss on the OSHA Log 300

- Employers have legal obligations to record qualifying hearing losses on the OSHA 300 Log.
- Reviewers must use their professional judgment and follow legal and ethical standards as closely as possible
- Resulting determination of determining work-relatedness is not up for negotiation.

26 NHCA Position Statement, Spectrum (2011) 28(1):1, 11-14

Steps in Work-relatedness Determination
 Rabinowitz, PM. (2005). Determination of work relatedness. CAOHC Update

1. *Is the audiometric test valid?*
2. *Is the employee exposed to potentially damaging noise (or ototoxic chemicals) at work?*
3. *Is the hearing loss consistent with NIHL, OR is there a medical condition present that can completely explain the loss?*
4. *Considering Steps 1-3, did a work exposure either cause or contribute to the hearing loss, or significantly aggravate a pre-existing hearing loss?*

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Buy-Quiet, Quiet-by-Design
 Engineering Noise Controls, in lieu of PPE emphasis

NASA NPR 1800.1c

- ✓ **Buy-Quiet Program**, covering *purchase* of new equipment
- ✓ **Quiet-by-Design Program**, covering *in-house* design and construction of equipment and systems

Contact Beth Cooper (NASA Glenn)

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Updates on adverse effects of combined exposures to noise and other ototoxic agents

"Good evidence" reported by EU-OSHA 2010 literature review (at least in animal studies)

Solvents
 Toluene, ethylbenzene, n-propylbenzene, styrene and methylstyrenes, trichloroethylene, p-Xylene, n-Hexane, carbon disulfide.

Metals and metal compounds
 Lead and lead compounds, mercury (methyl mercury chloride, mercuric sulfide), tin, organic compounds, germanium oxide

Asphyxiants
 Carbon monoxide and hydrogen cyanide and its salts

European Agency for Safety and Health at Work (2009), European Risk Observatory Literature Review

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Ability and Risk Evaluations

per NASA NPR 1800.1c

"If employee ... has a hearing profile equal to or worse than that listed in Table 2 below, the employee and employer shall receive a written notification of the requirement to perform an Ability and Risk Evaluation."

Frequency (Hz)	500	1000	2000	3000	4000	6000
HL (dB)	25	25	25	35	45	45

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NPR 18001.c criteria:

Frequency (Hz)	500	1000	2000	3000	4000	6000
HL (dB)	25	25	25	35	45	45

"Generalizations" of pure-tone averages (5, 1, 2 kHz)

- 26-40 dB HL: marginal difficulty understanding speech in quiet.
- 41-55 dB HL: difficulty in quiet environments unless facing speaker, vocabulary is limited.
- >55 dB HL: trouble understanding even loud speech in a quiet environment (Tye-Murray, 2004)

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BUT... Pure-tone audiometric pass-fail criteria were originally based on medico-legal definitions of handicapping hearing loss, not on fitness-for-duty concerns

- Criteria for "audiometric PASS" vary widely
- "Normal Hearing", as defined audiotically, is not necessary to perform most hearing-critical jobs, since detection of sounds at extremely low levels in quiet is rarely required.

Auditory Fitness for Duty (AFFD) refers to the possession of hearing abilities sufficient for safe and effective job performance

Tufts, JB, Vasil, KA, and Briggs S (2009). Auditory Fitness for Duty: A Review, Journal of American Academy of Audiology 20:539-557

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Auditory Fitness for Duty (AFFD) (JSC's approach)

- Job Communication Requirement**
 - Level I: Works alone, communication not necessary.
 - Level II: Works with one or two others, close proximity, visual cues available.
 - Level III: Works with others, distance factor, limited visual cues.
 - Level IV: Communication headset user, no visual cues available.
- Functional Impairment:** Ability to hear (conversations, caution/warning signals,)
- Site Safety Requirement:** consequences of potential errors that would result from an inability to perform hearing-critical tasks

Wyle Work Instruction, based on Begines (1995) NHCA Spectrum

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Auditory Fitness for Duty (AFFD) (JSC's approach)

As result of Ability and Risk review by multidisiplinary working group, individual may be found:

- capable of safely performing job
- capable of safely performing job with accommodations
- incapable of safely performing job (without undue risk to himself or others), necessitating restriction from that job

Wyle Work Instruction, based on Begines (1995) NHCA Spectrum

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Accommodations in HC program for hearing-impaired workers

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Will they be able to hear each other talk when wearing hearing protectors?

Depends on distance from the speaker, ability to see a speaker's face, familiarity with the topic, background noises, and hearing loss.

RESOURCES:

- OSHA Safety & Health Information Bulletin "Hearing Conservation for the Hearing Impaired Worker" (OSHA publication 12-27-2005)
- OSHA SHIB Innovative Workplace Safety Accommodations for Hearing-Impaired Workers (OSHA Publication 07-22-2005)

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Will he be able to hear ??

CONDITION	WORD RECOGNITION SCORE IN QUIET (% at 55dBA)	MOST COMFORTABLE LISTENING LEVEL (dBA)	"UNCOMFORTABLE LISTENING LEVEL" (dBA) and range
No Hearing Protector	20%	66 dBA	85 dBA
Passive - Earmuff	0%	84 dBA	COULD NOT TEST (beyond range of equipment)
Electronic Amp-Limiting Headset	88%	55 dBA (ON) 85 dBA (OFF)	85 dBA

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EPA is now considering new NRR standard (passive, active, and impulse)

80% Lower Limit of Attenuations Achieved by Test Panel

Noise Reduction Rating

0 10 20 30 40 50
PASSIVE

20% Upper Limit of Attenuations Achieved by Test Panel

The Noise Reduction Rating is comprised of two numbers. When this product is used as directed, the user may expect to receive a level of protection between the lesser and the greater NRR. Product not tested for high-level impulse noise environments

ABC Protective Equipment
123 Main Street
Anywhere, USA

MODEL ABC 1

Federal law prohibits removal of this label prior to purchase

EPA LABEL REQUIRED BY U.S. E.P.A. REGULATIONS 40 CFR Part 211, Subpart B

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NIOSH is now updating new online HPD compendium

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GINA- Genetic Information Non-discrimination Act of 2008

- Effective 1/10/2011 for private employers (and certain other entities) with +15 employees
- Restricts the use and collection of genetic information which includes "family history"
- Prohibits genetic discrimination regarding insurance and employment.
 - not OK to forward info back to the employer who could then potentially discriminate against the employee with that information
- Exempt- US Military, VA & Indian Health Service patients, Federal employees enrolled in the FEHB

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Lifetime Occupational Noise Exposure (LONE) ?

Bruce (2011) proposes calculation of LONE, using Pascal-squared-sec (PASQUES), to simplify noise dose

A-weighted Sound Level	Hours of Exposure/Year to Reach LONE in 40 yrs
80	2000 hrs
85	632 hrs
90	200 hrs
95	63 hrs
100	20 hrs
105	6 hrs
110	2 hrs
115	0.6 hrs (38 minutes)

Bruce (2010) A different look at noise exposure and hearing loss. CAOHC Update, 22(2)
Bruce et al. (2011) Safe Lifetime Occupational Noise Exposure—1 LONE, Sound and Vibration

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Verification of HPD Attenuation

TRAINING
new hires and STS retraining

VERIFICATION
Fitchchecks can document actual attenuation achieved by employee

ALTERNATE TO "DERATING"
Example: JET ENGINE TEST CELL: Extremely high noise levels, with severe limitations in allowable duration of exposures
- "Use of "OSHA de-rating" of HPDs may not represent actual attenuation achieved by experienced, well-motivated employees (who have been observed to practice better-than-average HPD use)

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