

Occupational Audiometric Testing

Part 1: Introduction

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Scope of instruction

- Purposes
- Equipment and environment
- Procedures and personnel
- Dealing with problems
- Interpretation of results

Purposes for audiometric testing

- Determine worker's hearing status
- Identify greater-than-normal hearing loss
 - Identify sensitive workers
 - Identify poorly protected workers
- Educate and motivate the worker
- Provide proof of hearing conservation effectiveness

Audiometric process outline

- Instrument is audiometer
- Measurements
 - Lowest audible sound determined (threshold)
 - Tests over multiple frequencies
 - Each ear separately tested
- Initial test is called baseline
- Subsequent tests annually

Audiometers

- Manually operated
 - Inexpensive but labor intensive
 - Most training needed
- Automatic
 - Stand-alone types
 - Computer-based
 - Expensive, but simple to operate



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Procedures

- Pure tones used
 - 500, 1000, 2000, 3000, 4000, 6000, [8000] Hz
- Subject indicates whenever tone heard
- Sound level decreased to inaudibility, then increased back to audible level
- Lowest audible tone at each frequency recorded as threshold

Audiometric Environment

- Low noise to avoid threshold elevation
- Normally inside special booth
- May test outside booth
 - Claustrophobic subjects
 - Occasional testing
 - Avoid clicks, squeaks that give clues



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Background Noise Levels

- Measured with octave band analyzer
- OSHA limits are marginally acceptable
- American National Standards Institute (ANSI) should be goal

Frequency	OSHA	ANSI
500	40	21
1000	40	26
2000	47	34
4000	57	37
8000	62	37

Audiometric personnel

- Trained technician
 - Certified course (CAOHC - Council for Accreditation in Occupational Hearing Conservation)
 - Locally supervised
- Professional supervisor
 - Audiologist
 - Specialist physician
 - Occupational physician

Occupational Audiometric Testing Part 2: Quality Control

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Quality control for audiometry

- Instrument calibration
- Procedural consistency
- Subject factors
- Goals
 - Accuracy
 - Consistency

Instrument calibration

- Daily sound level check
 - On an individual
 - On an instrument
- Daily listening check
 - Static, distortion, etc
- Annual instrument calibration
 - Only adjust if necessary



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Quality control - procedures

- Instructions
- Headphone placement
 - Placement and removal by technician, not the subject!
 - Place and remove from front
 - Check to ensure headphone centered over ear canal
- Check with last year's results



Instructions to subject

- Emphasize purpose of test
 - To see if hearing is changing
 - To determine the softest sound the subject can hear
- Describe what will be heard
 - Soft beep-beep-beep sound
 - At first will be louder, then softer
- Explain action needed
 - "When you hear the beeps, press and quickly release the button"

Instructions (2)

- Be consistent with instructions
 - Have them written down
 - Give same instructions to all subjects
- Provide in the subject's language
- Offer to discuss results
- Offer to answer questions
- Re-instruct if necessary

Quality control – TTS

- Temporary hearing loss (TTS - temporary threshold shift)
- 14 hours away from noise to minimize
- When to test to avoid TTS
 - Beginning of work shift (before exposure)
 - During work shift if protected
 - Good hearing protection will be adequate to avoid TTS

Quality control – ear blockage



<http://office.microsoft.com/clipart>

- Cold, allergy, sinus problems
- Collapsing ear canal
- Impacted earwax

Quality control – Instruction compliance

- Language barriers
- Misunderstanding of purpose
- Fatigue and sleepiness
- Deliberate lack of cooperation

Quality control – ear differences

- Cross hearing
 - 40 dB or more difference between ears
 - Better ear may hear sound before poorer ear
- Poorer ear threshold inaccuracy
- Corrected by masking noise in better ear
 - Requires special equipment
 - Requires special training - audiologist

Summary

- Procedures, personnel, environment
 - Threshold determination, multiple frequencies
 - Quiet location (normally special booth)
 - Technician to test, specialist to supervise
- Quality control
 - Calibration and procedures
 - Subject instructions
 - Other subject factors

Occupational Audiometric Testing

Part 3: Interpretation

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Interpretation of results

- Comparison of annual to baseline, one ear at a time
- $\text{Threshold}_{\text{Annual}} - \text{Threshold}_{\text{Baseline}} = \text{threshold shift}$

	500	1000	2000	3000	4000	6000
Baseline, RE	20	15	15	20	25	25
Annual, RE	20	20	25	25	35	40
Threshold shift	0	5	10	5	10	15

Standard Threshold Shift (STS)

- ≥ 10 dB average shift at 2, 3 & 4 kHz
- Each ear computed separately
- ≥ 10 dB average shift in either ear is STS
- Either average shifts or subtract threshold averages

	2000	3000	4000	AVG
Baseline, RE	15	20	25	20
Annual, RE	25	35	35	31.7
Threshold shift	10	15	10	11.7

Other factors in STS determination

- Test error or short term loss
 - Retest allowed within 30 days
- Age correction allowed
 - Subtracts normal aging loss from threshold shift

Age	30	40	50	60
M	2.3	6.0	11.7	19.0
F	2.0	4.3	7.7	11.7

STS - work related?

- Determination by health care professional
- Factors for determination
 - Workplace noise exposure
 - Hearing protection on the job
 - Non-occupational factors
 - Noisy hobbies, sports, other jobs
 - Lack of protection
- Only make determination of non-work-related if no significant contribution to hearing loss due to workplace factors



STS actions

- Notify worker in writing within 21 days
- Re-train and re-fit hearing protectors
- Change to new baseline if STS persistent
- Possibly record as occupational illness or injury
- Refer for medical evaluation if ear infection caused/aggravated by HPD

Baseline revision

- STS - if present on two consecutive
- Improvement - ≥ 5 dB average (2,3,4 kHz) on two consecutive audiograms
- General rules:
 - Revise to the better (or earlier) audiogram
 - Revise each ear separately
 - Revise all frequencies in each ear together
 - Subject to professional judgment

Recordability of hearing loss

- Meets all STS requirements **and**
- Average hearing level ≥ 25 dB at 2, 3 & 4 kHz in the same ear
- Recording requirements
 - Within 7 days of test on OSHA 300 log
 - May later be deleted if change isn't permanent

Check the "injury" column or choose one type of loss:

(M)					
Injury	See duration	Regulatory numbers	Priority	Hearing loss	Other illness
<input type="checkbox"/> (1)	<input type="checkbox"/> (2)	<input type="checkbox"/> (3)	<input type="checkbox"/> (4)	<input checked="" type="checkbox"/> (5)	<input type="checkbox"/> (6)

Occupational Audiometric Testing Part 4: Impairment & Referral

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Determination of hearing impairment

- Average thresholds at 0.5, 1, 2, & 3 kHz
- Determine degree of impairment, if any
 - 0-24 dB, normal range
 - 25-39 dB, mild hearing loss
 - 40-54 dB, moderate loss
 - 55-70 dB, moderately severe loss
 - 70-84 dB, severe loss
 - >85 dB, profound loss

Percentage of hearing loss

- Average thresholds at 0.5, 1, 2, & 3 kHz
- Subtract 25 dB from result (normal hearing)
- Multiply result by 1.5%
- Repeat for each ear

	500	1000	2000	3000	Avg.	%
Right Ear	20	25	25	40	27.5	4
Left Ear	20	30	35	45	32.5	11

Binaural impairment calculation

- Since hearing isn't averaged by ears, consider better ear more strongly
1. Multiply loss in better ear by 5
 2. Add loss in poorer ear
 3. Divide total by 6 for binaural loss
 $(4\% \times 5 + 11\%) = 31\%$
 $31\% \div 6 = 5\%$

Problem audiograms - medical

- Large shift in short period
- Large shift in one ear only
- Ear pain, dizziness, onset of tinnitus

Problem audiograms - measurement

- Cross hearing situation
- Uncooperative or difficult subject
- Hearing impaired subject

Referral to specialist

- Medical problems
 - Employer payment?
- Measurement problems
- Interpretation problems
 - Standard threshold shift - work related?
 - Recordable on OSHA log - work related?
 - Baseline revision

Recordkeeping

- What audiometric records must be kept
 - Name of employee & examiner, date of test
 - Threshold results
 - Calibration date of audiometer
 - Noise exposure assessment of employee
- How long to keep
 - OSHA: duration of employment
 - Others: extended period
- Other records to keep
 - Background noise, hearing history, training of examiner, daily calibration log

Summary

- Interpretation
 - STS calculation - 10 dB shift @ 2,3,4 kHz
 - STS actions and recordability
 - Impairment - 500 to 3000 Hz, >25 dB
- Referral of problem audiograms
 - Medical
 - Measurement
- Recordkeeping