HEARING GUIDELINES[1]

I. INTRODUCTION

It would be difficult to overstate the importance of hearing to the conduct of essential patrol officer job functions. This is a hearing-critical job, where the ability to hear, discriminate, localize and respond appropriately to a variety of speech and environmental sounds may literally mean the difference between life and death. These guidelines are intended to ensure that officers have the hearing ability necessary to protect themselves, their fellow officers, and the public. This update incorporates the latest developments in the assessment of auditory function. Additional depth and detail are provided to enable physicians and hiring authorities to establish guidelines that are fair and consistent, and to allow for the individualized consideration of agency and candidate specifics.

A. OUTLINE OF HIGHLIGHTED CONDITIONS

1) Abnormal Audiogram

2) Use of Hearing Aids

3) Retrocochlear conditions

B. IMPORTANCE OF HEARING TO PATROL OFFICER DUTIES

Analyses of the hearing demands of patrol officers have consistently demonstrated the importance of many hearing capacities to the successful performance of patrol officer essential functions. Officers must be able to adequately receive, perceive, and react appropriately to speech communication in a variety of situations, including face-to-face communication, radio communication and telephone conversations. They must also be able to recognize and respond appropriately to nonverbal auditory stimuli, such as the sound of a shotgun racking, retreating or approaching footsteps, or the sound of breathing.

POST has conducted several studies to identify and validate the hearing demands of patrol officers. The first such study, conducted in 1979, gathered data from more than 2,400 subject matter experts across 219 law enforcement agencies.

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Many hearing-related job tasks were rated as either very or critically important, including transmitting messages over police radios, interrogating suspects, coordinating tactical operations, and confronting hostile groups.

In 1984, POST conducted a second job analysis, which included 131 officers from seven agencies. These officers were asked to rate 13 hearing-related tasks for importance and frequency of occurrence in various background noise conditions. The tasks were grouped into four major categories: speech comprehension, sound localization, sound detection, and sound recognition. Tasks requiring speech comprehension, such as monitoring radio transmissions and conversing face-to-face, were rated very important to critically important, and occurred daily (Table XII-1). Many officers also rated tasks involving sound localization and sound detection as critically important, noting that these tasks occurred several times a week. Tasks involving sound recognition were rated as "important" to "very important" and occurred on a weekly basis. Moreover, all tasks had to be performed in a wide range of background noise environments from silence to wailing sirens and screaming mobs.

POST also asked each officer to provide information about a critical incident in which the ability to hear was particularly important. A total of 99 such incidents were reported: 29% involved sound detection, 28% sound localization, 21% speech comprehension, and 10% sound recognition. Of the 99 incidents, 15 occurred in quiet environments.

Based on this 1984 study, one can conclude that tasks involving speech comprehension, sound localization, sound detection, and sound recognition in a wide range of acoustic environments are essential job functions for patrol officers.

In support of the current guidelines, POST convened a 1998 job analysis panel meeting consisting of seven senior field-training officers representing police departments, sheriffs' offices, and the California Highway Patrol. These subject matter experts were given the task of reviewing and updating the information from the 1984 study. They rated the resulting hearing tasks on frequency and importance, and identified common background noises encountered during their execution. As in 1984, panelists provided critical incidents associated with each of the major hearing functions (speech comprehension, sound localization, sound detection, and sound recognition).

The results of this analysis (summarized in Table XII-2) confirmed the previous findings: namely, that all major hearing functions are critical to the safe and effective performance of a wide variety of essential patrol officer functions; and, furthermore, that these functions must be performed in the midst of a wide range of often adverse acoustical environments. The ability to comprehend speech, especially in the midst of moderate-to-loud background noise (e.g., freeway traffic, radio static) is clearly one of the most critical hearing skills for a patrol officer.

TABLE XII-1:
Hearing Related Tasks

Task	Importance* to Overall Job Performance	Frequency** of Performance Under Specific Background Noise Conditions			
		Silence [a]	Moderate [b]	Loud [c]	Very Loud [d]
Speech Comprehension					
Radio transmission	5.6	5.1	7.0	6.5	4.0
Face-to-face conversations	5.2	4.9	6.5	5.5	3.1
Conversation when speaker is not visible (excluding telephone and radio use)	4.5	2.8	3.5	3.1	2.0
Telephone use	4.3	4.7	5.1	4.2	2.4
Sound Localization					
While on foot	5.4	4.1	5.6	5.1	3.4
While in patrol vehicle	5.4	4.1	5.9	5.3	3.6
Sound Detection					
While on foot	5.4	4.4	5.8	5.2	3.3
While in patrol vehicle	5.4	4.1	5.9	5.4	3.5
Sound Recognition					
Identify various types of alarms	4.4	3.3	4.4	3.9	2.3
Notice changes in sound of patrol car	4.1	3.7	5.0	4.1	2.6
Recognize beeps or clicks signaling message from device	4.1	3.8	4.8	4.3	3.0
Identify by sound an approaching vehicle	4.0	3.8	5.2	4.3	2.6

*IMPORTANCE SCALE					
Critically Important	Very Important	Important	Of Some Importance	Of Little Importance	Task Not Important
6	5	4	3	2	1

**FREQUENCY SCALE							
More than once per day	Daily	Several times a week	Weekly	Several times a month	Monthly	Less than once a month	I have never performed this task
8	7	6	5	4	3	2	1

a Silence: virtually no background noise
b Moderate: muffled street sounds, running car engine, quiet conversation, etc.
c Loud: honking horns, motorcycle engines, noisy restaurant, etc.
d Very loud: wailing sirens, large burning building, screaming mob, etc.

TABLE XII-2:
Summary of 1998 Subject Matter Expert Panel Ratings of Hearing Related Tasks

	SPEECH COMPREHENSION	SOUND LOCALIZATION	SOUND DETECTION & RECOGNITION
MOST COMMON TASKS	Radio transmissions and face-to-face conversations, most often amidst noise	Localizing sound while driving in alleys, on bike patrol, and wearing headgear	Recognizing sounds to investigate while on foot or in vehicle (e.g., alarms, approaching vehicles)
MOST IMPORTANT TASKS	Understanding dispatcher transmission against background noise; understanding communication from portable radios.	Localizing sound in patrol vehicle and on foot; determining direction of oncoming vehicles	All tasks were important as in 1984 (e.g., identifying alarms, someone running from behind, changes in patrol car sounds, identify approaching vehicles)
MOST COMMON CRITICAL INCIDENTS	Talking to driver beside freeway; radio communication while on patrol, communicating with suspect/ other officers.	Footsteps of suspects, vehicle sounds, rustling sounds, gunshot/projectile impact sounds.	Running sounds, breaking branches, etc. while chasing suspects; voices, slaps etc. during domestic violence calls.
COMMON BACKGROUND NOISES DURING CRITICAL INCIDENTS	Crowd noises; radio transmissions; vehicle traffic; helicopters and aircraft.	Vehicle traffic; radio transmissions; sirens.	Vehicle traffic; radio transmissions; neighborhood noises; helicopters and aircraft.

The ability to localize sound is critical to determining the direction of oncoming vehicles, locating and pursuing suspects, and a wide variety of other critical functions. The ability to detect and recognize a wide variety of sounds - including footsteps, vehicles, leaves, etc. - was also found to be an essential, everyday part of the job.

C. IMPLICATIONS FOR THE PRE-PLACEMENT SCREENING OF PEACE OFFICERS

Given the importance of these hearing functions, it would seem necessary to require candidates to have normal abilities. While this is a reasonable assumption, it is not necessarily the case that minor degrees of functional hearing impairment would impair job performance or create safety risks. This is an important and relevant issue to the extent that these functional abilities can be assessed clinically, and those with only minor impairment reliably identified. At the present time, this is possible only for speech comprehension in quiet and noise.

Regarding speech comprehension in noisy environments, the major consideration, which determines the significance of minor impairment, is the ratio of the speech level to the background noise level (S/N ratio). As background noise levels exceed about 50 dB, people will try to compensate by speaking louder and moving closer together to maintain comfortable listening (Pearsons, 1977). However, for every 1 dB increase in background noise, the average person raises his/her voice by only 0.6 dB. Therefore, as background noise increases, the S/N ratio decreases. At sufficient noise levels, even people with normal hearing abilities are as close as they can be, and are speaking

as loudly as they can, but still cannot understand every word that is spoken. If patrol duties are conducted at such levels of background noise that even officers with normal hearing have difficulty understanding speech, then even minor degrees of impairment due to hearing loss would make it increasingly difficult for an officer to effectively carry out his/her duties.

To address this issue, POST contracted with the House Ear Institute in Los Angeles (HEI) in 1999 to do field testing to determine background noise levels for patrol officer duties. Acoustical measurements were obtained at a variety of locations identified by subject matter experts as representative of the most important and acoustically challenging environments faced by officers. These included the interior of patrol vehicles during routine duties and on interstate freeways with radio communications and traffic noise; outside of vehicles during emergency response situations with ambulances and crowds present; and outside of vehicles alongside the freeway in response to a rush hour accident. As indicated in Table XII-3, routine urban patrol duties often include working in noise environments that are 70-80 dB(A). On freeways, or when sirens are on, noise levels can exceed 85 dB(A).

TABLE XII-3:
Distribution of Background Noise Levels for Patrol Duties

Noise level:	70-75 dB(A)	75-80dB(A)	80-85 dB(A)	>85dB(A)
Patrol Duty	Percentage of sampling time			
Inside LAPD patrol vehicle on routine activities	35%	10%	0%	0%
Outside LAPD vehicle during emergency response situation with ambulance and crowds present	54%	28%	6%	6%
Inside CHP vehicle on interstate freeway with radio communications and traffic noise	11%	6%	16%	8%
Outside CHP vehicle along side of freeway during response to an accident at rush hour	0%	28%	59%	13%

Source: House Ear Institute data.

To determine the effect that such background noise has on the speech comprehension ability of persons with normal hearing, HEI tested more than 350 subjects with normal audiograms. Each subject was placed in a sound booth and asked to repeat recorded sentences while background noise was present. The sentences emanated from a speaker in front of the subject, while the noise came from either the same speaker or one located to the side of the subject. The former orientation is an acoustically more difficult listening situation.

This work indicated that even persons with normal hearing are likely to experience diminished speech comprehension in background noise at levels comparable to those that occur during patrol activities (Table XII-4). For example, LAPD patrol officers would be expected to experience up to 30% loss of speech comprehension as background noise levels approach 80 dB(A), and the noise source is in front or behind the officer.

This assessment assumed that the officer would get closer than 1 meter to the speaker as the noise increases. Of course, this may not be possible or desirable for patrol officers for various reasons. Given how challenging the acoustic environment is for persons with normal hearing, it appears reasonable to require that patrol officer candidates not have any additional impairment of this functional ability due to their intrinsic hearing loss.

TABLE XII-4:
Expected Speech Comprehension at Various Background Noise Levels and Directionality for Persons With Normal Hearing

Noise level:	70-75 dB	75-80 dB	80-85 dB	>85dB
Noise Orientation	Expected Speech Comprehension			
Noise in Front or Back	90%	70%	50%	<40%
Noise off to one side	100%	100%	100%	<100%

Source: House Ear Institute data based on sound-field HINT testing.
Assumes a maximum speech level of 85 dB based on work by Pearsons, 1977.

Regarding speech comprehension in quiet environments, the major consideration, which determines the significance of minor impairment, is the level of the speech likely to be encountered by patrol officers. The lower the level, the more difficult the task. Patrol officers may have to listen to conversations through windows or doors, or communicate to one another in whispered speech. Therefore, any acceptable impairment should not impede an officer's ability to perform these tasks.
Acoustic data regarding these tasks is limited. In a small study involving six males and four females, Nilsson (1992) found the average male whisper (measured at 1 meter) to be 40 dB(A) (s.d.=4.5) and the average female whisper to be 33 dB(A) (s.d.=4.7). The lowest whisper level was 27.4 dB(A). Two other sources report whispered speech to be 30 dB(A) (Borden 1984; Ostergaard, 1986). To ensure that a candidate could understand whispered speech from all male partners and most female partners, a reasonable guideline would require candidates to understand whispered speech at a volume of at least 30 dB(A) without difficulty. This guideline would also ensure the ability to understand male whispers at distances greater than 1 meter or through doors and windows.

Data collected by HEI indicates that candidates with some degree of impairment would still be able to pass this guideline. As part of a norming study for their speech comprehension test (the Hearing in Noise Test), the HEI found that persons with normal hearing could reliably repeat sentences presented at levels as low as 20 dB(A).

II. MEDICAL EXAMINATION AND EVALUATION GUIDELINES

A. GENERAL SCREENING RECOMMENDATIONS

1) History:

The Medical History Statement is adequate for general screening. However, note any history of severe head trauma (see definition in Neurology chapter), stroke, or attention deficit disorder.

2) Examination:

Ear examination is needed only if the screening audiogram is abnormal or there is a history of ear-related symptoms.

3) Routine Testing:

Pure tone threshold testing using appropriate psycho physical techniques should be conducted for each ear separately at 500, 1000, 2000, 3000, 4000, and 6000 Hz in an ANSI approved sound-treated booth (ANSI S3.1-1999) with equipment calibrated to ANSI standards (ANSI S3.6-1996). The test should be conducted by a certified audiologist, or CAOHC-certified "Hearing Conservationist." For acoustical reasons, audiograms must be done without hearing aids in place.

B. EVALUATION OF COMMON CLINICAL SYNDROMES

1) ABNORMAL AUDIOGRAM

a. GENERAL CONSIDERATIONS:

In general, an audiogram is considered to be abnormal if thresholds exceed 25 dB. In these cases, the examining physician must determine 1) whether the hearing loss is functionally relevant to the safe performance of patrol duties, and 2) whether the candidate needs to be evaluated by a hearing specialist to assess treatment options and/or prognosis.

High Frequency Loss:

The most common audiometric abnormality that the examining physician will encounter in candidates is the classic *"4000 Hz notch"* pattern. This audiogram is characterized by losses at 3000 and 4000 Hz and sometimes 6000 Hz, which greatly exceed those at 500, and 1000 Hz (Figure XII-1). The majority of these

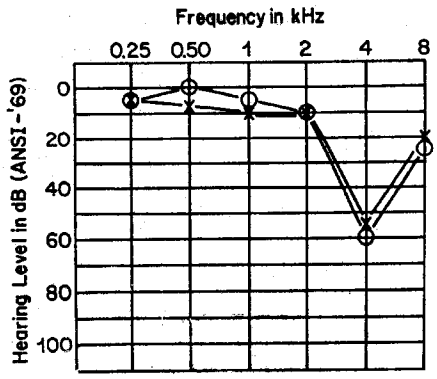

Figure XII-1. An example of a high-frequency notch audiometric configuration.

reflect sensorineural damage caused by noise exposure. In these cases, there are no treatment and the rate of progression depends primarily on whether the ears are protected from further damaging noise exposure.

The primary functional concern in these candidates is impaired speech comprehension in noise. However, it is difficult to predict impairment of this functional ability based on an audiogram alone. This is especially true with candidates whose hearing losses are usually in the mild to moderate range.

Therefore, many tests have been developed which require the subject to repeat lists of words or sentences presented in noise. However, these tests differ in a large number of testing characteristics which have a great impact an individual's performance on the test, including:

- use of words vs. sentences for speech material
- live voice vs. taped speech materials
- male voice vs. female
- use of headphones vs. sound field testing
- the spatial separation between the speech and the noise source
- the acoustics of the headphones or sound booth
- the type of background noise
- the S/N ratio
- the use of adaptive testing vs. fixed testing techniques

Consequently, speech comprehension scores from different tests are not directly comparable. Neither are scores from the same tests conducted at different locations, unless each location uses headphones/amplifiers calibrated with the same acoustical properties.

Additionally, most of the available tests have limited usefulness for pre-employment screening due to the lack of adequate control subjects. Establishing normative values is difficult, since all of the testing characteristics listed above must be the same for the controls and the subjects, and the control group must be of adequate size to have acceptable statistical properties.

At the present time, POST is aware of only one test, the Hearing in Noise Test (HINT) developed by HEI, which has acceptable minimum performance criteria for use in pre-employment screening. These major criteria include the following:

- *It is available in both headphone and sound field versions.* The headphone version is digitally engineered to create a virtual sound field listening environment so that information from both ears is available simultaneously. It offers the advantage of being commercially available; in addition, the results are not subject to testing error by inadvertent head movement by the candidate. However, it is imperative that a comparable free-field version of a test be available, since candidates who wear hearing aids cannot be tested using headphones. Presently, the free-field version is available in San Diego, Los Angeles, and San Francisco.

- *It has an adequate normal hearing control group.* Each of the three sites offering the free-field version has established its own normative values by testing 16-20 control subjects (no audiometric thresholds >25 dB). Normative values for the headphone version are based on a group of more than 50 subjects with normal hearing.

- *It is capable of spatial separation between the speech and the noise source.* In the sound field test, this is achieved by using two loudspeakers. In the headphone test, it is achieved by using computer-based virtual audio processing of the sounds for each headphone. This is important since functional impairment in many candidates may not be apparent unless there is a 90-degree spatial separation between the noise and the speech. This is also job relevant; for example, the ability to listen to patrol car radio communication while a window is down.

- *It uses adaptive testing techniques.* Non-adaptive tests consist of a fixed list of words or sentences of given difficulty. Consequently, many of the items will be well above or below the ability level of any given test taker, and therefore, will not contribute useful information on the hearing ability of that individual. In adaptive tests, the difficulty of items is adjusted to the ability of the test taker (based on their correct/incorrect response to previous items). Consequently, more information is obtained from each test item. Therefore, adaptive testing yields much more statistically powerful and reliable measurements compared to fixed tests of similar lengths, resulting in better differentiation between normal and abnormal hearers. In the HINT test, the presentation level of the test sentences is varied using an adaptive technique in a constant noise background until the subject repeatedly responds correctly to 50% of the test sentences. The result is then expressed as a S/N ratio.

- *It uses a stationary background noise with the same average level across frequencies as the speech.* The type of background noise used to measure speech understanding in noise will affect both the accuracy and the reliability of the measurement. Noise with a wide range of level variations over time, such as recordings of crowd noise, can produce unreliable measures of speech understanding unless very lengthy tests are used. Noise with small level variations over time, i.e., stationary noise, and with equal levels at all frequencies (white noise) can produce reliable measures of speech understanding that cannot be accurately generalized to job-related noise environments. The most appropriate background noise is a stationary noise with the same average levels at all frequencies as speech. This type of noise allows reliable, accurate, and conservative prediction of speech understanding in job-related noise environments.

Bilateral Low Frequency Loss:

Candidates with low frequency hearing loss commonly have audiograms that have a "flat" configuration (Figure XII-2), since the audiometric losses extend from the low frequencies through the high frequencies, and all of the losses are of the same approximate magnitude (±15 dB).

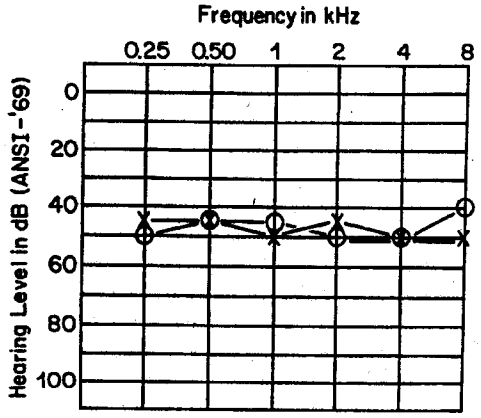

Figure XII-2. An example of a relatively flat audiometric configuration.

This loss can be either sensorineural or conductive in origin. This is an important distinction since conductive losses may be reversible. Common causes of conductive hearing loss among candidates include a wax build-up, serous otitis from allergies, and perforated tympanic membrane. An uncommon cause is otosclerosis. Sensorineural causes include Meniere's Syndrome and genetic disorders.

The primary functional significance of bilateral low frequency losses is impaired speech comprehension and sound detection in quiet. While speech comprehension in quiet is correlated with low frequency audiometric thresholds, there is a wide range of commercially available tests available for testing of speech comprehension in quiet. As

with speech in noise testing, these tests vary on a number of performance characteristics that can have an impact on the test results. However, an acceptable test of quiet functioning is routinely included as part of the HINT procedure discussed above.

There are no standard tests for sound detection in quiet, except the audiogram itself. The audiogram gives hearing thresholds or "detection abilities" at specific frequencies.

Asymmetric Hearing Loss:

In general, hearing loss is considered to have an asymmetric pattern if there is a difference between the left and right ears in average audiometric thresholds of 20 dB or more in the lower frequencies or 35 dB or more in the higher frequencies. This condition often has the same causes as low frequency hearing loss, as discussed above. However, in rare cases, this may be caused by an acoustic neuroma, a benign but progressively destructive lesion.

Persons with asymmetric hearing loss may have difficulty both understanding speech in noise and localizing environmental sounds. The impact on speech comprehension is most evident when there is a noise source on the subject's good side, and the hearing loss includes the higher frequencies. Impairment of the ability to localize environmental sounds is more likely to occur if the hearing loss involves all or most of the audiometric thresholds on one side. At the present time, it is not possible to accurately predict localization ability based on the audiogram alone, and there are no commercially available functional tests.

b. RECOMMENDED EVALUATION PROTOCOL:

Before assigning a candidate to one of the groups below, it is important to determine if the hearing loss is reversible. Recent colds, or bouts with allergies frequently cause a temporary conductive hearing losses, and warrant repeat audiometric testing after these conditions have resolved. The American Academy of Otolaryngology recommends a medical specialist evaluation based on any of the following:

1) Average hearing level at 500, 1000, 2000, and 3000 Hz greater than 25 dB, in either ear.

2) Difference in average hearing level between the better and poorer ears of

   a) More than 15 dB at 500, 1000, and 2000 Hz, or

   b) More than 30 dB at 3000, 4000, and 6000 Hz.

3) History of ear pain; drainage; dizziness; severe persistent tinnitus; sudden, fluctuating, or rapidly progressive hearing loss; or a feeling of fullness or discomfort in one or both ears within the preceding 12 months.

4) Cerumen accumulation sufficient to completely obstruct the view of the tympanic membrane or a foreign body in the ear canal.

When requesting an otologic evaluation, it is helpful to specify that the otologist should address only the issues of reversibility and prognosis, not fitness for duty as a patrol officer. The latter should be a separate assessment following the guidelines below.

Group I: Normal audiogram (all thresholds between 500-6000 Hz are 25 dB or better in both ears)

These candidates are unlikely to have functional impairment unless they have a retrocochlear condition discussed below in section (3).

Group II: One or more thresholds are >25 dB in either ear

A functional hearing evaluation is recommended. This evaluation should consist of directional speech comprehension in noise and speech comprehension in quiet using the HINT test or other tests that meet the performance characteristics stated earlier in this guideline. Candidates who perform more poorly than the 5th percentile of the normal hearing control group under any of the three background noise conditions (noise in front, right, or left) should be restricted from safety-sensitive tasks which require accurate and rapid understanding of speech in noise. Candidates with quiet thresholds greater than 28 dB(A) on the HINT should be restricted from safety-sensitive tasks, which require accurate and rapid understanding of whispered speech and speech heard through doors or windows. [Note: A quiet threshold on the HINT test of 28 dB(A) corresponds to an intelligibility of approximately 90% at the job-critical level for soft or whispered speech of 30 dB(A).]

Consideration of Prior Experience:

It could be argued that prior peace officer experience may mitigate some of the impact of functional impairment on a candidate's job performance. For example, familiarity with typical police communications may reduce the criticality of understanding *every* word of communication. Furthermore, the judgment gained from prior experience may somewhat compensate for the loss of speech information in a given situation. However, great caution must be exercised when considering prior experience. The degree and nature of prior law enforcement experience can vary dramatically, thereby limiting the ability to confidently generalize across this candidate group. It is possible that experience accrued elsewhere (e.g., a different state with different penal codes) could result in a negative transfer of training - i.e., these officers might need to *unlearn* some of the agency-specific jargon of their previous employers. For these reasons, it is recommended that prior experience <u>only</u> be considered in <u>very</u> close-call (i.e., borderline) cases.

2) USE OF HEARING AIDS

a. GENERAL CONSIDERATIONS:

There are two major considerations with hearing aids:

1. *Do they restore normal functional ability?*

   Hearing aids are battery-powered electronic circuits with a miniature microphone and loudspeaker that are designed to fit in the ear canal. The circuits amplify sound from the microphone by different amounts at different frequencies to compensate for loss of sensitivity. In theory, they should restore hearing function to normal.

   Unfortunately, the hearing aids that are currently available do not meet this goal completely. In fact, the U.S. F.D.A. requires manufacturers to warn consumers that these devices do not restore normal hearing. While hearing aids can substantially improve such tasks as sound detection and comprehension in quiet environments, they provide limited benefit for hearing critical tasks that are performed in noise. This is especially true for patients with predominantly high frequency losses. Improvement of sound localization ability is also difficult to achieve.

2. *If they can restore normal functional ability, can they be depended upon to reliably function as a mitigating device during full field activities?*

   To be considered a mitigating device, hearing aids would have to be worn at all times when an officer is assigned to field duties, and the aids would have to be effective when worn.

   Unfortunately, people who obtain hearing aids often choose to not wear them. Ovegard (1994) found that 34% of patients wore them less than one hour a day when asked one year after the aids were dispensed. Sorri (1984) found that 43% of patients did not wear them every day when asked two years after the aids were dispensed. Of perhaps the most relevance to the law enforcement candidate population, Surr (1978) found that 34/97 patients who were 21-40 years old wore their aids only "occasionally" (1%-50% of the time). The primary reasons for non-use were background noise and a perceived lack of need. These studies indicate that an employing law enforcement agency would need to use pre-placement agreements and have an active monitoring program to ensure compliance. This may or may not be practical depending on agency specific factors.

   However, unlike analogous monitoring programs for contact lenses, confirmation by a supervisor that an officer is wearing a hearing aid does not automatically mean that the device is providing its expected benefit under field conditions due to the following:

Acoustic feedback - Feedback produces an audible and distracting squealing sound from the hearing aid, and a distorted sound output. This occurs when sound from the hearing aid loudspeaker leaks back through the ear canal to the microphone. Feedback occurs when the hearing aid is improperly seated in the ear canal, during exaggerated jaw movements, or when a hand or other sound-reflecting object is held near the ear.

Batteries - Hearing aid batteries usually have a life of several weeks, depending on how much the hearing aid is used and whether it is turned off at night. Weak batteries or a difference in battery strength between the right and left aid could reduce the effectiveness of the aids.

Control switches and knobs - Many hearing aids have an on-off switch, volume control, and perhaps adjustable controls. Hearing aids may need to be adjusted as the sound environment changes. If the controls were misadjusted, less than optimal performance would occur.

Earwax and debris in the ear canal - The opening in the hearing aid for the loudspeaker output is relatively deep in the ear canal where earwax and tissue debris can accumulate and block the opening. This type of blockage is a common occurrence, and usually requires a visit to an audiologist to have the blockage removed without damage to the hearing aid.

Loss of the hearing aid during a critical incident - Hearing aids are held in place by the snugness of the device in the ear canal. Vigorous physical activity or a blow to the head could easily cause a hearing aid to be dislodged or shattered.

In conclusion, there are a number of very real concerns, both functional and practical, surrounding the use of hearing aids by patrol officers. However, fair employment laws require that an agency evaluate each aided candidate on a case-by-case basis. The Recommended Evaluation below provides a protocol for assessing functional hearing ability. If it is determined that a candidate possesses adequate functional ability, an agency should then consult with an otological specialist to review the practical concerns discussed above, as well as to evaluate the candidate's specific experience with hearing aids and any agency-specific factors which may be relevant before a final decision is made regarding whether the candidate's use of hearing aids is "acceptable."

b. RECOMMENDED EVALUATION PROTOCOL:

Aided candidates who wish to be tested with their hearing aids should be administered the HINT to assess speech comprehension ability in noise and quiet. Both tests must be administered by sound field methods rather than headphones. At the present time,

sound field HINT testing is available at San Francisco[2], Los Angeles[3], and San Diego[4]. An aided audiogram can be reviewed to evaluate sound detection ability.

Prior to functional testing, the examining physician should ensure that the aids have been worn regularly for at least one month, since it takes some practice before a patient obtains the maximum benefit from the hearing aids. Furthermore, the examining physician should obtain all records from the audiologist who dispensed the hearing aids. These must include documentation of the fitting program and other hearing aid settings, which are used on a regular basis by the subject. This information needs to be reviewed by the certified audiologist performing the HINT procedure to verify that the settings have not been intentionally altered.

It is critically important that the audiologist use the following protocol, and that no modifications to the candidate's hearing aid program or settings should be made prior to or during the performance of this protocol.

1) Evaluate whether the aids are working properly: The electroacoustic response characteristics of each hearing aid worn by the candidate should be measured in an appropriate acoustic coupler and test chamber according to ANSI specifications (ANSI 1992 and 1996). It is especially important that the response of the hearing aid(s) be measured at the four designated input levels with a broadband test signal, as specified in the standards. All measurements should be printed and retained in the subject's records. If the hearing aids are not in proper working condition, no further testing should be performed at the time. The subject may elect to have the hearing aids repaired or replaced and return to repeat the protocol. In this event, the entire protocol, including measurements of the electroacoustic response characteristics of each hearing aid, should be repeated with the new or repaired hearing aids. Hearing aid sales, repairs, and replacements should be from an independent provider other than the provider of the functional assessment services.

2) *Review the candidate's regular fitting program and settings:* These should be equivalent to those measured above. If not, no further testing should be performed at the time.

3) *Determine whether the functional gain is both physiologic and appropriate for the subject's hearing loss:* Unaided and aided binaural sound field thresholds should be measured at 250, 500, 1000, 2000, 3000, 4000, and 6000 Hz, using warble tone stimuli presented from a loudspeaker positioned 1 meter in front of the subject at 0 degrees azimuth. If the functional gain is not physiologic and appropriate, then no further testing should be performed at the time.

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[2] University of California, San Francisco Audiology Clinic (415) 353-2101

[3] House Ear Institute Audiology Clinic, Los Angeles (213) 483-9930

[4] San Diego State University Audiology Clinic (619) 594-7747

4) *Perform aided sound field HINT in noise and quiet:* Compare the results to the site-specific normal values for sound-field Noise Front, Noise Right, and Noise Left conditions. If the measured thresholds are better than the 5th percentile under all three conditions, then repeat the noise testing with the background noise fixed at 80 dB(A). The same normative values used with the standard background noise levels may be used to assign percentile scores to these results (Soli, 2001).

5) *Send all results to the examining physician.*

Upon receipt of the results from the audiologist, the examining physician may use the evaluation algorithm described in Section 1 (Abnormal Audiogram) with one exception. Since many present day hearing aids employ methods of sound processing that vary as a function of the background noise level, it is necessary to measure aided sound-field HINT thresholds through a range of background noise levels. Therefore, candidates who use hearing aids should be functionally normal both under standard HINT background noise levels (i.e., 65 dB) and at levels that are commonly encountered in the field (80 dB).

If the candidate has demonstrated acceptable functional ability when wearing hearing aids, the examining physician should inform the hiring department that the candidate must wear hearing aids when assigned to field duty or other hearing critical tasks. The subsequent determination as to whether hearing aids are acceptable should be determined by the hiring department, in consultation with otological specialists, as discussed above.

3) RETROCOCHLEAR CONDITIONS

Understanding speech is not just an auditory process, but also involves cerebral processing of the signals from the ear. Therefore, for a variety of reasons, functional impairment may occur when the audiogram is normal. Known as obscure auditory dysfunction or discriminatory hearing loss, this condition may represent up to 10% of the patients that visit hearing specialists. Known causes include cortical damage due to stroke or head trauma, and attention deficit disorder (Cook, et al., 1993). While not pathological, learning English as a second language also affects the ability to understand English in noise. This is especially true when English is learned after age 14 (Mayo, et al., 1997).

For these reasons, candidates with the following should be required to have functional hearing testing even when their audiograms are normal:

a) History of moderate-to-severe head trauma (see Neurological section for definition)

b) History of a stroke

c) History of attention deficit disorder

d) Learned English as a teenager or older.

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