Validity Report

Hearing Guidelines for the Selection of Entry Level Adult Corrections Officers

Local Adult Corrections Facilities

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BOARD OF STATE AND COMMUNITY CORRECTIONS

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The Standards and Training for Corrections Program

The Standards and Training for Corrections (STC) Program is a division of the Board of State and Community Corrections (BSCC). The role of the STC Program in developing selection guidelines for local corrections personnel is set forth in Section 6035 of the California Penal Code. This law mandates the STC Program to develop, approve, and monitor selection and training guidelines for Adult Corrections Officers who work in locally operated juvenile detention facilities throughout California.

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Executive Summary

This report describes research conducted by the Board of State and Community Corrections to establish a hearing guideline for the selection of Adult Corrections Officers who work in local jails operated by counties and cities throughout California.

The guideline emanating from this research applies to entry-level applicants for the Adult Corrections Officer position. Individuals in this position are responsible for the care, custody and control of over 70,000 inmates incarcerated in 266 California jails (2011).

The research described in this report shows that Adult Corrections Officers require a high degree of physical and sensory abilities to effectively perform their job. This research focused on hearing ability that officers need to perform hearing-critical job functions. Hearing-critical job functions are those functions where hearing is absolutely essential, and no other sense modality or behavioral adaptation can be used to supplement hearing to perform the function.

Public protection and personal safety issues are significant for this position. Adult Corrections Officers are required to react and respond appropriately in time-sensitive situations. They must prevent escape, quell riots, stop inmate-to-inmate attacks, as well as protect the public and other custody personnel. Officers are at risk of assault and even death. The inability to fully engage in a critical and potentially life-threatening situation based on an inability to hear could set in motion a series of events that could have substantial, even fatal, consequences.

Research Elements

To determine the hearing-critical job functions that Adult Corrections Officers perform and to establish a hearing guideline for the hiring decisions, the Board of State and Community Corrections conducted research that comprised several steps and consisted of the following elements:

- Identification of the hearing-critical job functions Adult Corrections Officers perform;
- Determination of hearing abilities important in the performance of these functions (e.g., speech communication, sound detection and recognition, sound localization, etc.);
- Assessment of the impact of the sound environment, especially background noise levels, on the performance of these functions; and,
- Selection of valid and reliable screening tests and protocols to predict the necessary hearing abilities.

Research Approach

The research described in this report incorporated scientific advances in research methods related to hearing abilities to produce a guideline supported by strong empirical evidence. The research team utilized advanced, standardized statistical methods for analyzing workplace noise environments to determine their impact on hearing-critical job functions. This process incorporated recent methods to test hearing ability, especially as they relate to speech communication in quiet and noisy environments.

Highlights of Findings

The report describes the entire set of research procedures conducted to establish a recommended screening guideline. Highlights from the research are as follows:

- Adult Corrections Officers must rely on effective speech communication to perform hearing-critical job functions such as responding to a variety of disturbances and emergencies, communicating orally with inmates or other Adult Corrections Officers, and coordinating movements with other officers.
- Speech communication is a frequently used and demanding job function in jails.
- Over half the cues for detecting incidents and emergencies involve hearing.
- Hearing-critical job functions are performed during all shifts.
- Background noise levels in the majority of local jails can reach levels (or average) between 65 dB and 80 dB. This is comparable to the noise levels in a noisy restaurant.
- Because of the noise levels occurring in the jails during a typical day, using a normal voice level will result in less than perfect understanding of speech communication.
- Even a 15% reduction in effective speech communication can have substantial adverse consequences because effective communication is already made difficult by background noise levels in the jail environment.

Recommended Screening Guideline and Testing Protocol

Given that speech communication is so important in jails, the best way to assess functional hearing is to measure speech communication capability. Measures of speech recognition in noise are the best predictors of functional hearing abilities needed by Adult Corrections Officers. The new guideline is based on measures of speech recognition in quiet as well as in background noise levels that are representative of the Adult Corrections Officer's workplace.

The most appropriate and valid test to evaluate the functional hearing ability for the position is to measure the applicant's ability to understand speech in noise. The Hearing in Noise Test (HINT) is recommended for this purpose. Using the HINT, the screening criterion in quiet is 27 dB (A) or less. In noise of 65 dB (A), the screening criterion is 61 dB (A) or less, corresponding to a signal/noise ratio of -4 dB or lower. These criteria are intended to insure that a reduction of effective speech communication of more than 15% will not occur in whispered or soft spoken speech as well as in background noise.

Role of Standards and Training for Corrections

The Standards and Training for Corrections (STC) Program is operated by the Board of State and Community Corrections to develop and maintain guidelines for the selection and training of Adult Corrections Officers who work in city and county operated jails throughout California. The STC Program conducts job analyses, validation studies and related research to produce job-relevant guidelines for local hiring decisions and training programs. Participation in the STC Program is voluntary. Guidelines that emanate from this research are advisory and should be tailored to the needs of each jurisdiction.

Local Adult Detention Facilities - Overview

As of October 31, 2011, there were 226 local jail facilities as defined by Title 15 of the California Code of Regulations (CCR). These facilities house adults from the age of 18 and up. All jails are secure facilities. Based on Jail Profile Surveys compiled by the Board of State and Community Corrections, a one-day "snapshot" of the composition of the jail inmate population is as follows:

- Approximately 700 inmates are classified as "3rd strike" felons.
- Approximately 1500 inmates as "2nd strike" felons.
- The average length of time inmates spend in local jails ranges from about 18-22 days.

Adult Corrections Officers interact almost constantly with the inmates during their detention as part of maintaining safety and security. Adult Corrections Officers handle a variety of behavioral issues inmates present in these facilities, including searching for weapons and other contraband, intervening in suicide attempts and preventing escapes. Additionally, Adult Corrections Officers are subject to assaults by inmates of which there were over 900 reported in 2011.

The Adult Corrections Officer Position

Position Titles

For the purposes of this report, the title Adult Corrections Officer is used to describe those officers who work in a local detention facility and are responsible for the care, custody and control of adult inmates. Titles for this position vary among jurisdictions throughout the state and include the following:

- Deputy Sheriff
- Correctional Officer
- Corrections Officer
- Custodial Officer
- Detention Officer
- Custody Assistant

Regardless of the title used by the local agency, the position studied in this research is that of a line officer working in a local detention facility. The majority of these officers perform similar functions even though the size or location of the facility or the officer's specific assignment may vary.

General Responsibilities

General areas of duties that Adult Corrections Officers perform include the following:

- Booking, receiving and releasing inmates
- Escorting and transporting inmates
- Record-keeping and report writing
- Supervising inmates
- Supervising non-inmate movement and visitors
- Searching and securing the facility
- Searching inmates
- Communicating with inmates, other corrections officers, visitors and non-custodial personnel
- Performing physically demanding tasks such as running, subduing inmates, and self-defense

GOAL OF RESEARCH: ENTRY-LEVEL SELECTION GUIDELINE

The hearing guideline resulting from this research pertains to the hiring of entry-level applicants for the local Adult Corrections Officer position. Approximately 7,000 people apply for this position annually.

The hearing guideline that emanates from the research described in this report is based on the minimum performance levels found to be applicable across the full range of agencies participating in the STC Program. Whether meeting this guideline indicates an applicant's ability to meet a specific agency's local performance requirements depends on how that agency's local circumstances compare to the statewide performance dimensions as identified through this research.

In circumstances where local performance requirements are the same as the statewide performance requirements and an applicant is unable to meet the guideline, the hiring agency should evaluate the applicant on a case-by-case basis. An applicant should not be automatically disqualified from placement in the Adult Corrections Officer position for failure to meet the recommended guideline. The employing agency should conduct a case-by-case evaluation and determine whether the agency is obligated under applicable statutes and/or regulations to make reasonable accommodation for an applicant who may be unable to meet the recommended hearing guideline.

RESEARCH STRATEGY

The goal of this research was to define valid hearing screening measures to evaluate applicants for the Adult Corrections Officer position. The strategy to develop these screening measures consisted of four major elements:

1) Identification of hearing-critical job functions and the hearing abilities needed to perform these functions;
2) Assessment of the noise levels in the environment where these functions are performed;
3) Analysis of these noise levels and the likelihood of ability to perform hearing-critical job functions in this noise level; and,
4) Selection of valid and reliable screening tests and protocols to predict the necessary hearing abilities.

The research strategy was designed as a sequence of steps, with each step establishing the foundation for the next. This approach linked the important hearing-critical job functions to the screening measures and screening criteria for hearing ability.

The Research Focus

The research process involved a decision about which hearing ability to focus on (sound detection, speech communication, sound localization, etc.). From the initial stages of the research, it became clear that speech communication was an important functional hearing ability for Adult Corrections Officers. It was also evident that this speech communication at times took place in noisy environments. These observations refined the research approach to determine if the ability to communicate with speech in noisy environments is a sufficiently important hearing ability to warrant use as a screening measure. If so, the selection of the guideline for hearing could focus primarily on speech communication.

There were several advantages to adopting such a focus. One advantage was the availability of standardized ways to quantify speech communication ability. Another advantage was that speech communication in quiet and noise is perhaps the most demanding and challenging of all functional hearing abilities. If applicants can hear well enough to communicate effectively with speech in quiet and noise, then it is reasonable to assume they can also hear non-speech sounds in these environments.

The remainder of this section summarizes the specific research steps, emphasizing the link between the hearing-critical job functions and the screening criteria.

Summary of Research Steps

Hearing-Critical Job Functions

The research began with a review of existing job analyses for the Adult Corrections Officer position. This review provided the context for subsequent steps that focused on specific hearing-critical job functions.

Research staff collected written incident reports from a representative sample of jails throughout the state. Incident reports document unusual or unlawful activities and events that occur within a detention facility. These incident reports were analyzed to identify important hearing-critical job functions Adult Corrections Officers perform when responding to the incidents.

Following the analysis of the incident reports, the research team conducted semi-structured interviews with experienced Adult Corrections Officers who served as subject matter experts (SMEs) to further identify hearing-critical job functions they performed during typical days and during emergencies.

The SMEs also identified the locations within the facilities and the times throughout the day where hearing-critical job functions involving speech communication are most likely to take place. This information served as an important basis for planning the visits to the jails so research staff could observe hearing-critical job functions being performed in the pertinent locations and at the appropriate times to measure and record background noise environments for later analyses.

Research staff synthesized the evidence gathered in the analysis of the incident reports and interview data. Findings from these steps repeatedly and consistently underscored the importance of accurate and effective speech communication in the performance of many hearing-critical job functions. Having identified the importance of speech communication in noise as a major functional hearing ability, the subsequent research focused primarily on this ability.

Background Noise Measurements

To assess the conditions under which Adult Corrections Officers perform hearing-critical job functions, research staff visited a representative sample of jails throughout the state. The primary aspects used in selection of the sample were the number of detained inmates, geographical regions within the state, security levels of housing within each facility, and gender of the inmates.

The research team made high quality calibrated digital sound recordings several minutes in length at each sampled facility at specified times and locations. The research team also maintained detailed logs describing the conditions for each recording.

Analysis of Background Noise Measurements

Each noise recording was analyzed using standardized, validated procedures for measuring speech intelligibility.

The research team assigned weights to the noise analyses for each location in the jails where hearing-critical job functions were performed. Using standardized calculations to estimate the likelihood of accurate and effective speech communication in each background noise environment, research staff incorporated reduced audibility estimates into estimates of the likelihood of effective speech communications.

Screening Guideline

The research evidence indicated that each aspect of the hearing guideline, the screening materials, the protocol, and the criteria, should be based on measures of the ability to communicate with speech.

Two different hearing screening criteria are recommended. The first is based on the Speech Reception Threshold (SRT) in quiet as measured with the Hearing in Noise Test (HINT). This criterion is specified to ensure that applicants with reduced audibility caused by hearing impairment can hear and understand soft or whispered speech.

The second is based on a composite of three SRTs measured in noise. This criterion is recommended to ensure that applicants with increased distortion caused by hearing impairment can hear and understand speech in the noise environments where Adult Corrections Officers routinely perform hearing-critical job functions.

STEP 1: EXISTING JOB ANALYSIS REVIEW

The first phase of the research identified hearing-critical job functions. The first step of this phase consisted of a review of the most recent job analysis questionnaires completed by incumbent line Adult Corrections Officers.

Background and Rationale

Research staff reviewed the results of the 2002 job analysis conducted by the Board of State and Community Corrections. This job analysis focused on line officers who had completed their probationary period, worked independently, and performed duties typical of the majority of Adult Corrections Officers.

The job analysis identified tasks performed and equipment used by Adult Corrections Officers who worked in various local facilities throughout the state. These tasks and equipment items were endorsed by both supervisors and line officers as being frequently performed and used as well as important to the job.

Methodology

As the initial step in the identification of hearing-critical job functions, research staff reviewed the job analysis findings. This involved examining the list of tasks and equipment items to determine those which had a hearing-critical component. Although the term "hearing" was not often used in the description of each task, the research team was able to identify hearing-critical tasks from words such as "listen", "communicate orally", and "monitor". Research staff were also able to identify equipment items with hearing ability as a key component, such as an intercom, telephone or radio.

Results

This phase of the research revealed that a large number of tasks required Adult Corrections Officers to hear on the job. Most of these tasks indicated that officers need to hear and understand spoken words as well as non-speech sounds.

The following list is a sample of hearing-related tasks that were rated in the job analysis as being frequently performed and critical to the job:

Supervising Individual Inmates

- Communicate orally with inmates
- Respond to inmates' verbal questions or requests
- Monitor (e.g., listen to/record) inmate's phone calls

Supervising Groups of Inmates

- Prevent unauthorized inmate communication
- Supervise and monitor behavior of inmates in exercise areas
- Observe/monitor attitudes and conduct of inmates, watching for signs of potential disturbance, medical or psychiatric needs, or signs of drug or alcohol use
- Anticipate, monitor and intervene in disputes between inmates (before a fight occurs)
- Notice subtle changes in group inmate behavior patterns (e.g., noise levels, inmate interactions, etc).

Communicating with Co-Workers and Supervisors

- Communicate orally with other Adult Corrections Officers regarding facility operations
- Respond to and dispatch help for emergencies
- Monitor outside radio (e.g., county radio, patrol car radio, transport radio) for information relevant to facility operations (e.g., recent arrests)
- Follow oral instructions from supervisors and others
- Attend staff meetings and confer with supervisors concerning facility operations

Other Hearing-Related Tasks

- Answer incoming phone calls, provide information (e.g., about facility policies, court procedures, individual inmates, etc), route calls and take messages
- Listen for unusual sounds or sounds that may indicate illegal activity or disturbance (e.g., whispering, scuffling, sudden quiet or change in noise level, horn honking, rattling of chain link fence)

Discussion

The review of the job analysis provided information about major areas of the Adult Corrections Officers responsibilities as well as allowed research staff to identify several tasks and equipment items with a hearing component. This review also provided a foundation for subsequent steps in the research, especially those steps that involved analysis of incident reports and interviews with Adult Corrections Officers.

STEP 2: INCIDENT REPORT ANALYSIS

The second step in the research process analyzed hearing-critical job functions from incident reports obtained from jails throughout the state.

Background and Rationale

An analysis of incident reports can, at least indirectly and often directly, reveal those hearing-critical job functions that were performed in response to incidents and the interventions needed to resolve them.

Incident reports are completed by the Adult Corrections Officer each time anything out of the ordinary occurs during their shift. This includes rule violations such as fights between detainees, assaults on Adult Corrections Officers and other staff, detainees behaving in a disruptive or unusual manner, or possession of contraband. Incident reports are also completed for any medical emergencies or suicide attempts. Three examples of incident reports included in Figure 1 below illustrate what is typically included in a report. These examples are presented with the names of individuals replaced with uppercase letters to preserve anonymity.

Methodology

The research team requested incident reports from jails that represented the diversity of geographic locations and facility sizes across the entire state. Jail representatives were asked to supply at least 30 incident reports representing all the shifts and covering as wide a range of types of incidents as possible (without regard to any hearing abilities or functions required of their officers).

It was anticipated that the incident reports would reveal the following types of information:

- How the incident was detected
- The location of the incident
- The time of the incident
- What happened during the incident
- How the incident was resolved

This was the starting point to develop a set of categories and the elements within each category that would represent the content of the incident reports. Once several hundred incident reports were received, research staff carefully reviewed them and developed a preliminary version of the coding schema. This preliminary version was then modified as necessary and applied to another set of incident reports. This iterative process continued until a final coding schema emerged.

Example 1: **Inmate Self-injury:** "On Saturday, January 8, 2011, I was assigned to work housing unit 4A. At approximately 0240 hours, Inmate K who was housed in 4A16 called via intercom and informed Deputy H that his cellmate, Inmate R was bleeding. Deputy H and I responded to 4A16 approximately 0241 hours and found Inmate R wearing his boxer shorts and lying on his bunk. There was blood coming from his left wrist. Deputy H asked Inmate R what happened. Inmate R told us he cut himself with a razor and wanted to die. He tossed away the razor and told us to leave him alone. Additional Deputies and Sergeant Y arrived on scene. Inmate R was handcuffed and taken to a safety cell to be treated by a nurse."

Example 2: **Threatening Behavior:** "On October 27, 2008, I was assigned to work movement on swing shift at the main adult detention facility. At approximately 2205 hours, I was assisting with a search of J-Module. Deputy R and I searched cell J-45 and had the two inmates return to the cell. As we were about to move on to the next cell, I heard Inmate M say "thanks for looking out, motherXXXXXX". Deputy R and I returned to cell J-45 and instructed Inmate M to exit the cell. We escorted Inmate M to the end of the top tier and had him face the wall with his hands behind his back. Deputy R and I attempted to counsel Inmate R about his disrespectful behavior. He was not receptive to the counseling, and said "do what you need to do." While talking to Inmate M, he jerked his right hand from Deputy R's grasp and pulled it in front of his body. Deputy R was able to regain control of his arm and placed it in a rear wristlock. Inmate M then turned his head in an aggressive manner towards Deputy R and continued to struggle. Deputy R instructed him to face forward, and Inmate M forcefully slammed his head into the wall. I placed handcuffs on Inmate M. Deputy R and I escorted him to Booking Cell 9 without incident. Inmate M was offered medical attention for his head butt, but refused."

Example 3: **Attempted Suicide:** "I was advised by dispatcher D that she could hear what sounded like someone gagging back in the jail area of the police dept. I responded to the jail and discovered Inmate W who was in custody in the first men's cells on the left side of the hallway, had apparently tied his long sleeve flannel shirt around his neck and around the jail cell bars and then dropped to his knees in order to hang himself. Inmate W was the only prisoner in that cell. At this point I entered Inmate W's jail cell and cut the flannel shirt in two and laid him on the floor. Inmate W was having a very difficult time breathing and he was also convulsing. I had dispatch contact an ambulance service and they responded and transported Inmate W to the hospital. At the hospital Inmate W was examined by Dr. K. Later Dr. K released Inmate W back into my custody and I transported him to the jail and advised them of his suicide attempt. Dispatch also contacted Dr. F of County Mental Health dept. and he was going to contact Inmate W at the facility."

Figure 1: Examples of Incident Reports

Coding of the Incident Reports

The final set of categories developed for the coding schema was as follows:

- Location of Incident
- Types of Incidents
- Time of Occurrence
- Sensory Cues
- Type of Sound Cue: Speech or Non-speech
- Visibility of Sound Source

Each category consisted of multiple elements that were coded and then tabulated in a frequency count. The elements that comprised each of the categories are listed in Location of Incidents.

Location of Incidents

One category included in the coding system was the location of where an incident took place. Based on the review of the incident reports, the research team determined that incidents in the following locations were documented in the reports:

- Housing
- Booking
- Inmate Movement
- Control Booth
- Medical
- Kitchen
- Yard
- Dining Hall
- Visiting Area
- Vocational
- Gym
- Laundry

Types of Incidents

Another category in the coding system was the type of incident that had occurred. The actual incident itself was categorized into one of the following seven elements:

- *Contraband*: Weapons, drugs, or any other unauthorized items (e.g., an extra blanket, extra socks, etc.)

- *Medical Intervention*: Death, bleeding, collapse, seizure, physical trauma, unintentional self-injury; need for First Aid, CPR
- *Non-Assaultive/Oppositional Behavior*: Active verbal/vocal interaction, oppositional behavior, not following instructions, banging on walls with attempts to be disruptive, and non-assaultive threatening behaviors such as fist clenching. Recounts of vocal/verbal events, summaries, or third party accounts not considered here
- *Physical Assault/Battery/Altercation One-on-One (2 people)*: Physical altercations, assaults, or battery; does not include physical threats such as fist clenching, or injuries against self
- *Physical Assault/Battery/Altercation Group (3+ People)*: Physical altercations, assaults, or battery among a group of three or more individuals; does not include physical threats such as fist clenching, or injuries against self
- *Suicide, Suicide Threat, Suicide Attempt/Self-Injury*: Suicide, suicide threats, attempts or other instance of self-injury; banging head on wall or floor, punching/kicking walls or other inanimate objects (with intent to harm oneself). Unintentional self-injury is not considered here
- *Unusual/Abhorrent Behavior*: Crying, indecent exposure, hallucinations, intoxication, altered emotional states, etc.; threats of suicide not included in this category

Time of Occurrence

The research team examined the time the incident occurred. These times were then grouped into three time periods or "watches":

- *Watch One* 10 pm until 6 am
- *Watch Two* 6 am until 2 pm
- *Watch Three* 2 pm until 10 pm

Sensory Cues

The research team then examined how the incident was initially detected by the reporting officer.

Each incident was examined to see if the reporting officer initially detected it by using only hearing, by using only vision, or by using both vision and hearing.

- *Vision only*: Officer detected the incident based on a visual cue
- *Hearing only*: Officer detected the incident based on an audible cue
- *Both vision and hearing*: Officer detected the incident based on simultaneous visual and audible cues

Type of Sound Cue: Speech or Non-Speech

If it was determined that an incident was detected with an audible cue, the research team looked at the next category of the coding system to determine if the cue was speech or non-speech. If an incident was detected by a visual only cue, it was not included in this category.

- *Speech*: Verbal communication
- *Non-speech*: All other sources of sound, excluding verbal communication

Visibility of Sound Source

The next category of the incident reports that was coded by the research team was the visibility of the sound source. This category dealt with only the incidents that were coded as having an audible cue; the audible cue was coded as being either visible or not visible. If the reporting officer was alerted to the incident by a visual cue, it was excluded from this category.

- *Visible*: Officer was able to see the source of the sound
- *Not visible*: Officer was not able to see the source of the sound

Results

Incident Reports Received

The research team collected 2224 incident reports from 29 representative facilities throughout the state, encompassing a range of facility types and sizes. A list of participating facilities is provided in Appendix I.

Each facility provided a different number of incident reports, ranging from as few as one to as many as 1100. Because of this range, it was determined that to be represented in the data analysis a facility needed to have sent a minimum of five incident reports. A maximum of 15 incident reports from each facility were processed; if a facility sent more than 15 reports research staff randomly selected a maximum of 15 for use in this research.

Weighting Process

The strategy for including incident reports in the data analysis resulted in facilities contributing different numbers of reports. To deal with this issue in the processing of the data, the research team implemented a weighting system so that all of the facilities could contribute equally to the compilation of the tabulated results. The general processes that were used to implement the weighting strategy are outlined below.

Conversion of Frequencies to Percentages by Facility

Research staff tabulated the frequency of occurrence for each element within each coded category. These frequencies were then transformed into a percentage of the total elements within each category for each facility. For example, if a facility had x number of incidents occurring in housing, y number of incidents occurring in booking, and z number of incidents occurring in the dining hall, research staff computed the total number of incidents across all locations for that facility. The percentage value for housing, booking, and dining hall represented the proportion of x, y, and z with respect to the total. These percentages rather than the raw frequency counts were then used as the data for subsequent data compilation. This process was carried out for each of the six coding categories for each facility.

Accounting for Rated Capacity of Facilities

Rated Capacity describes the number of occupants that can be housed in an adult facility based on compliance with all applicable standards (Title 15, California Code of Regulations). The 29 sampled facilities were divided into four groupings based on their rated capacity:

- Nine (9) facilities had a rated capacity of less than 300.
- Five (5) facilities had a rated capacity between 300 and 449.
- Nine (9) facilities had a rated capacity between 450 and 1000.
- Six (6) facilities had a rated capacity over 1000.

Weighting by Rated Capacity

Once the percentages were found for each element within each coding category for a facility, these percentages were averaged with the other facilities within their rated capacity group to provide a single percentage for each element within each category for the rated capacity group.

After computing the one percentage for each element within each category for each rated capacity group, the four rated capacity groups were then averaged. To project the percentages to the state as a whole, the proportion of facilities falling into the rated capacity groupings used here was taken into account. Across the state, 54% of facilities have a rated capacity of less than 300, 14% of facilities have a rated capacity of 300 to 449, 20% of facilities have a rated capacity of 450 to 1000, and 12% of facilities have a rated capacity of over 1000. Thus for each element within each category, the four percentages from capacity groups less than 300, between 300 and 449, between 450 and 1000 and over 1000 were combined to produce a weighted average using weights of .54, .14, .20, and .12, respectively, for the four capacity groups. These weighted averages are presented in the tables below.

Location of Incidents

Table 1 tabulates the areas in which incidents occurred. "Location" contains the names of the locations where incidents occurred within each facility. The number of incidents for each location is compiled over the full set of 424 reports. These counts are presented in Table 1. However, it is important to note that in the weighting process, the raw counts were immediately transformed to percentages. Thus, for example, the number of occurrences of housing for Facility A was converted to the percentage of reports indicating that an incident had taken place in housing. That percentage was averaged with the other housing percentages for all of the other facilities in its rated capacity group to yield a single housing percentage. This single percentage was subsequently included with the other three housing percentages from each of the other rated capacity groups to form a weighted average percentage of all four groups. The weighted average percentage, shown in the third column of Table 1, thus represents a composite summary of the sample of the facilities.

Because of the transformation of frequency counts to percentages that were used to compute the weighted average, it should be noted that the weighted average percentage may not exactly match the proportion of the number of incidents for the elements (locations). For example, the 301 incidents in housing represent 71% of the total 424 incidents, but the weighted average percentage for housing is 67.39%. Nonetheless, both ways of viewing the tabulation reveal that the majority of the documented incidents occurred in housing.

Table 1: Location of Incidents

Location	# of Incidents	Weighted Average Percentage
Housing	301	67.39%
Booking	59	17.51%
Inmate Movement	19	5.32%
Control Booth	12	2.95%
Medical	9	1.65%
Kitchen	8	1.47%
Yard	7	2.13%
Dining Hall	4	0.88%
Visiting Area	4	0.56%
Vocational	1	0.13%
Gym	0	0.00%
Laundry	0	0.00%
TOTAL	424	100.00%

Note. The Gym and Laundry locations are included in Table 1 with a frequency of zero. Subsequent research steps identified these locations as places where Adult Corrections Officers perform hearing-critical tasks. Therefore, to achieve consistency throughout this report, research staff created one standard list of locations.

Types of Incidents

Table 2 tabulates the areas in which incidents occurred. "Incident Report Type" contains the types of incidents occurring in the facilities. The number of incidents for each type is compiled over the full set of 424 reports. Table 2 also displays the weighted average percentage computed as previously described. Once again, the raw frequency counts were transformed to percentages as described above. Therefore, they are not necessarily interchangeable with each other but still allow the same conclusions to be drawn. Generally, incidents involving non-assaultive/oppositional behavior were most prevalent, followed by contraband, medical intervention, and physical assault/battery/altercation one-on-one. The fewest incidents were reported under the unusual/abhorrent behavior category.

Table 2: Types of Incidents

Incident Report Type	# of Incidents	Weighted Average Percentage
Non-Assaultive/Oppositional Behavior	127	31.11%
Contraband	95	22.86%
Medical Intervention	64	17.08%
Physical Assault/Battery/Altercation One-on-one	71	15.14%
Suicide, Suicide Threat, Suicide Attempt/Self-Injury	41	7.81%
Physical Assault/Battery/Altercation Group	15	2.79%
Unusual/Abhorrent Behavior	11	3.21%
TOTAL	424	100.00%

Time of Occurrence

Table 3 tabulates the times when the incidents occurred. "Shift" contains the watches when incidents occurred. The number of incidents for each watch is compiled over the full set of 424 reports. Table 3 also displays the weighted average percentage computed as previously described. Although the raw frequencies and the weighted average percentages are not completely interchangeable, it can be seen from the table that almost 80% of the incidents occurred during the second and third watches.

Table 3: Time of Occurrence

Shift	# of Incidents	Weighted Average Percentage
Watch One (10 pm – 6 am)	73	20.13%
Watch Two (6 am – 2 pm)	155	35.07%
Watch Three (2 pm – 10 pm)	185	43.46%
Not Reported	10	1.35%
TOTAL	424	100.0%

Sensory Cues

Table 4 displays the sensory cue used by the reporting officer to alert him/her that an incident was taking place. The number of incidents for each cue is compiled over a smaller subset of 299 reports because incidents detected by visual cues were excluded from this compilation. Table 4 also displays the weighted average percentage. As can be seen from the table, about 70% of the incidents (299/424 = 70.5) involved hearing as a critical component. Of those incidents with an audio cue, almost 70% involved both hearing and vision and about 30% involved hearing only.

Table 4: Sensory Cues for Incidents

Sensory Cue	# of Incidents	Weighted Average Percentage
Both vision and hearing	194	67.59%
Hearing only	105	32.41%
TOTAL	299	100%

Note. The total number of incident reports in the table differs from the total number of incident reports collected (424) because 125 (or 29.5%) of the incidents were detected using only vision. Incidents detected by vision only were excluded from this count.

Type of Sound Cue: Speech or Non-Speech

Table 5 tabulates the type of sound that alerted the officer to an incident. "Type of Sound Cue" indicates the number of incidents to which an officer was alerted by speech or non-speech sounds. The number of incidents for each type of alert is compiled over a smaller subset of 299 reports. About 30 percent of the incidents indicated vision was the only sensory cue used in incident detection and these were excluded from this compilation. Table 5 also displays the weighted average percentage. As can be seen from the table, about 70% of the incidents (299/424 = 70.5) involved hearing as a critical component. Of those incidents involving an audio cue, the vast majority of the alerts involved speech communication.

Table 5: Type of Sound Cue

Type of Sound Cue	# of Incidents	Weighted Average Percentage
Speech	259	84.13%
Non-speech	40	15.87%
TOTAL	299	100%

Note. The total number of incident reports in the table differs from the total number of incident reports collected (424) because 125 (or 29.5%) of the incidents were detected using only vision. Incidents detected by vision only were excluded from this count.

Visibility of Sound Source

Table 6 tabulates the type of sound that alerted the officer to an incident as visible or not. "Visibility" indicates the number of incidents to which an officer was alerted by a visible or not visible sound source. The number of incidents for each type of alert is compiled over a smaller subset of 299 reports. About 30 percent of the incidents indicated vision was the only sensory cue used in incident detection and these were excluded from this compilation. Table 6 also displays the weighted average percentage. As can be seen from the table, about 70% of the incidents (299/424 = 70.5) involved hearing as a critical component. Of those incidents involving hearing, about two thirds of the alerts involved a visible sound source.

Table 6: Visibility of Sound Source

Visibility	# of Incidents	Weighted Percentage
Sound Source Visible	194	67.59%
Sound Source Not visible	105	32.41%
TOTAL	299	100.00%

Note. The total number of incident reports in the table differs from the total number of incident reports collected (424) because 125 (or 29.5%) of the incidents were detected using only vision. Incidents detected by vision only were excluded from this count.

Discussion

From the 424 incident reports that were analyzed, about 70% of the incidents required the Adult Corrections Officers to detect and respond to the incidents using their hearing abilities. When hearing was the critical component (as opposed to vision) in alerting the Adult Corrections Officers to an incident, the majority of the audible cues were in the form of speech. This reinforces the importance of being able to detect and understand speech communication.

STEP 3: INTERVIEWS WITH ADULT CORRECTIONS OFFICERS

The third step in the research process identified hearing-critical job functions through interviews with Adult Corrections Officers who served as subject matter experts (SMEs). These interviews consisted of two phases: the first phase entailed semi-structured interviews with panels of incumbent Adult Corrections Officers and their immediate supervisors; the second phase comprised on-site, one-on-one interviews with line officers or their immediate supervisors.

Background and Rationale

Analysis of the incident reports conducted in Step 2 provided substantial detail about when and where incidents occurred. The interviews during Step 3 gathered more detail about the performance dimensions of the hearing-critical tasks.

For the panel interviews, the research team selected the commonly used method of semi-structured interviews (e.g., Guion, 1998) to examine the Adult Corrections Officer job as it relates to hearing. Research staff met with SMEs, experienced Adult Corrections Officers who have either performed the job for several years or who supervise them. Small groups of SMEs were interviewed together, which allowed each SME to enrich the information supplied by other SMEs. This method is not only time efficient, it also enables integration of SME responses (Brannick et al., 2007). Often, the group process allows information to surface that might not otherwise be obtained during individual interviews.

In contrast, the on-site interviews enabled the research team to engage in individual dialogue about specific hearing-critical job functions and hearing challenges in the SME's specific facility. Additionally, the on-site interviews had the advantage of allowing research staff to directly observe the specific locations officers worked and the distances from sound sources.

Panel Interview Methodology

The research team assembled two panels of Adult Corrections Officers. Six officers representing jails from six different agencies were selected for these panels based on their extensive knowledge of the job.

The SME panel meetings explored activities within jails that involved hearing-critical job functions. The research team asked the SMEs a series of questions related to these functions to determine where and when they occurred and what they entailed. The SMEs responses and subsequent discussion provided details about each function and the hearing abilities used to perform the function.

The panel interview process was divided into two phases. The first phase focused on hearing-critical job functions that occur throughout a routine workday; that is, a composite of duties officers perform as part of their day when they are not responding to emergencies or incidents. The second phase addressed hearing-critical job functions that occur in response to emergencies or incidents at any time during a shift.

Hearing-Critical Job Functions During a Routine Day

Each SME was assigned a different four-hour time segment during the routine day. They were then asked to identify 5–6 hearing-related hearing job functions that an Adult Corrections Officer might perform during that time segment. They were encouraged to construct a mental composite to represent the activities during that time period. This process was repeated for each time segment to characterize the entire routine day. Once the day had been reconstructed in this manner, the panel analyzed each identified job function to determine the hearing abilities used in performing the function.

For speech communication activities, SMEs were asked to identify or describe:

- Vocal effort of the communication (whispered/softly spoken, normal, raised, shouted)
- The degree to which the message was understood
- Whether the speech could be repeated

For non-speech sounds, SMEs were asked to identify or describe:

- Whether the activity required detection, recognition, or localization
- The amplitude of the sound
- The characteristics of the sound (single burst, continuous, intermittent)

For all sounds, SMEs were asked to identify or describe:

- The distance of the Adult Corrections Officer from the sound source
- Whether the source was visible
- The level of the background noise
- The overall effort needed to hear the sound

The specific questions posed to the SMEs are reported in Appendix B. Two interview questions did not yield useful information: the degree to which a message was understood; and, the distance of ACOs from the sound source. SMEs had difficulty providing these estimates; therefore, no data for these questions are reported.

Hearing-Critical Job Functions During Incidents

After the review of a routine day, SMEs described incidents. Since incidents do not necessarily occur during a specific watch, the SMEs were simply asked to recall an incident they had experienced that involved hearing. Once the SMEs related such an event, they were asked when and where that incident had occurred, and whether the cue for the incident involved speech communication or other non-speech sounds. With this information in hand, the research team guided the SMEs through the same series of questions as those presented during routine day recollections.

Panel Interview Results

Research staff analyzed the results from the interviews by tabulating the frequencies of occurrence for each response category. Separate tabulations were made for speech and non-speech sounds and for the routine day and for incidents. These results are summarized below. Additional information is reported in Appendix C.

Locations

Table 7 shows the percentages of time functional hearing abilities were used in the performance of hearing-critical job functions at the most commonly reported locations in the facility. Separate entries are given for a routine day and during responses to incidents. During routine days, Adult Corrections Officers used speech communication over 26% of the time in the performance of hearing-critical job functions in areas of inmate movement, 20% in booking, and about 13% in the control booth and housing. During responses to incidents, Adult Corrections Officers used speech communication in the control booth over 41% of the time, and in the booking area over 33% of the time.

SMEs reported the need to hear non-speech sounds during a routine day over 66% of the time in the control booth and over 33% of the time in areas of inmate movement. These functional hearing abilities were also used in the response to incidents in the control booth 100% of the reported times as well.

Table 7: Locations of Hearing-Critical Job Tasks

Areas where speech and non-speech functional hearing abilities were used to perform hearing-critical job functions during a routine day and during responses to incidents

Location	Speech		Non-Speech	
	Routine Day N=15*	Incidents N=12[1]*	Routine Day N=6	Incidents N=5
Inmate Movement	26.6%	8.3%	33.3%	
Booking	20.0%	33.3%		
Kitchen				
Medical				
Control Booth	13.3%	41.7%	66.6%	100%
Housing	13.3%	8.3%		
Outside Recreation (Yard)				
Dining Hall				
Visiting Area	6.6%			
Laundry				
Vocational				
Inside Recreation (Gym)				
Total	79.8%	91.6%	100%	100%

Note. Several locations are included in Table 7 without an entry. Subsequent research steps identified these locations as ones where Adult Corrections Officers perform hearing-critical tasks. Therefore, to achieve consistency throughout this report, research staff created one standard table that encompassed all sources of information referring to location.

Other Results from Panel Interviews

The SMEs reported that during both a routine day and incidents, the majority of the hearing-critical tasks require speech communication. The SMEs also noted that it is common for tasks to involve the detection and recognition of non-speech sounds as well.

During a routine day, the frequency of normal and raised vocal effort was relatively equally distributed, while shouting or whispered/softly spoken speech occurred rarely, if at all. This differs to some extent with the vocal effort used during responses to incidents, where normal, raised, and shouted vocal efforts were needed approximately equally to communicate. Whispering or softly spoken vocal effort was not reported as relevant during a routine day or in the response to incidents. Additionally, during both routine days and incidents speech communication could be repeated the majority of the time (about two thirds of the time during a routine day and about three quarters of the time during

[1] SMEs recounted two incidents occurring in administrative and undetermined areas; thus, they could not be classified into any of the location areas listed in the table. They are therefore not included in Table 7 above. Because the sample sizes (Ns) of 15 and 12 include those two incidents, the totals do not sum to 100 percent.

incidents). Thus, elevated levels of vocal effort and repetition were commonly needed to achieve effective communication with speech, particularly while performing hearing-critical job functions during the occurrence of incidents.

SMEs estimated the background noise during routine days to be predominantly at a medium level when hearing both speech and non-speech sounds. During incidents, background noise levels were generally quiet or medium when hearing both speech and non-speech sounds.

When asked if the source of the sound was visible, the SMEs indicated that during a routine day the source of sound or speech was not visible over 40% of the time. During incidents, the source was not visible almost 90% of the time.

During a routine day, Adult Corrections Officers needed to hear speech communication at all levels of effort; however, about half of the time they needed to exert medium effort to hear. During incidents, officers expended low amounts of effort most of the time to hear speech communication. During both routine days and incidents, officers needed to expend mostly low effort to hear non-speech sounds.

The SMEs described the hearing-critical job functions Adult Corrections Officers must perform to maintain safety and security. Many of these involved compelling examples of situations involving the need to hear. Three such examples are as follows:

- An inmate yelling for help while another inmate was being stabbed
- Inmates exchanging threats through the vents
- An inmate threatening to commit suicide from his cell

Individual Interview Methodology

To supplement the SME Panel Interviews, research staff conducted individual interviews with 30 Adult Corrections Officers at the officers' respective jails. The selection of the 30 facilities where interviews were conducted followed a stratified sampling plan that captured an approximately proportional representation of all local jails throughout the state according to geographical region and rated capacity. In some jurisdictions, more than one facility was sampled if rated capacity differences were represented. (For a list of facilities that comprised the sample, please see Appendix I.)

All SMEs interviewed had several years experience on the job and were knowledgeable about the Adult Corrections Officer position as well as their facility. In the few cases where the SME had worked in other facilities or jurisdictions, the SME was asked to respond to the interview questions from the perspective of his/her current assignment. This focus preserved the sampling plan's proportional representation.

Research staff asked each SME to cite a total of six examples of hearing-critical job functions; three examples of hearing-critical sounds (such as alarms) and three examples of hearing-critical speech communication (such as responding to inmates' questions). Research staff gathered examples for both sounds and speech communications that occurred during routine days as well as during emergencies or incidents.

For examples of hearing-critical sounds, research staff asked the SMEs for estimates of the background noise level against which the sound was heard (quiet like an office, noisy like a busy restaurant, or somewhere in between). Further, research staff asked if the source of the sound was visible.

For examples of hearing-critical speech communication, research staff asked about the background noise level (as above), the visibility (as above) as well as whether there was an opportunity to repeat the speech communication without negative consequences occurring. Further, the SMEs were asked to describe the voice level of the speaker during these communications (whispered or softly spoken, normal, raised or shouted).

Additionally, research staff asked each SME to rate the importance of speech communication to the job of an Adult Corrections Officer (not important, somewhat important, or very important).

Individual Interview Results

The SMEs provided 179 examples of hearing-critical job functions. Examples included both hearing-critical sounds and speech communication. Examples are as follows:

- Radio transmissions (often needed to be repeated; sometimes heard incorrectly)
- Listening for unauthorized conversations between inmates
- Monitoring the tension among the group as reflected by conversation level (either too loud or too soft)
- Understanding an inmate speaking in an agitated manner
- Hearing requests for help from inmates that another inmate is in trouble:"Man Down"
- Hearing the locking mechanisms engage on cell doors and other secure doors
- Listening for "swishing" sound of notes being slid on floor between cells
- Hearing chairs and tables being moved abruptly (indicates fight in progress)
- Hearing a "thump" as when an inmate falls off a bunk (may indicate inmate having a seizure)
- Hearing keys jingling rapidly (may indicate officer running to scene of emergency)

Categories of Examples

- *Sounds:* During a routine day, the SMEs reported hearing most often door locks engaging followed by sounds coming from phones ringing, intercoms beeping, alarms sounding and radio static. During emergencies, the SMEs reported hearing most frequently inmates pounding or hitting objects. Inmate fights were the second most common sounds heard followed by intercom, radios, and alarms.

- *Speech Communication*: During a routine day, the SMEs reported hearing most often speech communication over the radio, intercom, and phone, followed by direct staff and inmate communication. The SMEs reported hearing inmate communication the least often. During emergencies, the SMEs reported hearing the same types of speech communication except that inmate-to-inmate communication was more prevalent. The percentages of examples cited by officers are displayed in Figure 2 below.

Hearing-Critical Sounds During Routine Day

Door locks engaging (ensuring security doors locking)	33.33%
Phones, intercoms, radios, alarms	31.67%
Sounds prompting investigation (scraping objects, thumps)	21.67%
Officer's keys jingling (indicates officer approaching)	8.33%
Inmate movement within the facility	3.33%
Other	1.67%

Hearing-Critical Sounds During Emergencies or Incidents

Inmates pounding, throwing, hitting, scraping objects	43.33%
Inmate to inmate physical altercations	23.33%
Intercoms, radios, alarms	16.67%
Officer's keys jingling quickly (indicates officer running)	10.00%
Inmate movement within the facility	3.33%
Other	3.33%

Speech Communications During Routine Day

Radio/intercom/phone communication	41.67%
Staff /inmate communication	35.00%
Staff/staff communication	18.33%
Inmate/inmate communication	5.00%

Speech Communications During Emergencies or Incidents

Radio/intercom/phone communication	46.67%
Staff /inmate communication	23.33%
Inmate/inmate communication	16.67%
Staff/staff communication	13.33%

Figure 2: Percentage of SME Examples by Category

Estimated Background Noise Levels

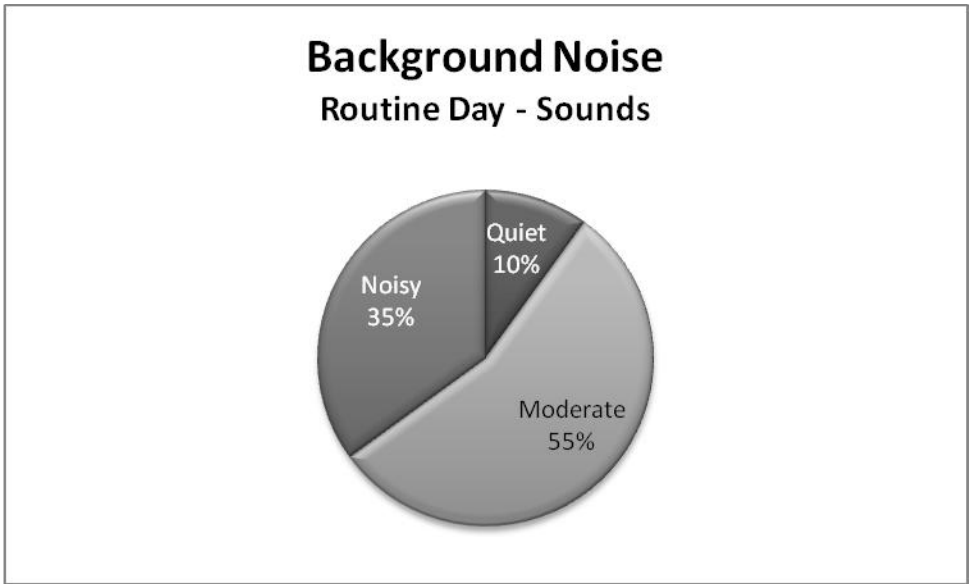


Figure 3: Background Noise Levels for Sounds During Routine Day

When listening for sounds during a routine day, the SMEs reported a moderate level of background noise 55% of the time, a noisy level of background noise 35% of the time. The background noise was quiet only 10% of the time.

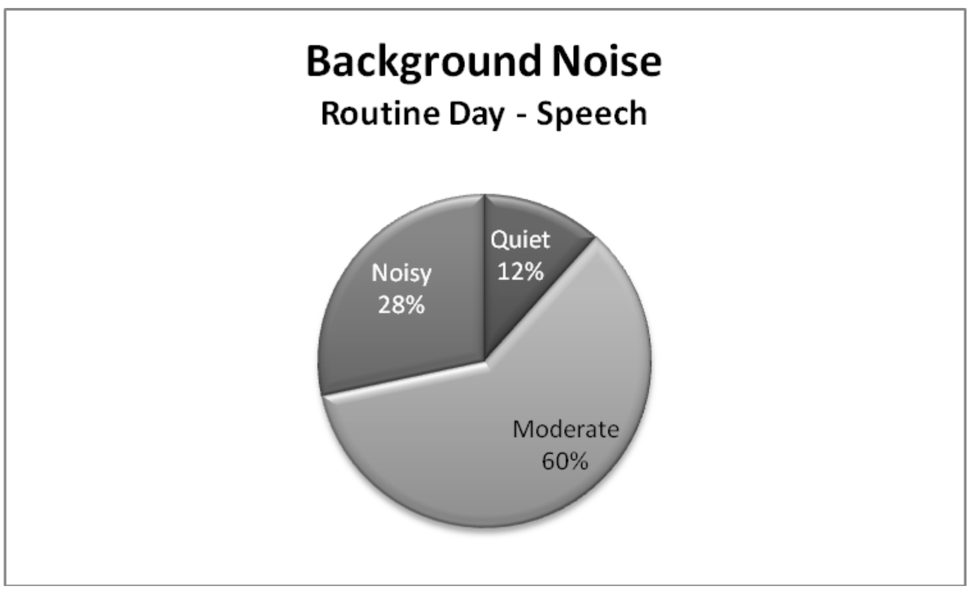


Figure 4: Background Noise Levels for Speech Communication During Routine Day

When listening for speech communication during a routine day, the SMEs reported a moderate level of background noise 60% of the time, a noisy level of background noise 28% of the time, and quiet background noise only 12% of the time.

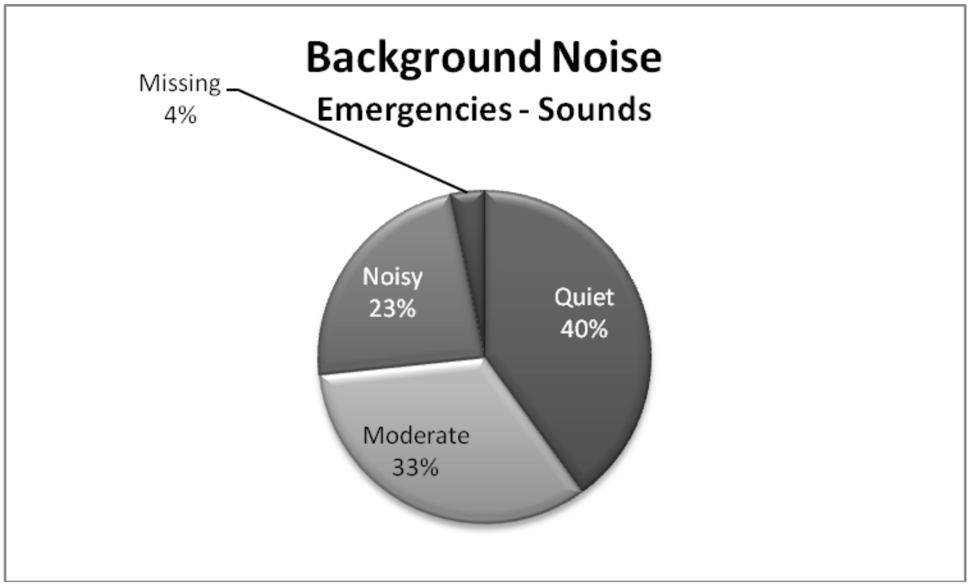


Figure 5: Background Noise Levels for Sounds During Emergencies

When listening for sounds during emergencies or incidents, the SMEs reported the background noise level as quiet 40% of the time, moderately noisy 33% of the time, and noisy 23% of the time.

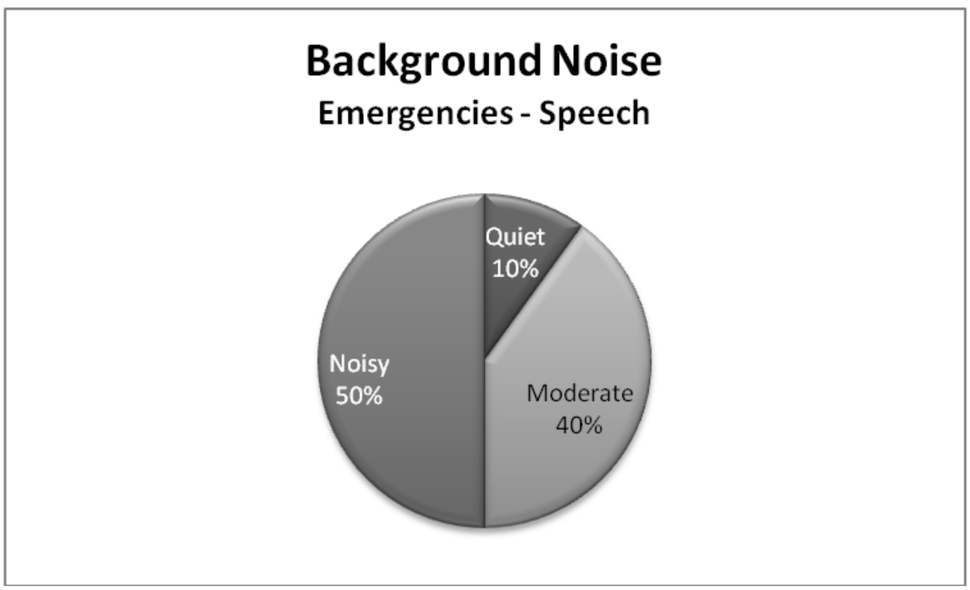


Figure 6: Background Noise Levels for Speech During Emergencies

When listening for speech communication during emergencies or incidents, the SMEs reported the background noise as noisy 50% of the time, moderately noisy 40% of the time and quiet 10% of the time.

Sound Source Visibility

The SMEs reported the sound source as visible over 80% of the time, except when listening for speech communication during a routine day. In this case, the sound source was visible only 45% of the time.

Opportunity to Repeat Speech Communication

During a routine day, the SMEs reported they were able to repeat speech communications 95% of the time if the initial communication was not understood. During emergencies, speech could not be repeated one-third of the time. While the majority of time communications can be repeated, SMEs noted that the sooner the speech was understood during an emergency, the quicker help is rendered.

Voice Levels

For examples during a routine day, the SMEs reported that the most common voice level they heard for speech communication was a normal voice level (75%). There were two reported examples of speech communication at the whispered/softy spoken level. Adult Corrections Officers explained that it is sometimes necessary to "eavesdrop" on softly spoken conversations between inmates to supervise the group effectively. Officers sometimes hear inmates' plans to disrupt the group, pick a fight, or pass contraband. For the remaining examples, raised voice levels were heard 20% of the time; shouted voice levels were heard about 3% of the time.

During emergencies, the SMEs reported that they heard shouted voice levels 44% of the time and raised voice levels 40% of the time. Normal voice levels were heard 13% of the time and whispered/softly spoken voice levels were heard 3% of the time.

SMEs Rated Importance of Speech Communication

Virtually all of the SMEs interviewed rated the importance of speech communication as very important. Officers emphasized this ability by using such phrases as "couldn't do job without it"; "crucial" and "essential."

Discussion

The interviews expanded the research team's understanding of the importance of an officer's ability to hear. SMEs provided evidence that the ability to understand speech communication is critical to the successful performance of the job. If Adult Corrections Officers do not have adequate hearing ability, they may be unable to maintain security and prevent injury or even the death of an inmate.

Step 4: Primary Functional Hearing Ability

The fourth step in the research strategy was to determine the primary functional hearing ability to be examined throughout the remainder of the research.

Background and Rationale

The analysis of the incident reports and the results of the interviews with Adult Corrections Officers clearly pointed to the criticality of speech communication as a functional hearing ability. These findings have important implications for the hearing guideline and for the screening measures used in the selection of applicants for the Adult Corrections Officer job.

Methodology

To determine if speech communication was the primary functional hearing ability for the Adult Corrections Officer job, research staff addressed several issues. The first was to determine whether there was adequate evidence of its importance. The second was to evaluate the significance of negative consequences of failed or ineffective speech communication. The third was to justify the consideration of speech communication at the exclusion of detection, recognition, and localization of non-speech sounds. The fourth was to assess whether there is sufficient scientific knowledge showing how background noise affects the ability to communicate with speech for the purpose of hearing screening. Finally, the fifth step was to identify well-established measures of speech communication that can be used for hearing screening. Each of these issues is addressed in turn below.

Results

Importance of Speech Communication

Several aspects of the information gained from the Adult Corrections Officers interviews and from analyses of the incident reports sharpened the focus of the research on speech communication. There was repeated evidence that speech communications between Adult Corrections Officers and between officers and detainees were frequent and hearing-critical job functions. Additionally, Adult Corrections Officers routinely monitor the speech communication between detainees. These activities are vital to safety of the detainees and the security of the facility. There was also repeated evidence that speech communication occurred in moderate to loud background noise levels approximately 90% of the time during routine days and emergencies. Further, there was evidence that Adult Corrections Officers often found it necessary to use loud or shouted vocal effort as well as repetition, and to achieve effective speech communication. Further, effective speech communication was found to be of critical importance in maintaining the health and safety of detainees and Adult Corrections Officers, for example:

- Notifying the necessary personnel of a medical emergency
- Instructing inmates to cease certain actions
- Interviewing inmates to determine security classification

Consequences of Failed Speech Communication

The consequences of failed speech communication in an adult detention facility are considerable. These include injury to, even death of, inmates, inappropriate response to medical emergency, suicide, and escape. These consequences of failed speech communication can seriously jeopardize the health and safety of individuals in the detention environment as well as the public.

Consideration of Non-Speech Sounds

The functional hearing abilities related to non-speech sounds are customarily defined as sound detection, sound recognition, and sound localization. However, for effective speech communication to occur, the speech sounds must also be detected, recognized, and, to some extent, localized. (When speech recognition is measured in noise with the speech and noise originating from different locations, the speech and noise are distinguished auditorily by their different locations.) Thus, if appropriate measures of speech communication are used for screening, evidence of adequate speech communication ability implies adequate non-speech functional hearing abilities.

Scientific Knowledge about Speech Communication in Noise

There is a substantial body of research literature that has examined the effects of noise on speech communication. (See Tufts et al., 2009, for a review.) Much of this literature has focused on how hearing impairment alters the ability to understand speech in noise. A standardized metric, the Speech Intelligibility Index (SII), has been used for many years to quantify the ability to understand speech in noise. Application of this metric to the prediction of speech understanding in everyday noise environments, such as those encountered by Adult Corrections Officers, has also been validated (Rhebergen & Versfeld, 2005; Rhebergen et al., 2006, 2008). This scientific knowledge, together with the SII standard, can be used for the purpose of hearing screening when speech communication in noisy environments is the primary functional hearing ability of interest.

Available Measures of Speech Communication in Noise

In recent years, a number of measures of speech communication in noise have been developed and published (e.g., Nilsson et al., 1994; Killion & Niquette, 2000; Bentler et al., 2000; Bilger et al., 1984; Cox et al., 1988; Kalikow et al., 1977). There is also a substantial body of both theoretical and applied research on the use of these measures and on the practical significance of the scores obtained with these measures. Recent studies have established a scientific link between this research and the research on speech communication in noise described above.

Discussion

Each of the issues presented above is relevant to the focus on speech communication as the primary functional hearing ability required for the Adult Corrections Officer job. This emphasis on speech communication concentrated the research efforts on objective measures of the noise environment where speech communication takes place within the adult detention facilities.

Step 5: Selection of Adult Facilities for On-Site Observations and Measurements

The fifth step in the research strategy was to select a representative sample of adult facilities for on-site observations and noise measurements.

Background and Rationale

The research strategy called for on-site visits to a number of adult facilities for observation of hearing-critical job functions where speech communication was the primary functional hearing ability. The research team designed a sampling plan that identified representative facilities throughout the state.

Methodology

Two primary factors were considered in forming a representative sample of adult facilities from throughout the State of California. These were the size of the facility and its geographical location. The size of the facility was determined by its rated capacity; although not all facilities are occupied to capacity at all times. Geographical location was most easily defined by identifying whether facilities are found in the northern, central, or southern portions of the state. Recordings were made at facilities between March 2011 and December 2011.

Results

The research team selected 36 adult facilities for observation and measurement. These facilities were distributed throughout all regions of the state, with a wide range of rated capacities. Table 8 lists these facilities. Analyses of the logs and recordings from each facility revealed that in most cases the predominant source of background noise that could interfere with speech communication was the voices of inmates and the other sounds they made. Thus, the number of adult inmates present during observations and recordings, as estimated from the rated capacity of the facilities, becomes an important consideration. Because of this consideration, Table 8 and the subsequent analyses are based in part on groupings of the measurements by rated capacity of the facilities where they were made.

Discussion

The facility sampling plan produced approximately equal numbers of facilities within each range of rated capacities.

Table 8: Selected Facilities for Background Noise Level Measurements

Adult facilities visited for observations and measurements. Facilities are grouped by rated capacity (RC).

Nr	Name of Facility	RC
	Rated capacity <300	
1	Berkeley City Jail	19
2	Del Norte County Jail	103
3	El Dorado County Jail	265
4	Kern County Central Receiving Facility	292
5	Lake County Jail	286
6	Los Banos City Jail	20
7	Merced County Main Jail	189
8	Yolo County Leinberger Jail	120
9	Yolo County Monroe Jail	272
	Rated capacity 300-450	
1	Humboldt County Jail	411
2	Kern Lerdo County Maximum Security	374
3	Los Angeles County Inmate Receiving Facility	336
4	San Diego County East Mesa Detention Facility	360
5	San Diego County East Mesa Jail	360
6	San Diego County Las Colinas Jail	432
7	San Francisco County Jail #4	402
8	Stanislaus County Main Jail	342
	Rated capacity 451-1000	
1	Butte County Jail	614
2	Kern Lerdo County Main Jail	800
3	Merced County John Latorraca Correctional Facility	564
4	Placer County Jail (Auburn)	488
5	San Bernardino County Central Detention Center	740
6	San Diego County Central Jail	944
7	San Francisco County Jail #5	768
8	Santa Clara County Elmwood Women's Jail	516
9	Solano County Main Jail	705
10	Stanislaus County Public Safety Center	702
	Rated capacity >1000	
1	Alameda County Santa Rita Jail	3,812
2	Fresno County Jail	1,064
3	Kern County Pre-Trial Facility	1,232
4	Los Angeles County Twin Towers Jail	2,244
5	Orange County Men's Central Jail	1,219
6	Orange County Theo Lacey Jail	2,448
7	San Diego County George Bailey Jail	1,380
8	Santa Clara County Elmwood Men's Jail	1,956
9	Santa Clara County Main Jail	1,353

Step 6: Selection of Locations and Times for On-Site Observations and Measurements

The sixth step in the research strategy was to select locations and times within each facility where hearing-critical job functions take place.

Background and Rationale

For each of the facilities sampled in the previous step research staff identified the locations and times where Adult Corrections Officers perform hearing-critical job functions involving speech communication. Staff used this information to plan on-site visits to observe and document the performance of these functions and to record the background noise.

Methodology

Locations and times at each facility were identified from the information obtained from the interviews with SMEs and from the locations where reportable incidents most commonly occurred. Staff used this information to form a prioritized list of the most important times and locations to be visited at each facility.

Top priority was assigned to locations where Adult Corrections Officers spend a substantial amount of time and where they perform a number of hearing-critical job functions involving speech communication. The information in the list was not facility-specific, as it represented the information obtained and compiled from Adult Corrections Officers working in facilities across the entire state. Thus, as a second step, the research team conducted interviews with Adult Corrections Officers who worked at each facility at the beginning of each on-site visit. Research staff reviewed the prioritized list with the Adult Corrections Officers at each facility and asked how the list could best be adapted to the specific locations and schedules in place at their facility. After any needed adjustments were made to the list, research staff planned a detailed schedule for visiting each location.

Results

Table 9 shows the prioritized list of locations for on-site visits identified from the interviews with SMEs and analysis of incident reports.

Officers most frequently stated that mornings are generally quiet as inmates are just waking up. Late afternoons and evenings, especially on the weekends tend to be the noisiest. However, officers also pointed out that there is no set pattern. Noise levels are affected by the composition of inmate population as well. Officers reported (and research staff observed) that one unruly inmate can make considerable noise by yelling and banging in his/her cell.

Table 9: Prioritized List of Locations Targeted for Observation, Sound Measurements, and Recordings

Location
Housing
Booking
Inmate Movement
Control Booth
Yard
Medical
Kitchen
Dining Hall
Visiting Area
Vocational
Gym
Laundry

Discussion

The prioritized list of locations for on-site recordings of background noise environments provided an efficient way to ensure that the research team observed the most important hearing-critical job functions involving speech communication. The pre-observation interviews identified specific spots at each location that were noisiest or where the most important speech communication activities occurred. Time schedules were also set to make the most efficient use of time available at the facility.

The on-site visits to each location at each facility allowed research staff to obtain observations and recordings that objectively documented the functional hearing requirements for Adult Corrections Officers. The following steps describe how the recordings were made, analyzed, and interpreted for this purpose.

STEP 7: BACKGROUND NOISE RECORDINGS AND MEASUREMENTS

The seventh step in the research strategy was to record and measure background noise environments where hearing-critical job functions occur.

Background and Rationale

The intended use of the background noise recordings was to provide quantitative information about the noise environments where Adult Corrections Officers must achieve effective speech communication to perform hearing-critical job functions throughout the routine day and during responses to incidents. By making calibrated recordings of these noise environments, it was possible to use a standardized metric, the Speech Intelligibility Index (American National Standards Institute, 2007), to predict the likelihood that otologically normal Adult Corrections Officers can achieve this level of performance. Published methods for calculating the SII and for making these predictions are available for this purpose. These methods have recently been extended to apply to everyday noise environments, such as those encountered by Adult Corrections Officers in a routine day.

Methodology

All recordings were made using a hand-held digital audio recorder, the Edirol R-09HR manufactured by Roland. Recordings were stored on a digital memory card and later transferred to a personal computer for data processing and analysis. Procedures for calibration of the recordings are given in Appendix D.

Results

The research team made a total of 185 recordings at the specified locations from the 36 facilities. A detailed summary of each recording is given in Appendix I.

Table 10 presents a brief summary of the recordings. The recordings are organized according to location within the facilities. For each location, e.g., "booking," the number of facilities and the total number of recordings is given. Note that in many cases there were more recordings than facilities, indicating that multiple recordings were made at the same location within some facilities.

Table 10: Summary of Recordings by Facility and Location

Total number (Nr) of noise recordings for each visited facility and number of recordings at each location within the facility. Facilities are grouped by rated capacity.

Facility	Nr	Book	Chow	Cont	Gym	Hous	Kitch	Laun	Med	Move	Rec	Visit	Voc
Rated capacity <300													
Berkeley City Jail	3	1		1			1						
Del Norte County Jail	8	5		1		1	1						
El Dorado County Jail	5			1		2	1	1					
Kern County CRF	4	1				3							
Lake County Jail	5		2			2	1						
Los Banos City Jail	5					5							
Merced County Main Jail	5			2				1		1	1		
Yolo County Leinberger Jail	4		1			3							
Yolo County Monroe Jail	4			1		2	1						
Subtotal	43	7	3	6	0	18	5	2	0	1	1	0	0
Rated capacity 300-450													
Humboldt County Jail	10	1		3		3	1	2					
Kern County Max-Med Lerdo	6		1			3				1	1		
LA County Old IRC	4									4			
San Diego County EMDF	4					4							
San Diego County EMJ	6					2	2	1					1
San Diego County Las Colinas	6	1	1			2	1						1
San Francisco County Jail #4	4			1		1	1			1			
Stanislaus County PSC	5		4	1									
Subtotal	45	2	6	5	0	15	5	3	0	6	1	0	2

Note: Book = Booking, Chow = Dining Hall, Cont = Control, Hous = Housing, Kitch = Kitchen, Laun = Laundry, Med = Medical, Move = Movement, Rec = Yard, Visit = Visitation, Voc = Vocational

Table 10 (continued)

Facility	Nr	Book	Chow	Cont	Gym	Hous	Kitch	Laun	Med	Move	Rec	Visit	Voc
Rated capacity 451-1000													
Butte County Jail	5					5							
Kern County Min Security	3					1	1	1					
Merced County JL CF	2					1				1			
Placer County Jail (Auburn)	6			1		3	1				1		
San Bernardino County CDC	5		1			2	1			1			
San Diego County Central Jail	7					2	2		2	1			
San Francisco County Jail #5	2				1	1							
Santa Clara County Elmwd W	5					4				1			
Solano County Main Jail	3			1		1	1						
Stanislaus County Main Jail	5			2		3							
Subtotal	43	0	1	4	1	23	6	1	2	4	1	0	0
Rated capacity >1000													
Alameda County Santa Rita	13	3		2	1	4	1	1		1			
Fresno County Jail	8					8							
Kern County Pre-trial Facility	5					2		1	2				
LA County Twin Towers	6					3	3						
Orange County Men's Central	2							2					
Orange County Theo Lacey	5					5							
San Diego County G Bailey	4					2	1		1				
Santa Clara County Elmwd M	6		1			3	1	1					
Santa Clara County Main Jail	5		2			2				1			
Subtotal	54	3	3	2	1	29	6	5	3	2	0	0	0
Overall Total Recordings	185	12	13	17	2	85	22	11	5	13	3	0	2
Overall Total Facilities	36	6	8	12	2	31	18	9	3	10	3	0	2

Note: Book = Booking, Chow = Dining Hall, Cont = Control, Hous = Housing, Kitch = Kitchen, Laun = Laundry, Med = Medical, Move = Movement, Rec = Yard, Visit = Visitation, Voc = Vocational

Discussion

The noise recordings provide a representative sample of the noise environments where Adult Corrections Officers perform hearing-critical job functions throughout the routine day and during responses to incidents. The sample includes data from a representative set of facilities throughout the State.

The sample includes only recordings made at locations and times where important hearing-critical job functions involving speech communication occur. Thus, subsequent analyses based on the SII standard and the published methods that extend these analyses to everyday noise environments allow an accurate characterization of the likelihood that otologically normal Adult Corrections Officers can achieve effective speech communication when performing hearing-critical job functions at these locations.

STEP 8: ANALYSIS OF NOISE RECORDINGS

The eighth step in the research strategy was to perform standardized analyses of the noise recordings.

Background and Rationale

The Speech Intelligibility Index (SII) is a standardized metric for predicting speech intelligibility, or speech understanding, in stationary non-fluctuating noise (American National Standards Institute, 2007). The SII has recently been extended to predict speech intelligibility in fluctuating noise as well, such as found in everyday noise environments (Rhebergen & Versfeld, 2005; Rhebergen et al., 2006, 2008). The Extended SII, or ESII, can be used to predict speech intelligibility and the likelihood of effective speech communication for otologically normal Adult Corrections Officers in each of the noise environments where they perform hearing-critical job functions throughout a routine day and during responses to incidents.

The SII and ESII are based on the principal that the level of the information in speech in relation to the level of the noise determines intelligibility and the likelihood of effective speech communication. The importance of information in speech for intelligibility and effective communication is not the same at all frequencies. For example, speech information below 2000 Hz is more important than speech information above 2000 Hz. To calculate the SII and ESII it is necessary to filter the noise into narrow frequency regions and to determine the level of the noise in each region. The level of speech in each frequency region is stated in the standard (American National Standards Institute, 2007). The level of the speech in relation to the noise in each frequency region, together with the importance of the speech information in each region, allow the SII and ESII to be calculated.

The speech levels used to calculate the SII and ESII can vary depending on the vocal effort used to produce the speech. The standard allows a "normal," "raised," "loud," or "shouted" level of vocal effort to be specified. All four levels of vocal effort are appropriate for use in the analyses because SMEs reported and research staff observed on-site regular use of these levels of vocal effort by Adult Corrections Officers throughout the day.

The standard also allows communication distance to be specified. Again, observations during on-site recordings indicated that relatively short communication distances were commonly used because of high background noise levels.

In fluctuating background noise there are times when the noise level drops, making speech communication easier and more effective. There also are times when the noise level increases, making speech communication more difficult and less effective. Thus, it is appropriate to consider the likelihood of effective speech communication in fluctuating background noise. The ESII provides an effective means of quantitatively characterizing this likelihood for otologically normal individuals. The ESII for a fluctuating noise environment is determined by first calculating the SII over and over on brief "snapshots" of the noise, approximately 100 per second, and then averaging these values over the entire duration of the noise (Rhebergen & Versfeld, 2005; Rhebergen et al., 2006, 2008). This method can be readily adapted to determine the ESII for a segment of the noise, rather than the entire duration of the noise. The standard states that "good" speech communication can occur when the SII exceeds 0.45 This also applies to the ESII; however, when binaural hearing and the opportunity to repeat communications are considered, this value decreases to 0.30. Appendix G provides the detailed rationale for using 0.30 as the criterion value.

Most brief two-way communications between individuals take place over a few seconds, e.g., 4 seconds. Thus, by calculating the ESII for a 4 second segment of the noise it is possible to determine whether effective speech communication can occur during that segment. ESII values over 0.30 indicate that it can, and values under 0.30 indicate that it cannot. Finally, if an entire on-site noise recording is divided into 4 second segments and the ESII for each segment is calculated, the percent of segments with ESII values over 0.30 corresponds to the percent of time effective speech communication can occur in the fluctuating noise environment. This percentage is defined as the likelihood of effective speech communication in that noise environment for an otologically normal individual.

Research staff used these analyses to determine the likelihood of effective speech communication for Adult Corrections Officers with normal hearing at the times and locations where Adult Corrections Officers perform the most important hearing-critical job functions involving speech communication. Research staff also repeated these analyses to determine the type and degree of hearing impairment that reduces the likelihood of effective speech communication to a level where safe and effective job performance could become an issue. This approach provides an explicit and objective connection between the measures of hearing impairment to use for screening applicants for the job and the hearing-critical job functions that Adult Corrections Officers must perform during a routine day and when responding to incidents.

Methodology

The recordings were processed according to the procedures specified in the standard (American National Standards Institute, 2007). The noise was filtered into 1/3 octave bands with center frequencies ranging from 160 Hz to 8000 Hz. Calibrations were applied to each noise band, and the SII was calculated every 9.2 milliseconds from noise "snapshots" and averaged over 4 second intervals to produce ESII values. These calculations were repeated for several levels of vocal effort and several communication distances. Cumulative frequency distributions of the resulting ESII values were formed. These ESII data sets were used to determine the likelihood of effective speech communication for various combinations of vocal effort and communication distance at each location and time at each facility where Adult Corrections Officers perform hearing-critical job functions. A detailed description of this methodology is given in Appendix H.

Results

Research staff processed each of the 185 recordings according to the procedure described above to produce an ESII data set for each recording. Of primary interest were the cumulative distributions of ESII values from each location. Analysis of these distributions quickly revealed that the ESII values for communication distances of 5 and 10 meters were uniformly low, often 0.00. Consequently, these two communication distances were not included in the subsequent analyses.

Discussion

The 185 ESII data sets represent measurements and analyses from 12 different locations at 36 different jails. The size of each data set, as well as the number of data sets from each location and each facility, varied in an unsystematic manner, complicating interpretation of the analyses. These considerations made it necessary to pool and weight the ESII data sets to control these unsystematic variations. The next step in the research strategy addressed these considerations.

STEP 9: LIKELIHOOD ESTIMATES OF EFFECTIVE SPEECH COMMUNICATION

The ninth step in the research strategy was to estimate the likelihood of effective speech communication for noise environments throughout a typical day in adult detention facilities.

Background and Rationale

One of the primary observations by the research staff about the noise levels observed during the recordings was that these levels appeared to be directly related to the number of individuals present at the location where the recordings were being made. In other words, the primary noise source for many locations was the sound produced by individuals. The more individuals present, the greater the noise level. Since it was not possible to accurately determine, especially after the fact, the number of individuals present during recordings, the rated capacity of the facility where the recordings were made was used instead as an estimate of the number of individuals present.

In addition, there were varying numbers of recordings at the same location from different facilities. For example, one facility might have only 2 recordings from housing while another facility might have 5 recordings. Thus, it was necessary to weight the ESII data from each facility equally in determining the composite ESII data for each location.

Finally, the distribution of rated capacity for the sample of 36 facilities did not match the distribution of rated capacity for the 226 adult facilities throughout the State. These considerations made it necessary to utilize a stratified sampling plan that controlled the weighting of ESII data from facilities with different numbers of recordings and different rated capacities. The methods used to achieve appropriate weighting are described below.

Once the stratified samples of ESII data for each of the 12 locations had been formed and pooled, these data from each location were again pooled to provide a single, overall estimate of the likelihood of effective speech communication throughout the typical day of an Adult Corrections Officer. The data from each location were weighted according the proportion of incidents reported per location. (See Step 2: Incident Report Analysis.)

Methodology

The following process was repeated for each of the 12 locations given in Table 9. The first step in forming the stratified sample of ESII data sets was to equally weight the data from each facility. For example, there were 85 ESII data sets produced from recordings in housing locations at 31 different facilities. The data sets from facilities where more than one recording was made were averaged to produce a single ESII data set for each facility. In the case of housing, this produced 31 ESII data sets, since no recordings were made in housing locations at 5 of the facilities.

The second step was to group the data sets according to the rated capacity of the facilities from which they originated. The 36 facilities in the sample were divided into four groups of approximately equal size. The facility names, number of recordings per facility, and rated capacity of each facility are reported in Appendix F.

Table 11 shows that the first group was comprised of facilities with rated capacities of 300 or less. Of all local jails, 54% fall within this range. The second group from the sample consisted of facilities with rated capacities of 300 to 450. Of all local jails, 14% are in this range. The third group included facilities with rated capacities of 451 to 1000, which represents 20% of all local jails. Finally, the fourth group includes facilities with rated capacities greater than 1000, representing 12% of all local jails.

Table 11: Distribution of Rated Capacity in Sampled Jails and in all Local Jails

Rated capacity	Sample jails	Percent of all jails
<300	9	54%
300-450	8	14%
451-1000	10	20%
>1000	9	12%

The third step was to average the ESII data sets from the facilities in each capacity group to produce a single data set for each capacity group. For example, the ESII data sets were averaged from the 9 facilities in the first group with rated capacity less than 300.

The fourth step was to weight the four ESII data sets representing each capacity group by the percent of local jails falling within that group. Again, for example, the values in the data set representing the first group were multiplied by 0.54. The weighted values in the four ESII data sets were then summed to produce a single data set for the location, based on a representative sample of facilities throughout the state. This process was repeated for each of the 12 locations.

The fifth step was to combine the ESII data sets for each location in a manner that represents the hearing requirements for the typical day of an Adult Corrections Officer. The data sets from each location were weighted according to the proportion of reported incidents involving hearing that occurred at these locations. (See Step 2: Incident Report Analysis.) These proportions were calculated from the 424 incident reports analyzed for this study. Absolute proportions were used as weights for locations with 2% or more of all reported incidents. The remaining unallocated proportion of incidents was divided equally among the locations with less than 2% of incidents.

The final step involved accessing the ESII data sets for each location to determine the likelihood of effective speech communication at each location, given a specified ESII value. For example, otologically normal individuals require an ESII of 0.30 or greater for effective communication. The proportion of 4 second segments that exceed 0.30 in the ESII data sets for each location was determined, and these proportions were weighted by the proportions for each location defined in the previous analysis step. The sum of the products of these two proportions over the 12 locations gives the overall likelihood of effective speech communication throughout an Adult Corrections Officer's typical day.

Results

Table 12 summarizes the results of the pooling and weighting process. The weights in column 4 are based on the proportion of reports from each location describing incidents that involved hearing-critical job functions. Yard, for example, was weighted 0.02, and kitchen areas received a weight of 0.01. Housing received a weight of 0.67, the largest weight allocation for any of the locations, reflecting the importance of hearing-critical job functions performed in and around the housing area.

The final columns in Table 12 provide the likelihood of effective speech communication at a close distance of 0.5 meters under different levels of vocal effort. The levels of vocal effort represented are normal voice, raised voice, loud voice, and shouted voice.

To illustrate how to read the information in Table 12, consider booking. The pooled ESII data for this location was from 12 different recordings made at 6 different facilities. The likelihood of effective speech communication using normal vocal effort at a distance of 0.5 meters is 0.92. This likelihood increases to 1.0 for loud vocal and shouted vocal effort. These likelihood values are weighted by 0.17 when combined with the other weighted likelihood values to produce the overall estimate of the likelihood of effective speech communication throughout an entire day. In the example shown in the table, the overall likelihood estimate is 0.74 when normal vocal effort is used. This value increases to higher likelihoods as vocal effort is increased, and reaches 0.99 with shouted vocal effort.

Table 12: Results of Pooling and Weighting Process

Locations selected to comprise the routine day of an Adult Corrections Officer for communication at a distance of 0.5 meters. Shaded cells represent locations with fewer than 2% of the incidents and were assigned equal weights of 0.0067.

Location	Facilities	Recordings	Weight	N	R	L	S
Housing	31	85	0.67	0.72	0.97	1.00	1.00
Booking	6	12	0.17	0.92	0.98	1.00	1.00
Movement	10	13	0.05	0.68	0.97	1.00	1.00
Kitchen	18	22	0.01	0.00	0.05	0.73	1.00
Medical	3	5	0.01	0.94	1.00	1.00	1.00
Control booth	12	17	0.03	0.91	1.00	1.00	1.00
Yard	3	3	0.02	0.86	0.98	1.00	1.00
Dining hall	8	13	0.01	0.82	0.93	1.00	1.00
Laundry	9	11	0.01	1.00	1.00	1.00	1.00
Vocational	2	2	0.01	0.30	0.64	0.78	1.00
Gym	2	2	0.01	0.41	1.00	1.00	1.00
Overall		**185**	**1.00**	0.74	0.95	0.98	0.99

Note. For Vocal Effort: N = Normal; R = Raised; L = Loud; S = Shouted.

Discussion

The results of pooling and weighting the ESII data sets to estimate the likelihood of effective speech communication throughout an Adult Corrections Officer's routine day provide several objective insights into the hearing requirements for the job. The data in Table 12, which apply only to otologically normal Adult Corrections Officers, reveal that even these individuals do not experience a high likelihood of effective speech communication at all times. For example, speech produced with normal vocal effort is likely to result in effective communication only 73% of the time throughout the day. This likelihood increases to 95% with raised vocal effort, and reaches 98-99% with loud or shouted speech. In the noisiest locations, e.g., kitchen, only loud or shouted speech at short distances results in effective speech communication. In the location with the highest weight, i.e., housing, raised or loud vocal effort usually can result in effective speech communication.

Effective speech communication is challenging for all Adult Corrections Officers at numerous times and locations throughout the routine day. However, it may be even more challenging more often for hearing impaired individuals. The next step in the research strategy was to examine how hearing impairment, as measured by elevation of the speech reception threshold in noise, affects the likelihood of effective speech communication in the challenging noise environments where Adult Corrections Officers must perform hearing-critical job functions that include communication with speech.

STEP 10: IMPACT OF HEARING IMPAIRMENT ON LIKELIHOOD ESTIMATES

The tenth step in the research strategy was to determine the impact of hearing impairment on the likelihood of effective speech communication.

Background and Rationale

The ESII calculations described above apply to otologically normal individuals (American National Standards Institute, 2007). These calculations show that even with normal hearing, the likelihood of effective speech communication in some locations and on average throughout an Adult Corrections Officer's routine day is not always high. Thus, the question becomes how hearing impairment affects the likelihood of effective speech communication.

Hearing impairment can be quantified in terms of the need for more favorable signal/noise ratios (SNRs) to understand speech when both the speech and noise are audible, as determined by elevation of the speech reception threshold (SRT) in noise above normal. The effects of elevated SRTs are determined as follows. An individual whose SRT is elevated above normal requires a larger ESII value for effective speech communication (Houtgast & Festen, 2008). For example, an otologically normal individual requires an ESII of 0.30 or better for effective speech communication. However, an individual whose SRT is 1 dB higher (poorer) than the average requires an ESII of approximately 0.33 for effective speech communication. In other words, the ESII required for effective speech communication increases by about 0.03 for every 1 dB increase in SRT. Thus, the effects of elevated SRTs on the likelihood of effective speech communication are determined from the distribution of elevated ESII values corresponding to elevated SRTs of different magnitudes. Using this approach, research staff calculated the effects of hearing loss on the likelihood of effective speech communication throughout an Adult Corrections Officer's routine day for different magnitudes of SRT elevation.

Methodology

Research staff calculated ESII for each hearing loss configuration using four levels of vocal effort (normal, raised, loud, shouted) and two communication distances (0.5 meter and 1.0 meter). These calculations were used to determine the likelihood of effective speech communication for each set of parameters and each hearing loss configuration, given normal SRTs. Greater communication distances were not included because even individuals with normal pure-tone thresholds and normal SRTs had very low likelihoods of effective speech communication at these distances.

The previous ESII calculations for otologically normal individuals were used to determine how the likelihood of effective speech communication decreases as SRTs increase, thus increasing the magnitude of the ESII required for effective communication. These analyses were performed using two different sets of ESII data. First, the ESII data from the locations throughout the typical day, as weighted by the proportion of incident reports from each location that involved hearing, were analyzed to determine the effects of increased SRTs on the likelihood of effective speech communication throughout the day over locations. Second, the ESII data from only the Housing location, where the majority of incidents (67%) involving hearing occurred, were analyzed.

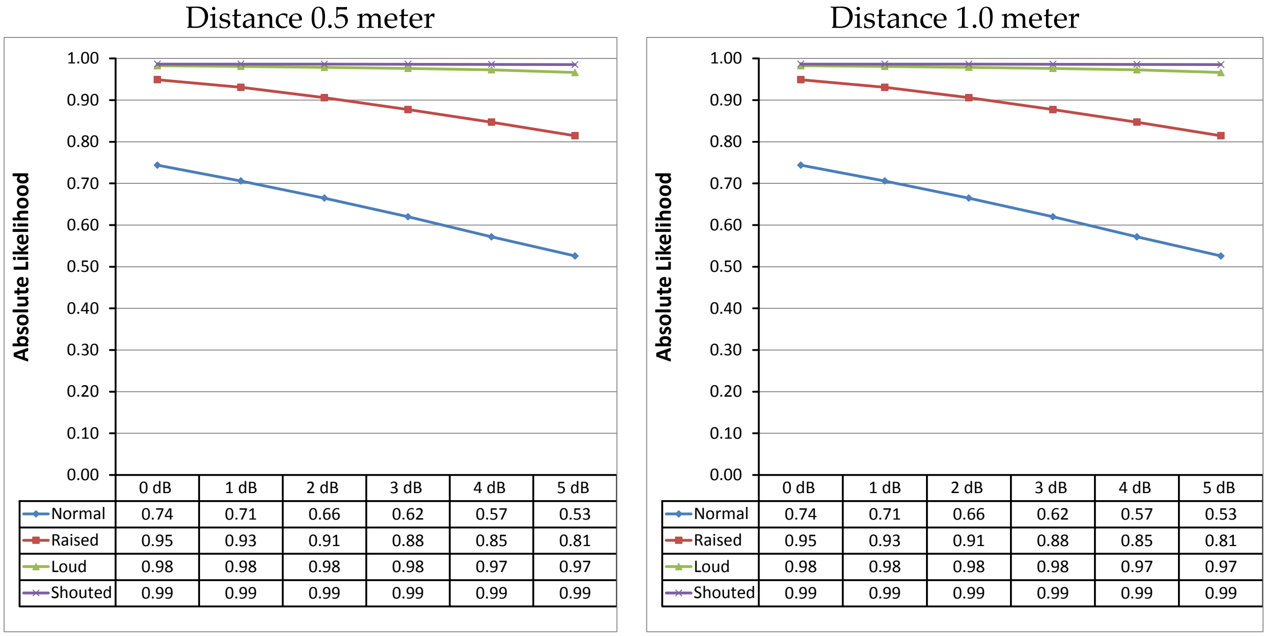
Results

The results of these analyses are reported in several sets of charts. The first set of charts displays the estimated absolute likelihood of effective speech communication at 0.5 and 1.0 meter communication distances for the entire typical day of the Adult Corrections Officer and for the Housing location. Four traces are plotted on each chart corresponding to Normal, Raised, Loud, and Shouted vocal effort. These traces are plotted as a function of SRT elevation over that of the average otologically normal individual. Likelihood estimates for threshold elevations of 1 dB, 2 dB, 3, dB, 4 dB, and 5 dB are reported.

The second set of charts is based on the first set and reports the proportional likelihood of effective speech communication under all of the same conditions as in the first set. Proportional likelihood for each condition is defined as likelihood expressed as a proportion in relation to the absolute likelihood seen for an otologically normal individual. For example, if an otologically normal individual is estimated to have 0.80 absolute likelihood of effective speech communication using normal vocal effort at a communication distance of 1.0 meter and an individual with an elevated SRT is estimated to have 0.60 absolute likelihood of effective speech communication under these same conditions, the proportional likelihood is 0.75 = 0.60/0.80. This method of calculating proportional likelihood takes into consideration that in noisy locations even otologically normal individuals may find effective speech communication difficult. Proportional likelihood quantifies deficits in speech communication associated with SRT elevation not on an absolute scale, but in relation to the expected performance of otologically normal individuals.

Effects of SRT Elevation on Estimates of Absolute Likelihood

Figure 7 displays estimates of absolute likelihood of effective speech communication at distances of 0.5 meter (left panel) and 1.0 meter (right panel) throughout an Adult Corrections Officer's typical day. Note that using normal vocal effort even at the shortest communication distances does not result in more than 0.75 likelihood of effective communication. This likelihood decreases systematically with SRT elevation. At the shortest communication distance, raised vocal effort has greater than 0.90 likelihood of effective communication regardless of SRT elevation. At 1.0 meter the likelihood for otologically normal is about 0.80, but decreases to less than 0.60 for individuals with elevated SRTs. Loud and shouted vocal effort is highly effective at both communication distances, regardless of SRT elevation. These high levels of vocal effort, however, may not be appropriate in many situations.



Distance 0.5 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	0.74	0.71	0.66	0.62	0.57	0.53
Raised	0.95	0.93	0.91	0.88	0.85	0.81
Loud	0.98	0.98	0.98	0.98	0.97	0.97
Shouted	0.99	0.99	0.99	0.99	0.99	0.99

Distance 1.0 meter

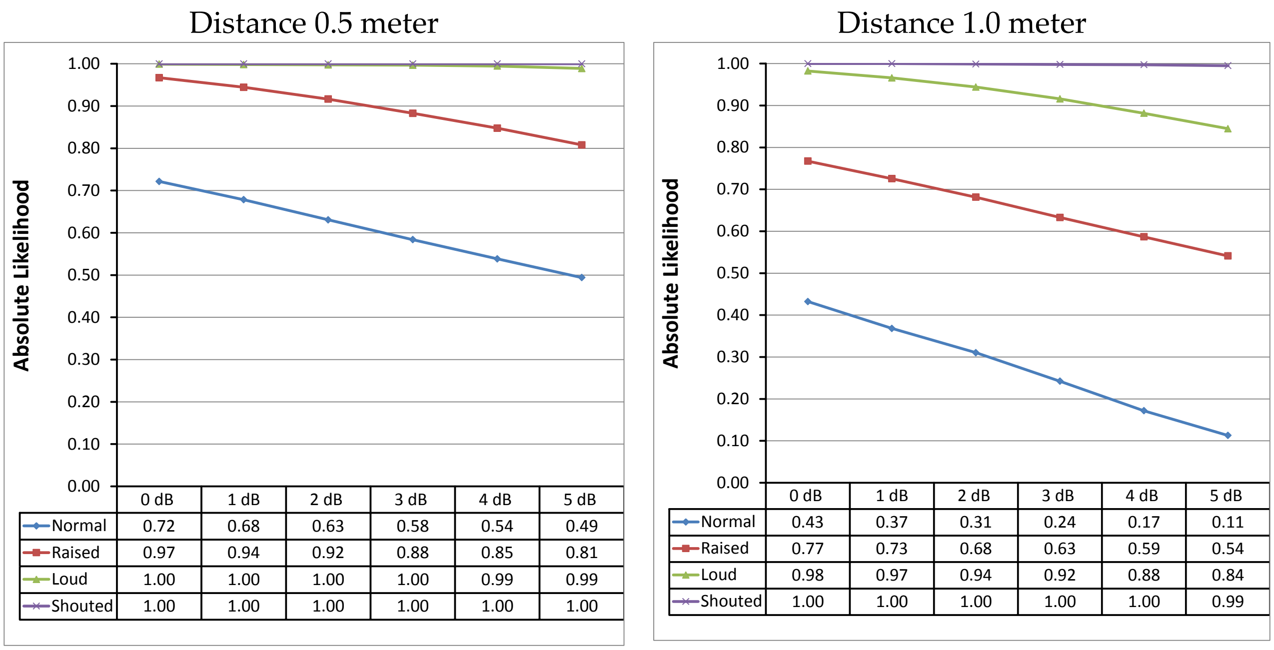
	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	0.74	0.71	0.66	0.62	0.57	0.53
Raised	0.95	0.93	0.91	0.88	0.85	0.81
Loud	0.98	0.98	0.98	0.98	0.97	0.97
Shouted	0.99	0.99	0.99	0.99	0.99	0.99

Figure 7: Estimates of Absolute Likelihood of Effective Speech Communication Throughout an Adult Corrections Officer's Typical Day

The left panel of Figure 7 displays results for communication distances of 0.5 meters, and the right panel displays estimates for communication distances of 1.0 meters. The vertical axes display the likelihood of effective speech communication. The horizontal axes display the SRT in dB expressed in relation to the average threshold for otologically normal individuals. The four traces in each chart display the absolute likelihood of effective speech communication using normal, raised, loud, and shouted vocal effort as a function of SRT elevation.

The absolute likelihood of effective speech communication at 0.5 to 1.0 meter communication distances for otologically normal individuals using normal vocal effort was between approximately 0.70 and 0.40, depending on communication distance. Raised vocal effort improved the likelihood to approximately 0.75-0.95, while loud and shouted vocal effort was entirely effective. As SRT elevation increased to 5 dB over that of otologically normal individuals, likelihoods decreased systematically to as much as 0.50 at 0.5 meter and 0.20 at 1 meter. Thus, the effects of SRT elevation on the likelihood of effective speech communication are evident in this location where even otologically normal individuals require raised or loud vocal effort to communicate effectively even at short distances.

Figure 8 displays estimates of absolute likelihood of effective speech communication for only Housing locations in the same manner as in Figure 7. Note that 67% of incidents involving hearing took place in Housing locations, causing the ESII data set from Housing to receive a weight of 0.67. Only one of the weights (Booking) for the remaining 11 conditions exceeded 0.10. Thus, the noise environment in a typical day is dominated by the noise environments found in Housing locations, which causes the pattern of results in Figures 7 and 8 to appear almost identical.



Distance 0.5 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	0.72	0.68	0.63	0.58	0.54	0.49
Raised	0.97	0.94	0.92	0.88	0.85	0.81
Loud	1.00	1.00	1.00	1.00	0.99	0.99
Shouted	1.00	1.00	1.00	1.00	1.00	1.00

Distance 1.0 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	0.43	0.37	0.31	0.24	0.17	0.11
Raised	0.77	0.73	0.68	0.63	0.59	0.54
Loud	0.98	0.97	0.94	0.92	0.88	0.84
Shouted	1.00	1.00	1.00	1.00	1.00	0.99

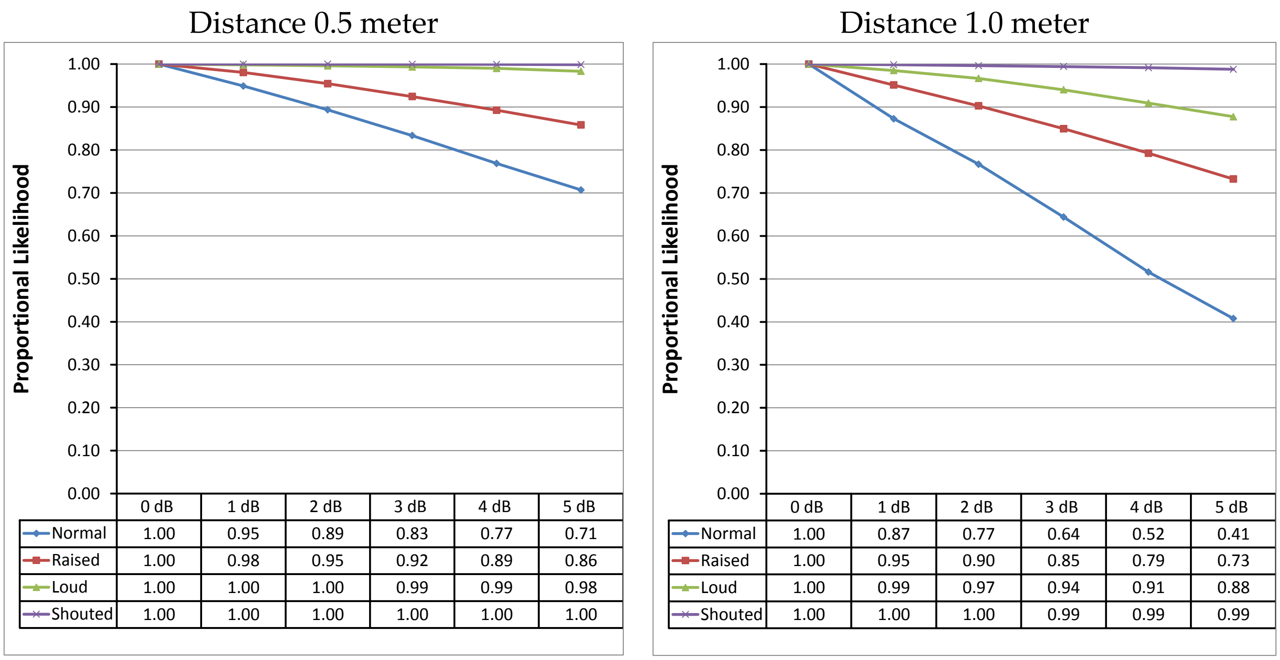
Figure 8: Estimates of Absolute Likelihood of Effective Speech Communication in Housing Locations

See Figure 7 caption for details.

Effects of SRT Elevation on Estimates of Proportional Likelihood

Figure 9 displays estimates of proportional likelihood of effective speech communication at distances of 0.5 meter (left panel) and 1.0 meter (right panel) throughout an Adult Corrections Officer's typical day. These charts differ from the comparisons of absolute likelihoods shown in that all likelihood values are expressed as proportions of the absolute likelihood for otologically normal individuals using the same vocal effort. Proportional likelihood values for normal vocal effort at 0.5 meter communication distances decrease to about 0.70 with increasing SRT elevation. However, with raised vocal effort they only drop to about 0.90. Note, though that the absolute likelihood of effective speech communication using normal vocal effort at 0.50 meter is only about 0.75.

A similar pattern is seen at 1.0 meter communication distances. The proportional likelihood of effective speech communication decreases to about 0.50 for normal vocal effort as SRTs increase. Decreases to about 0.75 are seen for raised vocal effort, 0.90 for loud vocal effort, and 0.98 for shouted vocal effort. The decreasing patterns of proportional likelihoods are more similar for the two communication distances than are the patterns for absolute likelihoods seen in Figures 7 and 9: Estimates of proportional likelihood of effective speech communication throughout an Adult Corrections Officer's routine day. The left panel displays results for communication distances of 0.5 meter, and the right panel displays estimates for communication distance of 1.0 meter. The vertical axes display the proportional likelihood of effective speech communication. The horizontal axes display the SRT in dB expressed in relation to the average threshold for ontologically normal individuals. The four traces in each chart display the proportional likelihood of effective speech communication using normal, raised, loud and shouted vocal effort as a function of SRT elevation.



Distance 0.5 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	1.00	0.95	0.89	0.83	0.77	0.71
Raised	1.00	0.98	0.95	0.92	0.89	0.86
Loud	1.00	1.00	1.00	0.99	0.99	0.98
Shouted	1.00	1.00	1.00	1.00	1.00	1.00

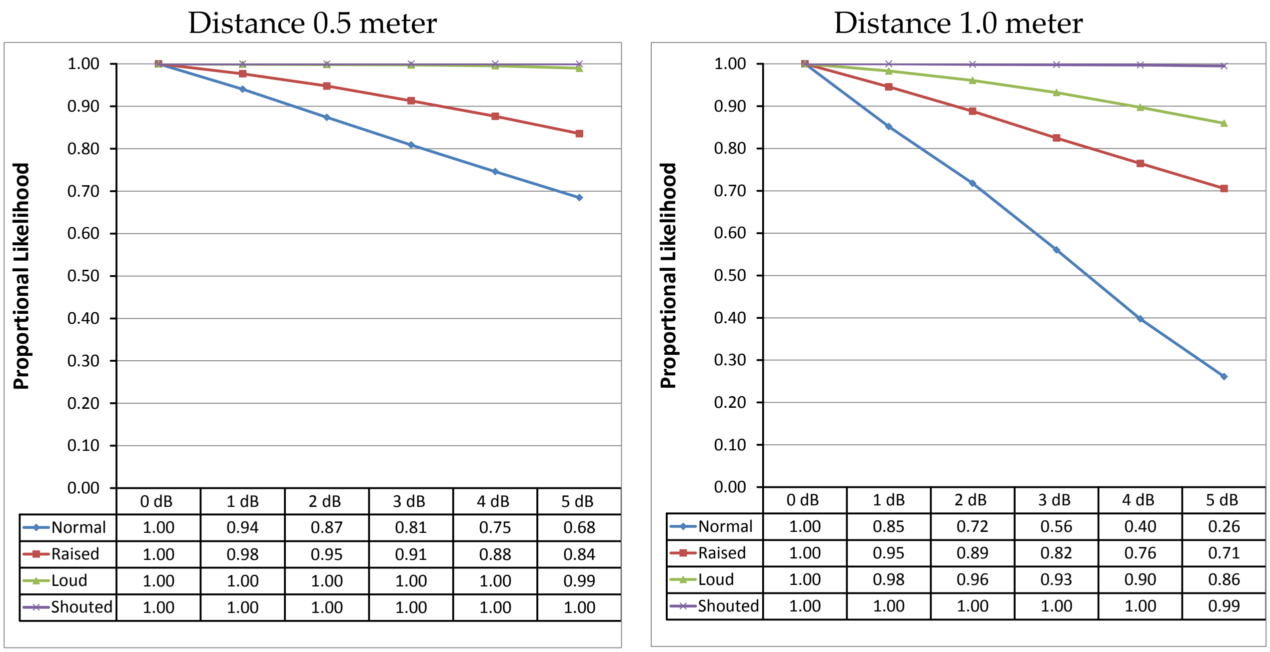
Distance 1.0 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	1.00	0.87	0.77	0.64	0.52	0.41
Raised	1.00	0.95	0.90	0.85	0.79	0.73
Loud	1.00	0.99	0.97	0.94	0.91	0.88
Shouted	1.00	1.00	1.00	0.99	0.99	0.99

Figure 9: Estimates of Proportional Likelihood of Effective Speech Communication Throughout an Adult Corrections Officer's Typical Day

The left panel displays results for communication distances of 0.5 meters, and the right panel displays estimates for communication distances of 1.0 meters. The vertical axes display the proportional likelihood of effective speech communication. The horizontal axes display the SRT in dB expressed in relation to the average threshold for otologically normal individuals. The four traces in each chart display the proportional likelihood of effective speech communication using normal, raised, loud, and shouted vocal effort as a function of SRT elevation.

Figure 10 displays estimates of proportional likelihood of effective speech communication for only Housing locations in the same manner as in Figure 8. As stated above, 67% of incidents involving hearing took place in Housing locations, causing the ESII data set from Housing to receive a weight of 0.67. As with the absolute likelihood values, the pattern of proportional likelihood results for Housing and for the typical day are highly similar.



Distance 0.5 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	1.00	0.94	0.87	0.81	0.75	0.68
Raised	1.00	0.98	0.95	0.91	0.88	0.84
Loud	1.00	1.00	1.00	1.00	1.00	0.99
Shouted	1.00	1.00	1.00	1.00	1.00	1.00

Distance 1.0 meter

	0 dB	1 dB	2 dB	3 dB	4 dB	5 dB
Normal	1.00	0.85	0.72	0.56	0.40	0.26
Raised	1.00	0.95	0.89	0.82	0.76	0.71
Loud	1.00	0.98	0.96	0.93	0.90	0.86
Shouted	1.00	1.00	1.00	1.00	1.00	0.99

Figure 10: Estimates of Proportional Likelihood of Effective Speech Communication in Housing Locations
See Figure 9 caption for details.

Discussion

These analyses provide a number of important insights as to how hearing impairment, as measured by elevated SRTs, affects the likelihood of effective speech communication throughout an Adult Corrections Officer's typical day. First, it is evident that even those officers who are otologically normal are limited in the effectiveness of their speech communication because of background noise levels. This is true throughout the typical day, which is dominated by activities in Housing locations, and is especially so in the noisiest spots encountered during the typical day, such as Outdoor Recreation, Gym, and Kitchen locations.

Second, because of the background noise levels, Adult Corrections Officers must use raised or loud vocal effort to ensure effective speech communication, except at the shortest communication distances. As communication distances increase, officers must rely on radios or other means of electronic communication.

Proportional likelihood measures are perhaps more important than absolute likelihood measures in evaluation of the effects of hearing loss on the ability to perform the hearing-critical job functions of an Adult Corrections Officer. These measures express the hearing impaired individual's ability to perform such functions relative to the abilities of otologically normal individuals. Thus, they do not directly reflect the difficulties that even individuals with normal hearing encounter in the high background noise environments found at times in jails. However, when individuals with normal hearing encounter situations where the likelihood of effective communication is reduced substantially, even small additional reductions caused by hearing impairment may compromise safety and effectiveness by an unacceptable amount.

As SRTs become elevated due to hearing impairment, larger values of ESII are required for effective speech communication. The likelihoods for most levels of vocal effort decrease consistently with increasing SRT elevation, as compared with normally hearing individuals. For example, proportional likelihoods for raised or loud vocal effort drop below 0.90 in most of the analyses as SRTs increase. These considerations indicate that SRT elevation is a sensitive indicator of reduced likelihood of effective speech communication suitable for use in hearing screening.

HEARING GUIDELINES

Background

The data and analyses reported above that describe the effects of SRT elevation on the likelihood of effective speech communication throughout an Adult Corrections Officer's routine day indicate that normal vocal effort does not always result in effective speech communication, even at communication distances of 0.5 meter. Raised vocal effort is more effective at 0.5 meter distances, as are loud and shouted vocal effort at both distances.

These considerations indicate that SRT elevations having relatively small effects on the likelihood of effective speech communication should be used as screening criteria. This is because even individuals with normal SRTs do not have high likelihoods of effective speech communication in all noise environments in adult detention facilities. At the same time, however, the screening criteria cannot be so restrictive that individuals with normal hearing are excluded. Both of these considerations can be satisfactorily addressed by selecting screening criteria that do not exclude individuals with normal hearing and that result in only small reductions in the likelihood of effective speech communication.

Hearing screening of applicants and incumbents for jobs with hearing-critical tasks requires a measure of hearing impairment that is objectively related to the ability to perform these tasks. The Hearing in Noise Test (HINT) has been shown to provide such a measure. The HINT was initially developed as a general research and clinical tool to measure hearing impairment in a number of listening conditions that allow one to determine a subject's ability to understand and effectively communicate with speech in quiet and in noise. Listening conditions include measures of binaural ability, which are important for understanding speech in noise. The HINT Occupational Screener Technology (HOST) is a specialized adaptation of the general research and clinical tool used in the past. The HOST system is an effective and efficient method to screen applicants for Adult Corrections Officer[2] position.

Hearing Screening Protocol and Criteria

The Standards and Training for Corrections Hearing Guidelines specify two hearing screening criteria based on the HINT Composite Speech Reception Threshold (SRT) measured in noise and the SRT measured in quiet. The screening criterion defined by the Composite SRT in noise is based on the need for effective speech communication in the background noise environments where hearing-critical job functions are performed throughout an Adult Corrections Officer's routine day and during responses to incidents.

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[2] Position titles vary among local jurisdictions and may include Deputy Sheriff, Detention Officer, Custody Assistant, etc.

The screening criterion based on the SRT measured in quiet is based on the additional need to understand soft and whispered speech, as well as speech originating from behind doors or through windows.

The screening protocol consists of the Hearing in Noise Test administered in four test conditions, Quiet, Noise Front, Noise Right, and Noise Left. These test conditions are administered under headphones semi-automatically by the HINT Occupational Screener Technology (HOST). Testing can be done in a quiet room without visual distractions. The complete protocol can usually be administered in less than 20 minutes. Under all scenarios, devices that are used for testing will be run through a calibration procedure.

In each test a different list of 20 sentences is presented in random order in quiet or in the presence of a reference noise. For tests in noise the presentation level of the noise remains fixed at 65 dB (A), and the level of each sentence is adjusted automatically by the HOST, depending on whether the previous sentence was repeated correctly. The average presentation level of all sentences after the first four sentences defines the speech reception threshold for the test condition.

During a HINT test in noise, headphone signals for the left and right ears are processed to simulate the spatial location of the speech and noise sources. This simulation has been validated on multiple occasions. In the Noise Front condition, the speech and noise sources are co-located directly in front of the subject. In the Noise Right condition, the speech remains in front and the noise is located 90° to the right, and in the Noise Left condition, the speech remains in front and the noise is located 90° to the left.

The screening criterion for effective speech communication in noise is based on the elevation of the applicant's HINT Composite SRT above the average for otologically normal individuals. The average Composite SRT, expressed as a speech-to-noise ratio or SNR, is -6.4 dB SNR which defines the norm for individuals with normal hearing (Soli & Wong, 2008). The screening criterion is a HINT Composite SRT **of -4.0 dB SNR** or less. By placing the screening criterion at 2.4 dB SNR above the norm, over 99% of otologically normal individuals are expected to obtain passing scores. SRTs in noise are to be measured with the noise level fixed at **65 dB (A)**. The screening criterion for speech communication in noise may also be expressed as a HINT composite threshold of **61 dB (A)** or less. The preceding analyses indicate that a hearing impaired applicant who fails to meet this screening criterion is likely to have at least 15% less effective speech communication in noise throughout a typical workday as an Adult Corrections Officer, as compared with an otologically normal individual.

The hearing screening guideline for speech communication in quiet is based on the average level of soft or whispered speech heard at a short distance, 30 dB (A) (Nilsson, 1992;

Goldberg, 2001; Borden, 1984; Ostergaard, 1986). The hearing screening for speech communication in quiet is a HINT SRT in quiet of **27 dB (A)** or less. Over 99% of otologically normal individuals are also expected to obtain passing scores with this screening criterion.

An applicant who fails to meet either or both of the screening criteria may elect to be retested. Only the failed criteria need to be retested. Retesting should be done immediately after initial testing during the same visit. The illustration below displays a flowchart summarizing the retesting procedure. If the applicant fails again on the retest the applicant does not meet the guideline.

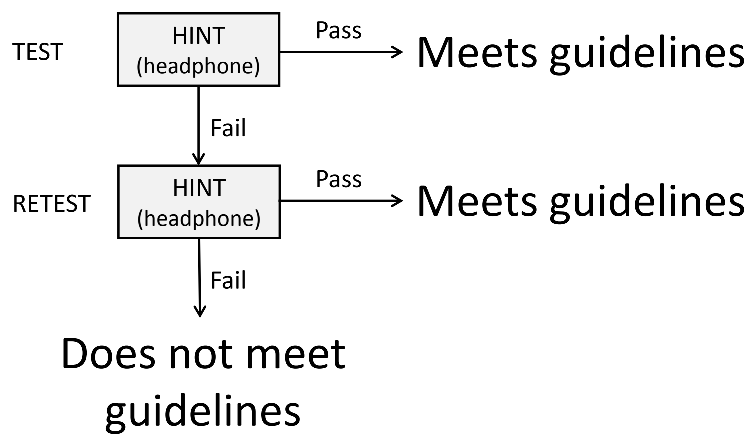

Figure 11: Screening Protocol – Test/Retest Procedure

Supplemental Screening Protocol for Applicants with Auditory Prostheses

Evaluation of Auditory prostheses

An applicant for the job of Adult Corrections Officer may require the use of one or two auditory prostheses, such as hearing aids, to meet the hearing screening criteria established by the hearing guideline. In this case, it will be necessary for the individual to wear and use his or her prostheses at all times on the job.

Test Administration

Supplemental screening should be administered by an audiologist experienced with the type of auditory prostheses used by the applicant.

Sound Field Screening

Prior to administration of the HINT screening protocol, the audiologist must verify that the prostheses are functioning properly and adjusted to physiologically appropriate settings.

Sound field HINT testing is done with the same protocol as headphone HINT testing. An applicant who meets both of the screening criteria during the initial sound field HINT tests meets the guideline. An applicant who fails to meet either or both of the screening criteria can be retested. If the applicant passes the retest the applicant has met the guideline. If the applicant fails again on the retest the applicant has not met the guideline.

Sound field testing must be conducted by an audiologist at a facility with a sound room large enough to conduct the screening protocol in the sound field. Again, the audiologist must verify that the prostheses are functioning properly and adjusted to physiologically appropriate settings. Evidence that the loudspeakers in the sound room have been calibrated within the last year and that the HINT norms have been appropriately adjusted for sound field testing must also be provided together with the printed report summarizing the test results.

The screening criterion for the sound field HINT are the same for the Quiet SRT, 27 dB (A) or less. However, the criterion for the composite SRT must be based on the adjusted sound field composite SRT, and not on the headphone composite SRT. This adjusted criterion is defined as the SNR 2.4 dB above the adjusted sound field composite HINT norm. The HINT test instrument automatically incorporates adjustments to the sound field norms after data have been input to achieve the appropriate adjustments.

The Hint Occupational Screener Technology (Host) System

As noted above, the HOST system is a specialized adaptation of the Hearing in Noise Test (HINT) for occupational screening. There are several features of this adaptation that are intended to make the HINT screening evaluations more portable, simpler, and more efficient, while ensuring the integrity of the data and test results used to make screening decisions. One of the advantages of the HOST system design is that it will enable users to minimize capital equipment costs at individual test facilities.

At the time of this report, the sole licensed distributor for the HOST system is Hearing Test Systems. Contact information is as follows:

HEARING TEST SYSTEMS
1395 Garden Highway, Suite 250
Sacramento, CA 95833
www.hearingtest.pro
jhart@hearingtest.pro
916-580-9644

Selecting Hint Testing Facilities

Should an agency wish to obtain HINT testing through a facility or vendor other than those served by HTS (above), the agency should ensure that the following criteria are met:

- The HINT screening is conducted for pre-employment screening, not clinical or diagnostic evaluations.
- The entity that administers the test uses the current version of HINT.
- The HINT instrumentation is calibrated correctly and maintained appropriately.
- Testing is conducted in accordance with HIPAA.
- Test reports are available to the hiring agency in a secure and controlled manner.
- Test administrators have been trained in the correct use of HINT for pre-employment screening and the Standards and Training for Corrections Hearing Guidelines.

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Appendix B: Questions Posed to Panels of Subject Matter Experts

SME Question
Was the task speech or non-speech?
Speech Only Inquiries
Was the voice level a whispered/softly spoken, normal, raised, or shouted level?
How much of the message did you understand?
Low- Did not hear enough of the message to figure it out
Medium- Understood the general idea of the message, but missed most of the details
High- Understood most of the message
Could the message be repeated?
Non-speech Only Inquiries
What did you know about the sound?
Detection- Heard something
Low- Uncertain (thought I heard something)
Medium- Moderately certain (heard something)
High- Certain (certain of what I heard)
Recognition- Heard and knew what I heard
Low- Uncertain (thought I heard something)
Medium- Moderately certain (heard something)
High- Certain (certain of what I heard)
Location- Knew where the sound came from
Low- Uncertain about the direction that the sound came from
Medium- Know the very general direction of where the sound came from
High- Know within a narrow margin the direction where the sound came from
Location and Recognition- Heard and knew where the sound came from
How loud was the sound? (Soft, Medium, or Loud)
How frequent was the sound? (Single, Continuous, or Intermittent)
Speech and Non-speech Inquiries
How far away (in feet) was the sound?
Was the sound source visible?
How loud was the background noise? (Quiet, Medium, or Loud)
What was your overall effort to hear? (Low, Medium, or High)

APPENDIX C: SUPPLEMENTAL RESULTS FROM SUBJECT MATTER EXPERT PANELS

Table C-1: Hearing of Speech vs. Non-Speech Sounds

Number and percent of hearing-critical job functions: shows speech communication as well as detection and recognition of non-speech sounds.

Sound Type	Routine Day	Incident	Total	% of Total
Speech	15	12	27	71%
Non-Speech	6	5	11	29%
Total	21	17	38	100.0%

Table C-2: Vocal Effort

Vocal effort used to communicate with speech during a routine day and during responses to incidents.

Effort	Routine Day N=23	Incidents N=7
Whisper/Softly Spoken		
Normal	53.3%	25.0%
Raised	40.0%	41.7%
Shout	6.7%	33.3%

Table C-3: Repetition Opportunity

Opportunity to repeat speech communications during a routine day and during responses to incidents.

Repetition	Routine Day N=15	Incidents N=12
Yes	66.7%	75.0%
No	33.3%	25.0%

Table C-4: Estimated Background Noise Levels

Judged background noise levels while speech and non-speech functional hearing abilities were used during a routine day and during responses to incidents.

	Speech		Non-speech	
Noise Level	Routine Day N=15	Incidents N=12	Routine Day N=6	Incidents N=5
Quiet	20.0%	25.0%	16.7%	40%
Medium	73.3%	66.7%	66.7%	40%
Loud	6.7%	8.3%	16.7%	20%

Table C-5: Visibility of Sound Source

Visibility of the sound source for routine day and incidents.

Visible	Routine Day N=21	Incidents N=17
Yes	57.1%	11.8%
No	42.9%	88.2%

Table C-6: Hearing Effort

Effort necessary to perform speech and non-speech functional hearing abilities during a routine day and during responses to incidents.

	Speech		Non-speech	
Hearing Effort	Routine Day N=15	Incidents N=12	Routine Day N=6	Incidents N=5
Low	26.7%	83.3%	66.7%	80.0%
Medium	47.7%	8.3%	33.3%	20.0%
High	26.7%	8.3%	0.0%	0.0%

Appendix D: Methodology for Making On-Site Calibrated Sound Recordings

All recordings were made using a hand-held digital audio recorder, the Edirol R-09HR manufactured by Roland. Recordings were made in stereo using the built in microphones on the device. The sampling rate was set to 44.1 kHz, and the sampling word length was set to 24 bits. According to the manufacturer's specifications, the microphones exhibit a uniform polar plot with directional variations in sensitivity of less than 3 dB. The manufacturer's specification also state that the microphone's frequency response is flat from 50 Hz up to 8 kHz, although this did not prove to be the case during calibration measurements. Recordings were stored on an SD memory card and later transferred to a personal computer for processing and analysis.

The field recordings from each location at each facility were manually edited to remove spoken comments by the individuals making the recordings and comments by Adult Corrections Officers and other jail staff. A free waveform editing software tool, Audacity (Version 1.2.6), was used to excise comments from each recording, leaving only the background noise for subsequent analysis. The remaining background noise often consisted of the voices of staff and inmates in addition to the sounds of equipment and other sounds typically present in those environments.

Appendix E: Calibration Procedures

Calibration of the recorder was done with the microphone sensitivity set to "high" and input gain set to "40," which is midrange on a scale with a maximum setting of 80. Automatic gain control and compression features of the recorder were turned off at all times (the Edirol R-09HR is designed for recording live music, and thus is capable of sampling high sound pressure levels over a wide dynamic range). Calibration was performed using a Fonix 7000 Hearing Aid Analyzer manufactured by Frye Electronics. The recorder was turned on and placed in the Fonix test box. A 1 kHz pure tone was presented at 80 dB SPL and recorded for approximately 2 minutes. This recording was transferred to computer via the SD memory card, and its root mean square (RMS) level was calculated using Matlab. The RMS level expressed in dB corresponds to 80 dB SPL and to 80 dB (A), since dB SPL and dB (A) are equivalent at 1 kHz.

A second set of calibration recordings at different frequencies was made using the same procedure described above. Pure tones at 80 dB SPL were presented at 100 Hz intervals ranging from 100-1000 Hz and at 1000 Hz intervals ranging from 1000-8000 Hz (these are the intervals and frequencies that the Fonix system is capable of producing). The RMS values for these recordings revealed that the microphone frequency response was flat up to about 2 kHz, and then decreased by about 6 dB per octave up to 8 kHz.

The frequency-specific calibration recordings were used in two different ways. First, they provided the information necessary to convert RMS values to dB SPL for each of the 18 1/3 octave band filter outputs used to calculate SII and ESII. A total of 9 of the 18 center frequencies for these filters correspond to calibration frequencies measured with the Fonix system, with the lowest being 200 Hz and the highest 8000 Hz. Calibrations for the remaining 9 filter outputs were obtained by extrapolation.

The second use of the frequency-specific calibration recordings was to specify the frequency response for a modified A-weighted filter that could be used both to apply A-weighting and pre-emphasis to the recordings so that accurate L(eq) values could be calculated for each recording. L(eq) is expressed in dB (A) and is the long term RMS of the recording after A-weighted filtering. Use of a standard A-weighted filter to obtain the L(eq) for the current recordings would underestimate the true L(eq) because of the roll off in the frequency response of the microphone above 2 kHz. Thus, a modified A-weighted filter was designed with a frequency response matching the specifications for A-weighting up to 2 kHz. Above this frequency, 6 dB per octave of pre-emphasis was added to the specifications for A-weighting. Application of this pre-emphasis gain did not cause saturation in any of the recordings.

APPENDIX F: DETAILED SUMMARY OF SOUND RECORDINGS

A total of 185 recordings were made at the specified locations from the 36 facilities. The details describing these recordings are presented Table I-1. The recordings are organized according to location within the facilities. Within locations the recordings are grouped according to the rated capacity of the facility. Facilities with a rated capacity ≤ 300 are coded Q1. Facilities with a rated capacity > 300 and ≤ 450 are coded Q2. Facilities with a rated capacity > 450 and ≤ 1000 are coded Q3, and facilities with a rated capacity > 1000 are coded Q4. The date and time of the recording and the facility where the recording was made are given in the left columns of the table.

The table also describes the general area where the recording was made (e.g., "control booth") and the specific location of the recording within the general area. The activity in progress at the time of the recording is also given. This information was noted on a recording log that was completed at the time of the recording.

The table also summarizes the research team's assessment of the characteristics of the noise, including its source, the distance of the source from the recording, and an estimate of the noise level. Also recorded was an estimate of the vocal effort used for speech communication by the Adult Corrections Officers. Raised or loud vocal effort was used for communication almost twice as often as normal vocal effort. The most common noise sources were the voices of the staff and inmates and the sounds associated with their activities. Exceptions to this general observation were seen for recordings from the kitchen, laundry, and vocational areas; in these areas, equipment was also a common noise source. The distance of the noise from the recorder varied widely because in most cases there were multiple noise sources. The log keeper most often judged the level of the noise to be "moderate" or "loud."

It should be noted that the presence of the research team members with clipboards and recording instruments often had the effect of drawing the inmates' attention and, in so doing, quieting their vocal activities. A number of the Adult Corrections Officer escorts observed that this was happening. Thus, the typical noise levels may actually be higher than those observed on some of the recordings.

The remaining entries in the table were generated at the time the recordings were processed. The duration is reported, as well as the L(eq), the long term RMS of the recording after it had been filtered with the modified A-weighting filter. L(eq) values were typically between 70 and 80 dB (A). In kitchen and vocational locations the L(eq) often exceeded 80 dB (A). Finally, the number of ESII values calculated for each recording is given.

Table F-1: Background Noise Measurements – Summary Description of All Recordings

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
1	Q1	Booking	AM2	Berkeley City Jail	64.7	151	23-Jun-11	7:11 AM	10.1	Control room	Voices, cuffs, keys			L	N
2	Q1	Booking	NM2	Del Norte Jail	56.3	35	20-Jun-11	12:34 PM	2.3						
3	Q1	Booking	NM3	Del Norte Jail	63.3	70	20-Jun-11	12:49 PM	4.7	Hallway	Chains, gates	15		L	N
4	Q1	Booking	NM4	Del Norte Jail	61.4	78	20-Jun-11	4:06 PM	5.2	Booking cells	Voices, cuffs, keys	6		L	N
5	Q1	Booking	NM5	Del Norte Jail	59.8	77	20-Jun-11	4:20 PM	5.1	Front counter	Voices, cuffs, keys	5		L	R
6	Q1	Booking	NM6	Del Norte Jail	62.0	101	20-Jun-11	4:31 PM	6.7	Front counter	Voices, cuffs, keys	5		L	R
7	Q1	Booking	KR1	Kern CRF	67.7	107	10-May-11	2:08 PM	7.1	Center of area	Voices, intercom, keys	1	15	M	R
					62.2	619			41.3						
8	Q2	Booking	HM6	Humboldt	78.7	30	21-Jun-11	1:54 PM	2.0	Booking cells	Doors banging in cells	6		H	R
9	Q2	Booking	DC6	San Diego Las Colinas	63.5	135	15-Jun-11	12:02 PM	9.0	Hallway	Voices, intercom, keys	5	20	L	N
					71.1	165			11.0						
10	Q4	Booking	IM12	Alameda Santa Rita Jail	73.5	75	7-Jul-11	1:53 PM	5.0	Holding cell	Talk	6	8	M	R
11	Q4	Booking	IM13	Alameda Santa Rita Jail	71.1	14	7-Jul-11	2:00 PM	0.9						
12	Q4	Booking	IM14	Alameda Santa Rita Jail	76.4	69	7-Jul-11	2:08 PM	4.6	Holding cell	Talk	3	5	M	R
					73.7	158			10.5						
					69.0	942			62.8						

Table F-1 (continued)

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
13	Q1	Chow	WM2	Lake Jail	70.2	7	22-Jun-11	12:06 PM	0.5						
14	Q1	Chow	WM3	Lake Jail	69.5	68	22-Jun-11	12:08 PM	4.5	Dining hall	Voices, radio	6	20	M	N
15	Q1	Chow	YL8	Yolo Leinberger Jail	69.6	151	9-Jul-11	4:10 PM	10.1	Chow hall	Talk	30		M	N
					69.8	226			15.1						
16	Q2	Chow	KL	Kern Max-Med Lerdo	77.7	4	9-May-11	4:25 PM	0.3	Chow in dorm	Eating, radio, intercom	1	5	M	N
17	Q2	Chow	DC6	San Diego Las Colinas	82.2	82	15-Jun-11	11:23 AM	5.5	Middle	Eating, radio, intercom	5	20	H	S
18	Q2	Chow	SP1	Stanislaus PSC	76.6	133	18-Apr-11	4:35 PM	8.9	CO station	Eating, radio, intercom	3	10	L	N
19	Q2	Chow	SP3	Stanislaus PSC	69.3	1	18-Apr-11	5:00 PM	0.1						
20	Q2	Chow	SP4	Stanislaus PSC	72.9	1	18-Apr-11	5:01 PM	0.1						
21	Q2	Chow	SP5	Stanislaus PSC	73.8	65	18-Apr-11	5:01 PM	4.3	Room and tier	Chatter while eating	10	20	M	R
					75.4	286			19.1						
22	Q3	Chow	BJ13	San Bernadino CDC	64.7	136	7-Jul-11	10:40 AM	9.1	Chow hall	Radio, trays, doors	5	40	M	N
					64.7	136			9.1						
23	Q4	Chow	CE1	Santa Clara Elmwood Men	75.1	189	28-Apr-11	10:47 AM	12.6	Walk around area	Talk, trays	5	50	M	N
24	Q4	Chow	CM1	Santa Clara Main Jail	73.3	251	25-Apr-11	3:30 PM	16.7	By sink	Eating, radio, intercom	5	20	M	R
25	Q4	Chow	CM2	Santa Clara Main Jail	73.2	216	25-Apr-11	3:13 PM	14.4	By sink	Eating, radio, intercom	5	20	M	R
					73.9	656			43.7						
					70.9	1304			86.9						

Table F-1 (continued)

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
26	Q1	Control	AM1	Berkeley City Jail	62.5	75	23-Jun-11	7:05 AM	5.0	Middle of room	Voices, cuffs, keys			L	N
27	Q1	Control	NM1	Del Norte Jail	63.6	56	20-Jun-11	12:13 PM	3.7	Booth	Phone, intercom	2		L	W
28	Q1	Control	EM3	El Dorado Jail	63.4	84	13-Jul-11	1:07 PM	5.6	Booth	Voices, cuffs, keys	10	30	L	N
29	Q1	Control	MM1	Merced Main Jail	66.9	72	19-Apr-11	11:57 AM	4.8	Control room	Sally port, talk	1	8	M	N
30	Q1	Control	MM2	Merced Main Jail	63.6	55	19-Apr-11	11:04 AM	3.7	Control room	Voices, cuffs, keys	1	3	L	N
31	Q1	Control	YM4	Yolo Monroe Jail	73.0	88	9-Jul-11	3:38 PM	5.9	Booth	Voices, intercom, keys	2	3	M	N
					65.5	430			28.7						
32	Q2	Control	HM1	Humboldt	68.4	10	21-Jun-11	1:14 PM	0.7	Court holding	TV, talk	3		L	N
33	Q2	Control	HM2	Humboldt	73.6	56	21-Jun-11	1:17 PM	3.7	Court holding	TV, talk	3		L	N
34	Q2	Control	HM7	Humboldt	62.7	78	21-Jun-11	2:01 PM	5.2	Central control	Intercom, bells, phone	1		L	N
35	Q2	Control	FM1	San Francisco Jail #4	70.0	86	29-Jun-11	10:17 AM	5.7	Desk area	Voices, intercom, keys	5	10	M	N
36	Q2	Control	SP2	Stanislaus PSC	75.5	169	18-Apr-11	4:21 PM	11.3	CO station	TV, phone, talk	2	12	L	N
					70.0	399			26.6						
37	Q3	Control	PA6	Placer Auburn Jail	65.1	75	10-May-11	2:06 PM	5.0	Shift change area	Talk, keys, radio	5	10	M	N
38	Q3	Control	XM1	Solano Jail	70.9	72	10-Jul-11	11:57 AM	4.8	Booth	Intercom, radio	2		M	N
39	Q3	Control	SM1	Stanislaus Main Jail	77.0	78	18-Apr-11	2:50 PM	5.2	CO station	Voices, cuffs, keys	3	10	M	R
40	Q3	Control	SM2	Stanislaus Main Jail	74.2	49	18-Apr-11	2:41 PM	3.3	CO station	Voices, cuffs, keys	3	5	M	R
					71.8	274			18.3						
41	Q4	Control	IM6	Alameda Santa Rita Jail	69.2	36	7-Jul-11	11:08 AM	2.4	Console	Phone, intercom	3		L	N
42	Q4	Control	IM9	Alameda Santa Rita Jail	67.5	134	7-Jul-11	11:50 AM	8.9	Main control	Phone, intercom	3	5	L	N
					68.4	170			11.3						
					70.0	1273			84.9						

Table F-1 (continued)

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
43	Q3	Gym	FM6	San Francisco Jail #5	81.8	15	29-Jun-11	11:41 AM	1.0	Inside gym	Sport activities	5	15	H	R
					81.8	15			1.0						
44	Q4	Gym	IM7	Alameda Santa Rita Jail	76.7	86	7-Jul-11	11:20 AM	5.7	Yard attached to unit	Running, ball bouncing	6	9	M	N
					76.7	86			5.7						
45	Q1	Housing	NM7	Del Norte Jail	74.2	159	20-Jun-11	4:44 PM	10.6	Hallway	Food carts, doors	3	10	M	R
46	Q1	Housing	EM4	El Dorado Jail	75.0	125	13-Jul-11	1:15 PM	8.3	Day room	TV, games, talking	5	20	M	N
47	Q1	Housing	EM5	El Dorado Jail	70.7	129	13-Jul-11	1:26 PM	8.6	Dorm	TV, games, talking	5	25	H	R
48	Q1	Housing	KR2	Kern CRF	71.1	85	10-May-11	1:41 PM	5.7	Holding cell	Voices, cuffs, keys	2	15	H	R
49	Q1	Housing	KR3	Kern CRF	65.9	1	10-May-11	1:41 PM	0.1						
50	Q1	Housing	KR4	Kern CRF	66.9	76	10-May-11	1:50 PM	5.1	Changing area	Voices, cuffs, keys	5	15	H	R
51	Q1	Housing	WM1	Lake Jail	68.5	52	22-Jun-11	12:02 PM	3.5	Day room, open bunks	TV	10	30	M	R
52	Q1	Housing	WM5	Lake Jail	73.6	85	22-Jun-11	12:19 PM	5.7	Open dorm	Voices, cuffs, keys	10	30	M	N
53	Q1	Housing	ZM1	Los Banos Jail	67.6	30	25-Aug-11	2:44 PM	2.0	Hallway	Voices	3	20	L	N
54	Q1	Housing	ZM2	Los Banos Jail	75.9	6	25-Aug-11	2:49 PM	0.4						
55	Q1	Housing	ZM3	Los Banos Jail	70.3	38	25-Aug-11	2:50 PM	2.5	Hallway	Voices	3	20	L	N
56	Q1	Housing	ZM4	Los Banos Jail	72.1	11	25-Aug-11	7:11 PM	0.7						
57	Q1	Housing	ZM5	Los Banos Jail	80.7	5	25-Aug-11	7:15 PM	0.3						
58	Q1	Housing	YL5	Yolo Leinberger Jail	64.6	11	9-Jul-11	3:50 PM	0.7						
59	Q1	Housing	YL6	Yolo Leinberger Jail	62.3	75	9-Jul-11	3:51 PM	5.0	Cells	TV, talk, intercom	5	10	L	R
60	Q1	Housing	YL7	Yolo Leinberger Jail	73.3	40	9-Jul-11	4:06 PM	2.7	Dorm	TV, talk	10		H	R
61	Q1	Housing	YM1	Yolo Monroe Jail	72.7	45	9-Jul-11	3:14 PM	3.0	Cells	TV, talk	5	10	M	R
62	Q1	Housing	YM2	Yolo Monroe Jail	63.6	1	9-Jul-11	3:24 PM	0.1	Dayroom	TV, talk	10	20	M	N
					70.5	974			64.9						

Table F-1 (continued)

Nr	Location Information			Information from Recordings						Information from Logs					
	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
63	Q2	Housing	HM8	Humboldt	65.8	122	21-Jun-11	2:12 PM	8.1	Segregated housing	TV, games, talking	3	10	M	N
64	Q2	Housing	HM9	Humboldt	71.8	116	21-Jun-11	2:22 PM	7.7	Day room, showers	TV, games, talking	6	20	M	R
65	Q2	Housing	HM10	Humboldt	69.9	18	21-Jun-11	2:36 PM	1.2	Day room	TV, games, talking	10	20	M	R
66	Q2	Housing	KL4	Kern Max-Med Lerdo	76.8	76	9-May-11	2:20 PM	5.1	Hallway of tier	TV, talk, carts	2	20	L	R
67	Q2	Housing	KL5	Kern Max-Med Lerdo	72.8	48	9-May-11	2:28 PM	3.2	Outside ACO station	Voices, cuffs, keys	2	10	M	N
68	Q2	Housing	KL6	Kern Max-Med Lerdo	81.8	112	9-May-11	2:07 PM	7.5	Hallway of tier	TV, talk, carts	2	20	L	S
69	Q2	Housing	DD1	San Diego EMDF	69.3	140	24-Jun-11	11:31 AM	9.3	Dayroom	Voices, intercom, keys	8	20	M	N
70	Q2	Housing	DD2	San Diego EMDF	67.0	77	24-Jun-11	11:42 AM	5.1	Dayroom	Voices, intercom, keys	5	20	M	N
71	Q2	Housing	DD3	San Diego EMDF	74.2	123	24-Jun-11	11:52 AM	8.2	Dayroom, open rec	Voices, intercom, keys	8	20	M	R
72	Q2	Housing	DD4	San Diego EMDF	68.7	101	24-Jun-11	12:05 PM	6.7	Dayroom	Voices, intercom, keys	5	20	M	R
73	Q2	Housing	DE3	San Diego EMJ	78.5	76	14-Jun-11	10:55 AM	5.1	TV area	TV, talk	5	20	H	S
74	Q2	Housing	DE4	San Diego EMJ	79.5	60	14-Jun-11	11:01 AM	4.0	Dayroom	TV, talk	5	20	M	R
75	Q2	Housing	DC4	San Diego Las Colinas	73.6	75	15-Jun-11	11:43 AM	5.0	Middle	Talk, TV, toilet, fan	5	10	H	R
76	Q2	Housing	DC5	San Diego Las Colinas	61.0	76	15-Jun-11	11:54 AM	5.1	Ad seg hallway	Talk, TV, toilet, fan	5	10	L	N
77	Q2	Housing	FM4	San Francisco Jail #4	71.9	95	29-Jun-11	10:39 AM	6.3	Hallway	TV, talk, keys, shower	5	20		
					72.6	1315			87.7						

Table F-1 (continued)

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
78	Q3	Housing	UM1	Butte Jail	69.2	150	22-Apr-11	2:16 PM	10.0	Day room	Voices, intercom, keys			N	
79	Q3	Housing	UM2	Butte Jail	77.6	150	22-Apr-11	1:59 PM	10.0	Hallway	Voices, keys, radio	5	20	M	
80	Q3	Housing	UM3	Butte Jail	78.9	150	22-Apr-11	2:46 PM	10.0	Day room	Table games, talk	5	20	M	R
81	Q3	Housing	UM4	Butte Jail	74.9	155	22-Apr-11	2:30 PM	10.3	Dorm pod	Voices, cuffs, keys	5	20	M	N
82	Q3	Housing	UM5	Butte Jail	70.9	77	22-Apr-11	1:50 PM	5.1	Female tank	Voices, keys, radio	5	20	M	N
83	Q3	Housing	KM1	Kern Min Security	74.8	74	11-May-11	9:18 AM	4.9	Barracks	PA, talk Showers	1	10	M	R
84	Q3	Housing	MJ4	Merced John Latorraca CF	77.0	57	19-Apr-11	4:43 PM	3.8	Lock down	TV, intercom, doors	2	20	L	R
85	Q3	Housing	PA1	Placer Auburn Jail	66.4	75	10-May-11	1:15 PM	5.0	Tables	Talk, TV, games	5	20	L	N
86	Q3	Housing	PA2	Placer Auburn Jail	70.3	82	10-May-11	1:01 PM	5.5	Tables	Talk, TV, games	5	20	L	N
87	Q3	Housing	PA3	Placer Auburn Jail	66.2	88	10-May-11	12:53 PM	5.9	Station	Voices, cuffs, keys	10	50	L	N
88	Q3	Housing	BJ10	San Bernardino CDC	64.2	76	7-Jul-11	10:09 AM	5.1	Catwalk	Talk, radio, fan	5	20	L	N
89	Q3	Housing	BJ14	San Bernardino CDC	61.5	163	7-Jul-11	10:51 AM	10.9	Dayroom	Voices, intercom, keys	5	30	L	N
90	Q3	Housing	DM6	San Diego Central Jail	66.7	80	15-Jun-11	9:58 AM	5.3	Staging area	Talk, carts, doors	5	15	H	R
91	Q3	Housing	DM7	San Diego Central Jail	69.9	80	15-Jun-11	10:05 AM	5.3	Ad seg dayroom	Voices, intercom, keys	5		H	R
92	Q3	Housing	FN5	San Francisco Jail #5	65.2	76	29-Jun-11	11:35 AM	5.1	Dayroom	Voices, intercom, keys	5	15	L	N
93	Q3	Housing	CW2	Santa Clara Elmwood Women	77.7	104	28-Apr-11	1:33 PM	6.9	CO station	Voices, intercom, keys	2	25	M	R
94	Q3	Housing	CW3	Santa Clara Elmwood Women	80.5	83	28-Apr-11	2:27 PM	5.5	Dayroom open rec	Voices, intercom, keys	3	20	M	R
95	Q3	Housing	CW4	Santa Clara Elmwood Women	66.6	99	28-Apr-11	12:57 PM	6.6	CO station	Doors, talk,	2	20	L	N
96	Q3	Housing	CW5	Santa Clara Elmwood Women	70.8	108	28-Apr-11	1:15 PM	7.2	CO station	Voices, cuffs, keys	2	40	M	R
97	Q3	Housing	XM3	Solano Jail	72.3	261	10-Jul-11	12:02 PM	17.4	Dayroom	Talk, doors	10	20	H	R
98	Q3	Housing	SM3	Stanislaus Main Jail	72.2	88	18-Apr-11	2:34 PM	5.9	Walk around area	TV, talk, doors	5	10	H	S
99	Q3	Housing	SM4	Stanislaus Main Jail	74.1	65	18-Apr-11	2:22 PM	4.3	Officer's station	TV, radio, carts, doors	3	M	N	
100	Q3	Housing	SM5	Stanislaus Main Jail	79.1	76	18-Apr-11	2:16 PM	5.1	Walk around area	TV, talk, doors	5	10	H	S
					71.6	2417			161.1						

Table F-1 (continued)

Nr	Location Information			Information from Recordings						Information from Logs					
	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
101	Q4	Housing	IM4	Alameda Santa Rita Jail	76.7	45	7-Jul-11	10:47 AM	3.0	Housing pod	Talk, TV, games	3	5	M	N
102	Q4	Housing	IM5	Alameda Santa Rita Jail	64.2	58	7-Jul-11	11:00 AM	3.9	Day room	Talk, TV, games	6	10	L	N
103	Q4	Housing	IM8	Alameda Santa Rita Jail	73.1	41	7-Jul-11	11:28 AM	2.7	Day room	Talk, tram noise	6	20	M	N
104	Q4	Housing	IM15	Alameda Santa Rita Jail	77.6	166	7-Jul-11	3:26 PM	11.1	Day room	Trays moving, talk	6	15	H	R
105	Q4	Housing	RM1	Fresno Jail	76.7	77	29-Jun-11	1:20 PM	5.1	Linear, old jail	TV, games, talking	3	20	M	R
106	Q4	Housing	RM2	Fresno Jail	75.2	73	29-Jun-11	1:32 PM	4.9	So annex jail	Voices, intercom, keys	2	10	M	R
107	Q4	Housing	RM3	Fresno Jail	75.5	60	29-Jun-11	1:39 PM	4.0	So annex jail	Voices, intercom, keys	3	10	M	N
108	Q4	Housing	RM4	Fresno Jail	72.1	66	29-Jun-11	1:59 PM	4.4	Male pod	TV, games, talking	4	40	M	R
109	Q4	Housing	RM5	Fresno Jail	78.1	69	29-Jun-11	2:15 PM	4.6	Main area in pod	TV, games, talking	3	25	M	S
110	Q4	Housing	RM6	Fresno Jail	71.4	100	29-Jun-11	2:41 PM	6.7	Pod	TV, games, talking	3	10	M	R
111	Q4	Housing	RM7	Fresno Jail	80.0	65	29-Jun-11	2:59 PM	4.3	Pod common area	TV, games, talking	3	30	M	R
112	Q4	Housing	RM8	Fresno Jail	78.3	69	29-Jun-11	3:19 PM	4.6	Pod common area	TV, games, talking	3	15	M	R
113	Q4	Housing	KP1	Kern Pre-trial Facility	66.2	94	10-May-11	11:00 AM	6.3	Near control	TV, games, talking	2	40	M	R
114	Q4	Housing	KP2	Kern Pre-trial Facility	66.8	161	10-May-11	10:45 AM	10.7	ACO desk	Voices, toilets, doors	2	15	M	R
115	Q4	Housing	LT1	LA Twin Towers	66.0	60	7-Jun-11	4:30 PM	4.0	Discipline module	Voices, radio	2	40	L	N
116	Q4	Housing	LT5	LA Twin Towers	76.9	99	7-Jun-11	3:11 PM	6.6	Linear cells	Voices, toilets, doors	5	100	M	N
117	Q4	Housing	LT6	LA Twin Towers	63.9	61	7-Jun-11	4:18 PM	4.1	Indoor rec area	Voices	10	60	L	N
118	Q4	Housing	TL1	Orange County Theo Lacey	67.4	28	21-Dec-12	10:19 AM	1.9	Walk around area	Voices, intercom, keys	5	20	L	N
119	Q4	Housing	Tl2	Orange County Theo Lacey	65.5	31	21-Dec-12	10:23 AM	2.1	Walk around area	Voices, shower	5	20	L	N
120	Q4	Housing	TL3	Orange County Theo Lacey	61.7	32	21-Dec-12	10:28 AM	2.1	Walk around area	Voices, cuffs, keys	5	20	L	N
121	Q4	Housing	TL4	Orange County Theo Lacey	75.1	39	21-Dec-12	10:34 AM	2.6	Walk around area	Voices, TV	5	20	M	N
122	Q4	Housing	TL6	Orange County Theo Lacey	73.4	84	21-Dec-12	10:47 AM	5.6	Walk around area	Voices, TV	5	40	H	N
123	Q4	Housing	DB3	San Diego George Bailey	64.6	76	14-Jun-11	10:03 AM	5.1	Dayroom	Voices, cuffs, keys	5	25	H	R
124	Q4	Housing	DB4	San Diego George Bailey	68.8	89	14-Jun-11	10:16 AM	5.9	Dayroom	Trays, voices	5	25	H	R
125	Q4	Housing	CE2	Santa Clara Elmwood Men	70.8	134	28-Apr-11	9:00 AM	8.9	CO desk	Voices, cuffs, keys	5	50	M	N
126	Q4	Housing	CE3	Santa Clara Elmwood Men	63.7	110	28-Apr-11	8:47 AM	7.3	CO desk	Voices, cuffs, keys	5	50	L	N
127	Q4	Housing	CE6	Santa Clara Elmwood Men	70.2	118	28-Apr-11	9:20 AM	7.9	CO desk	Voices, cuffs, keys	5	50	M	N
128	Q4	Housing	CM4	Santa Clara Main Jail	71.3	152	25-Apr-11	2:23 PM	10.1	Dayroom CO station	Voices, cuffs, keys	3	20	M	R
129	Q4	Housing	CM5	Santa Clara Main Jail	73.4	123	25-Apr-11	2:11 PM	8.2	Main room	Voices, cuffs, keys	3	20	M	R
					71.2	2380			158.7						
					71.6	7086			472.4						

Table F-1 (continued)

	Location Information			Information from Recordings						Information from Logs					
Nr	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
130	Q1	Kitchen	AM3	Berkeley City Jail	72.2	91	23-Jun-11	7:29 AM	6.1	Small kitchen	Appliances	5		M	N
131	Q1	Kitchen	NM8	Del Norte Jail	75.2	206	20-Jun-11	4:56 PM	13.7	Kitchen prep area	Voices, cuffs, keys	6		M	R
132	Q1	Kitchen	EM1	El Dorado Jail	78.9	107	13-Jul-11	10:10 AM	7.1	Middle of kitchen	Trays, equipment	5	10	H	R
133	Q1	Kitchen	WM4	Lake Jail	78.7	30	22-Jun-11	12:14 PM	2.0	Food prep cleaning	Tray water spray	10	30	H	R
134	Q1	Kitchen	YM3	Yolo Monroe Jail	77.7	60	9-Jul-11	3:30 PM	4.0	Kitchen	Equipment, radio, talk	10	20	M	R
					76.5	494			32.9						
135	Q2	Kitchen	HM5	Humboldt	72.8	45	21-Jun-11	1:35 PM	3.0	Food prep	Equipment, radio, talk	6	20	M	R
136	Q2	Kitchen	DE1	San Diego EMJ	83.9	80	14-Jun-11	10:37 AM	5.3	Middle of room	Equipment, radio, talk	5	20	H	R
137	Q2	Kitchen	DE6	San Diego EMJ	89.5	76	14-Jun-11	11:20 AM	5.1	Walk around area	Equipment, radio, talk			H	S
138	Q2	Kitchen	DC1	San Diego Las Colinas	78.0	75	15-Jun-11	11:14 AM	5.0	Middle	Equipment, radio, talk	5	10	M	R
139	Q2	Kitchen	FM3	San Francisco Jail #4	83.4	78	29-Jun-11	10:32 AM	5.2	Food prep line	Equipment, radio, talk	5	20	M	R
					81.5	354			23.6						
140	Q3	Kitchen	KM2	Kern Min Security	77.6	80	11-May-11	9:07 AM	5.3	Center of area	Equipment, radio, talk	2	20	H	R
141	Q3	Kitchen	PA4	Placer Auburn Jail	74.1	75	10-May-11	1:32 PM	5.0	Doorway	Equipment, radio, talk	5	25	H	R
142	Q3	Kitchen	BJ11	San Bernardino CDC	71.5	106	7-Jul-11	10:17 AM	7.1	Middle of room	Equipment, radio, talk	5	30	M	N
143	Q3	Kitchen	DM4	San Diego Central Jail	73.4	79	15-Jun-11	9:44 AM	5.3	Hallway	Talk, radio, carts	5	10	H	R
144	Q3	Kitchen	DM5	San Diego Central Jail	76.4	75	15-Jun-11	9:51 AM	5.0	Middle of room	Pots and pans, carts	5	20	H	R
145	Q3	Kitchen	XM4	Solano Jail	80.0	46	10-Jul-11	12:25 PM	3.1	Kitchen	Equipment, radio, talk	10		L	N
					75.5	461			30.7						
146	Q4	Kitchen	IM2	Alameda Santa Rita Jail	84.7	69	7-Jul-11	10:31 AM	4.6	Food prep	Clean up equipment	3	6	H	R
147	Q4	Kitchen	LT2	LA Twin Towers	85.8	92	7-Jun-11	3:23 PM	6.1	High ceiling kitchen	Equipment, radio, talk	15	40	H	R
148	Q4	Kitchen	LT3	LA Twin Towers	87.3	91	7-Jun-11	4:45 PM	6.1	Center of area	Equipment, fans, carts	15	40	H	R
149	Q4	Kitchen	LT4	LA Twin Towers	82.0	60	7-Jun-11	4:10 PM	4.0	Cooking area	Equipment	5	50	H	R
150	Q4	Kitchen	DB2	San Diego George Bailey	80.3	76	14-Jun-11	9:51 AM	5.1	Middle	Equipment, radio, talk	5	25	M	R
151	Q4	Kitchen	CM4	Santa Clara Main Jail	84.2	108	28-Apr-11	9:30 AM	7.2	Walk around area	Equipment, radio, talk	5	100	H	S
					84.1	496			33.1						
					79.4	1805			120.3						

Table F-1 (continued)

Nr	Location Information			Information from Recordings						Information from Logs					
	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
152	Q1	Laundry	EM2	El Dorado Jail	72.9	76	13-Jul-11	10:19 AM	5.1	Middle of laundry	Equipment, radio, talk	5	10	M	N
153	Q1	Laundry	MM3	Merced Main Jail	74.6	142	19-Apr-11	11:11 AM	9.5	Folding clothes area	Talk, radio, carts Doors	2	20	M	R
					73.8	218			14.5						
154	Q2	Laundry	HM3	Humboldt	73.8	2	21-Jun-11	1:24 PM	0.1						
155	Q2	Laundry	HM4	Humboldt	73.4	45	21-Jun-11	1:27 PM	3.0	Laundry	Dryers, TV	8		H	R
156	Q2	Laundry	DE5	San Diego EMJ	84.3	78	14-Jun-11	11:13 AM	5.2	Walk around area	Equipment, talk, carts	5	25	H	S
					77.2	125			8.3						
157	Q3	Laundry	KM3	Kern Min Security	83.9	90	11-May-11	8:56 AM	6.0	ACO station	Equipment, talk, carts	2	20	H	S
					83.9	90			6.0						
158	Q4	Laundry	IM10	Alameda Santa Rita Jail	86.1	76	7-Jul-11	12:08 PM	5.1	Cleaning clothes	Equipment	3	10	H	R
159	Q4	Laundry	KP3	Kern Pre-trial Facility	60.5	68	10-May-11	9:43 AM	4.5	ACO station	Radio, talk	2	8	M	N
160	Q4	Laundry	OM7	Orange Mens' Central Jail	84.0	5	3-Mar-11	8:58 AM	0.3						
161	Q4	Laundry	OM8	Orange Mens' Central Jail	87.8	52	3-Mar-11	8:55 AM	3.5						
162	Q4	Laundry	CE5	Santa Clara Elmwood Men	84.7	97	28-Apr-11	9:20 AM	6.5	CO station	Equipment, talk, carts	10	50	H	S
					80.6	298			19.9						
					78.9	731			48.7						
163	Q3	Medical	DM2	San Diego Central Jail	68.1	38	15-Jun-11	9:32 AM	2.5	Hallway	Voices, cuffs, keys	5	15	L	N
164	Q3	Medical	DM3	San Diego Central Jail	65.5	75	15-Jun-11	9:36 AM	5.0	Hallway	Voices, cuffs, keys	5	15	L	N
					66.8	113			7.5						
165	Q4	Medical	KP4	Kern Pre-trial Facility	64.0	75	10-May-11	9:59 AM	5.0	Nursing station	Yelling, talk, flushing	4	10	M	R
166	Q4	Medical	KP5	Kern Pre-trial Facility	66.3	77	10-May-11	9:28 AM	5.1	Nursing station	Screaming, talk	2	10	M	R
167	Q4	Medical	DB1	San Diego George Bailey	71.9	77	14-Jun-11	9:44 AM	5.1	Hallway	Voices, cuffs, keys	5	25	M	R
					67.4	229			15.3						
					67.1	342			22.8						

Table F-1 (continued)

Nr	Location Information			Information from Recordings						Information from Logs					
	RC	Activity	Code	Facility	L(eq)	Samples	Date	Time	Dur	Location	Source	Min dist	Max dist	Level	Effort
168	Q1	Movement	MM5	Merced Main Jail	82.3	161	19-Apr-11	11:27 AM	10.7	Daily rounds	Voices, intercom, keys	2	8	M	R
					82.3	161			10.7						
169	Q2	Movement	KL2	Kern Max-Med Lerdo	79.0	75	9-May-11	4:19 PM	5.0	ACO handing out trays	Voices, cuffs, keys	1	3	M	N
170	Q2	Movement	LI1	LA Old IRC	81.7	92	7-Jun-11	5:34 AM	6.1	Linear holding cells	Voices	8	40	M	R
171	Q2	Movement	LI2	LA Old IRC	84.3	140	7-Jun-11	5:41 AM	9.3	Linear holding cells	Voices	5	40	H	R
172	Q2	Movement	LI3	LA Old IRC	85.9	153	7-Jun-11	5:54 AM	10.2	Linear holding cells	Voices	5	50	H	R
173	Q2	Movement	LI4	LA Old IRC	84.4	94	7-Jun-11	6:09 AM	6.3	Linear holding cells	Voices	10	50	H	R
174	Q2	Movement	FM2	San Francisco Jail #4	84.3	140	29-Jun-11	10:25 AM	9.3	Hallway	TV, talk, doors	5	10	L	N
					83.3	694			46.3						
175	Q3	Movement	MJ1	Merced John Latorraca CF	77.2	12	19-Apr-11	4:53 PM	0.8	Rounds in dorm	Voices	2	20	L	R
176	Q3	Movement	BJ12	San Bernardino CDC	62.4	84	7-Jul-11	10:28 AM	5.6	Catwalk	Talk, radio, fan	5	40	L	N
177	Q3	Movement	DM8	San Diego Central Jail	64.1	78	15-Jun-11	10:14 AM	5.2	Hallway	Chains, keys, radio	5	20	M	R
178	Q3	Movement	CW1	Santa Clara Elmwood Women	68.9	68	28-Apr-11	1:05 PM	4.5	CO station	Doors, talk,	2	20	L	N
					68.2	242			16.1						
179	Q4	Movement	IM11	Alameda Santa Rita Jail	70.4	68	7-Jul-11	1:13 PM	4.5	Housing to program	Talk	3	6	M	N
180	Q4	Movement	CM3	Santa Clara Main Jail	81.6	145	25-Apr-11	2:57 PM	9.7	Cage control area	Yelling, keys, doors	5		H	S
					76.0	213			14.2						
					77.4	1310			87.3						
181	Q2	Vocational	DE2	San Diego EMJ	75.5	79	14-Jun-11	10:46 AM	5.3	Middle of room	Printing press	5	15	H	R
182	Q2	Vocational	DC3	San Diego Las Colinas	71.8	80	15-Jun-11	11:34 AM	5.3	Deputy station	Sewing machines	5	20	H	R
					73.7	159			10.6						
					73.7	159			10.6						
183	Q1	Yard	MM4	Merced Main Jail	70.2	79	19-Apr-11	12:19 PM	5.3	Rooftop rec	Sports activities				
					70.2	79			5.3						
184	Q2	Yard	KL3	Kern Max-Med Lerdo	71.1	28	9-May-11	2:38 PM	1.9	Outside ACO station	Exercising, yelling	2	7	M	R
					71.1	28			1.9						
185	Q3	Yard	PA5	Placer Auburn Jail	63.4	91	10-May-11	12:46 PM	6.1	Middle of yard	Voices, intercom, keys	5	20	L	N
					63.4	91			6.1						
					68.2	198			13.2						

APPENDIX G: RATIONALE FOR SPECIFICATION OF CRITICAL VALUE FOR THE EXTENDED SPEECH INTELLIGIBILITY INDEX

To describe the process by which criterion ESII values are defined and applied, it is first necessary to consider the relationship between HINT SRTs, ESII, speech intelligibility, and the likelihood of effective speech communication in complex, fluctuating background noise environments. HINT SRTs were related to ESII (and SII) values by applying the 18 1/3-octave filter band analysis to the reference stationary HINT noise scaled to correspond to a sound pressure level of 65 dB(A), the presentation level used during testing. The filter outputs for the HINT noise were converted to spectrum levels and combined with the standard speech spectrum levels for normal vocal effort and the band importance function for "short passages of easy reading material" (ANSI S3.5-1997, 2007) to obtain the SII. Note that the standard also specifies 62.35 dB SPL as the standard speech spectrum level for normal vocal effort.

The SII for the HINT noise under these assumptions is 0.34. The HINT Noise Front condition most closely approximates the assumptions used for the SII calculation. The norm for individuals with normal speech communication ability in this condition is an SRT of 62.4 dB (A), closely approximating the standard speech spectrum level for normal vocal effort, and the SII at the Noise Front norm is 0.35. Thus, the ability of the SII to predict the Noise Front SRT for individuals with normal speech communication ability is evident. Note also that other investigators have found that the SII at the SRT to be approximately 0.34 (e.g., Houtgast & Festen, 2008).

The speech spectrum levels and band importance functions used to calculate the SII and ESII for the HINT Noise Front threshold are those reported in the standard short passages of easy reading materials produced with normal vocal effort (Tables 3 and B.2 in ANSI S3.5-1977, 2007). These speech spectrum levels from the standard for normal vocal effort (62.35 dB SPL at 1 meter) can be compared with the speech spectrum levels of the HINT sentences at the Noise Front threshold (62.4 dB(A) at 1 meter). The average spectrum level difference across the 18 1/3-octave bands was 0.98 dB, with the HINT speech spectrum levels slightly higher. More importantly the average spectrum level difference for the range of 1/3 octave bands from 315-3150 Hz, which contribute 82% of the overall band importance, was only 0.02 dB, with the spectrum levels in the standard slightly higher. These data indicate there are small differences in the HINT and ANSII spectrum levels at the extremes of the frequency range for the 1/3-octave band filters; however, the impact of these differences on the ESII calculations and the hearing screening standard is anticipated to be minimal because of the very close agreement in spectrum in the mid frequency regions where band importance is greatest for speech intelligibility.

Speech intelligibility, measured as the percent of words correctly recognized from all sentences, is approximately 70% at the HINT SRT for Noise Front and for the other HINT test conditions as well (Nilsson et al., 1994; Vermiglio, 2008). The slope of the function relating percent intelligibility to presentation level for levels near the SRT is 10%/dB (Soli & Wong, 2008). Thus, increasing the presentation level by 3 dB from 62.4 dB (A) to 65.4 dB (A) should result in 100% intelligibility. The SII (and ESII) at this presentation level is 0.45, which corresponds exactly to the value given as the minimum SII for acceptable intelligibility (ANSI S3.5-1997, 2007).

Neither the SII nor the ESII adequately consider listening conditions in which speech and noise sources originate from different locations. In these conditions the binaural auditory system allows one to listen selectively and improve the SRT, as discussed above. The effects of the binaural auditory system are considered by use of the HINT Composite threshold. The Composite HINT threshold equally weights the best- and worst-case listening scenarios to provide an overall estimate of the SRT across a variety of listening conditions. The published norm for the Composite SRT is 58.6 dB (A) (Soli & Wong, 2008; Vermiglio, 2008). The ESII corresponding to this level is approximately 0.25, or 0.10 units lower than the value calculated under the assumptions in the standard. These considerations suggest that the minimum ESII and SII for acceptable intelligibility is also 0.10 units lower than the value stated in the guideline, or 0.35 instead of 0.45, when best- and worst-case listening conditions are given equal consideration.

Another consideration is that effective speech communication, especially in situations where the utterances can be repeated, does not necessarily require 100% intelligibility, that is, an ESII of 0.35. For example, if an ESII corresponding to 80% intelligibility is specified, this means that 80% of the time communication is effective and 20% of the time it is not. If communication is not effective and the utterance is repeated, the likelihood that the repetition will also not be effective is also 20%, assuming the two attempted communications are independent—a conservative assumption. Thus, the joint probability that both communications will be ineffective is the product of the two probabilities of ineffective communication, or 0.20 X 0.20 = 0.04, and the probability of an effective communication after one repetition is 1.00 – 0.04 = 0.96; thus, when a single repetition is allowed nearly perfect communication can occur when the likelihood of effective speech communication without repetition is 0.80.

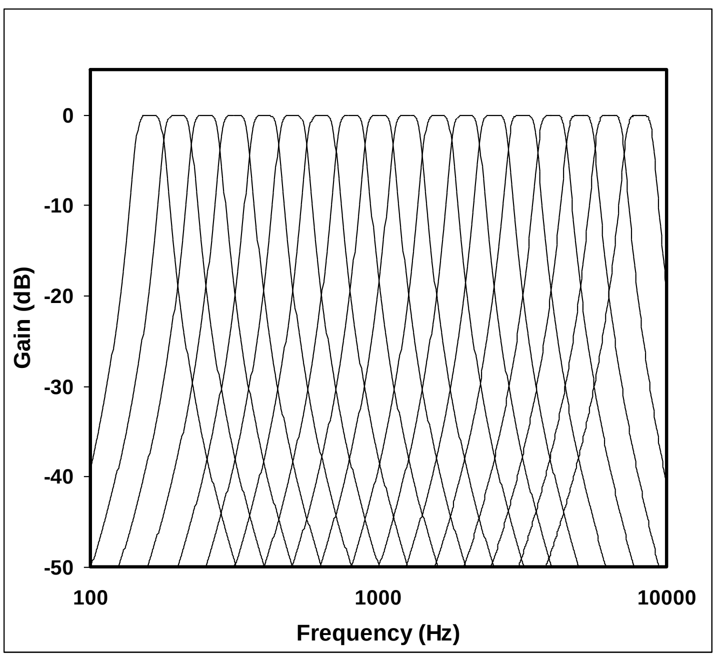
The ESII corresponding to 80% intelligibility under worst-case conditions is 0.40. If the prior reasoning that weights best- and worst-case scenarios equally is applied, the ESII value for effective speech communication is reduced by 0.10 to 0.30. Thus, an ESII of 0.30 can serve as a conservative criterion for evaluation of the 16 cumulative frequency distributions associated with each location to determine the proportion of 4-second intervals in which the ESII exceeds the criterion value. This proportion defines the likelihood of effective speech communication in the background noise environments associated with each location. In summary, these analyses can define the likelihood that Adult Corrections Officers with normal speech communication ability working in these locations encounter background noise environments allowing effective speech communication while performing the hearing-critical job functions of a normal work day.

Appendix H: Method for Calculation of the Extended Speech Intelligibility Index

Preparation of ESII Data Sets

The SII and ESII are based on the band importance function for speech (ANSI 3.5-1997, 2007). The band importance functions specify for different frequency bands the relative importance of speech information contained in the band. The standard for calculating SII also specifies the standard speech spectrum level in each band as a function of vocal effort, which is defined as either normal, raised, loud, or shouted. The spectrum level of speech information in a band in relation to the spectrum level of noise in the same band, together with the band importance of the speech information, is used to calculate the SII. Thus, it is essential to determine the spectrum level of the noise for each band. This is done by filtering the noise recordings into a number of frequency bands. The standard specifies that one such method of filtering is to use 18 1/3 octave band filters with center frequencies ranging from 160 Hz to 8000 Hz with equal logarithmic spacing.

A 1/3 octave band filter set was designed using a Matlab program developed by Courvreur (1997). This program designs fractional octave band filters, that is, 1/3 octave band, according to specifications in ANSI S1.1-1986. The frequency responses of the 18 filters used in the current analyses are show in the figure below. Note that all of the filters exhibit unity gain in their pass band, which is important for the use of the RMS-to-dB calibration for each band.



Frequency responses of 18 1/3 octave band filter set used to process background noise recordings for ESII calculations.

The SII does not specify the duration of the time interval over which the spectrum level of the noise in each band is to be calculated, since it assumes the noise is stationary. However, the ESII makes no such assumptions. It specifies precisely the duration for each of the 18 frequency-dependent time windows, with the windows for the lowest frequency band having the longest duration (35 ms) and the windows for the highest frequency band having the shortest duration (9.4 ms; Rhebergen & Versfeld, 2005). These windows are aligned at their offsets and are spaced every 9.4 ms, the duration of the shortest time window. This means that the windows for low frequency bands overlap substantially.

A Matlab program was written to filter each recording with the 18 1/3 octave band filters. Rectangular frequency-dependent time windows were applied to the 18 filtered time waveforms every 9.4 ms, and the RMS level for each window was calculated. This process produced slightly more than one hundred RMS values per second of recording for each of the 18 1/3 octave band filter outputs. These RMS values were converted to band levels expressed in dB SPL using the calibration information for each band described above. Next, the noise band levels were converted to noise spectrum levels by applying the bandwidth adjustment values given in Table 3 of the standard (ANSI 3.5-1997, 2007).

The noise spectrum levels for the 18 bands, expressed every 9.4 ms, together with the speech spectrum levels and the band importance function for short passages of easy material from the standard (ANSI 3.5-1997, 2007), were used to calculate slightly more than 100 SII values per second of recorded background noise. These calculations were performed with a series of Matlab programs developed by Muesch (2005) and posted on the web page for the standard (www.sii.to). The ESII specifies that these "snapshot" SII values be averaged over the time interval of interest to obtain a single estimate of the ESII for that interval (Rhebergen & Versfeld, 2005). Rather than use the entire duration of the recording as the interval of interest, it is more appropriate to define a shorter interval during which a typical brief two-way communication might occur. This interval was specified as 4 seconds Thus, the average ESII was calculated for all 4-second intervals in each recording. There are 435 SII snapshots in each 4-second interval that contribute to the average. Note that these intervals are not exactly 4 seconds in duration because there is no integer multiple of 9.4 ms whose product is exactly 4 seconds.

The ESII calculation process described in the preceding paragraph was repeated 16 times for the data from each location, using the four levels of vocal effort specified in the standard (normal, raised, loud, and shouted) and four communication distances (0.5 m, 1 m, 5 m, and 10 m).

The final step in processing the 16 ESII data sets from each location was to cast each data set into cumulative frequency distributions. Once in this form, it was possible to determine the proportion of 4-second intervals in which the ESII exceeded a specified criterion value for each level of vocal effort and each communication distance. The ESII step size for the frequency distributions was set at 0.03, which is the change in ESII corresponding to 1 dB change in SRT for an audiometrically normal individual.

Appendix I: Local Adult Corrections Facilities that Participated in the Research

Facility	Incident Reports	SME Panel Interviews	Individual SME Interviews	Background Noise Measurements
Alameda County Santa Rita Jail				X
Amador County Jail			X	
Anaheim City Jail		X		
Berkeley City Jail				X
Butte County Jail				X
Colusa County Jail			X	
Contra Costa County Martinez Detention Facility			X	
Contra Costa West County Detention Facility			X	
Del Norte County Jail				X
El Dorado County - Placerville Jail				X
Fresno County Main Jail			X	X
Fresno County South Annex Jail			X	
Glenn County Adult Detention Facility			X	
Hawthorne City Jail	X			
Humboldt County Correctional Facility	X			X
Huntington Beach City Jail	X	X		
Imperial County Regional Adult Detention Facility			X	
Inyo County Jail			X	
Kern County Central Receiving Facility	X			X
Kern County Lerdo Maximum Security Facility				X
Kern County Lerdo Minimum Security	X			X
Kern County Lerdo Pre-Trial Facility	X			X
Kings County Jail	X			
Lake County Correctional Facility	X			X
Long Beach City Jail		X		
Los Angeles County Central Jail	X	X		
Los Angeles County Twin Towers Correctional Facility				X
Los Angeles County Inmate Reception Center		X		X
Los Banos City Jail	X			X
Marin County Jail			X	
Merced County Main Jail	X			X
Merced County John Latorraca Correctional Facility				X
Mono County Jail			X	
Monterey County Main Jail	X			

Facility	Incident Reports	SME Panel Interviews	Individual SME Interviews	Background Noise Measurements
Monterey County Rehabilitation Facility			X	
Napa County Department of Corrections	X		X	
Nevada County Wayne Brown Correctional Facility			X	
Orange County Central Men's Jail	X			X
Orange County Intake Release Center	X			
Orange County Theo Lacy Jail	X	X		X
Orange County Women's Jail	X			
Placer County Jail	X			X
Riverside County Robert Presley Detention Center	X			
Sacramento County Main Jail	X		X	
San Benito County Jail			X	
San Bernardino County Central Detention Center				X
San Bernardino County West Valley Detention Center	X			
San Diego County Central Jail				X
San Diego County East Mesa Detention Facility				X
San Diego County East Mesa Jail				X
San Diego County George Bailey Detention Facility				X
San Diego County Las Colinas Women's Det. Facility				X
San Francisco County Jail #1	X			
San Francisco County Jail #2	X			
San Francisco County Jail #4				X
San Francisco County Jail #5				X
San Francisco County Jail #8	X			
San Francisco County Jail #9	X			
San Joaquin County Main Jail			X	
San Joaquin County John J. Zunino Detention Facility	X			
San Luis Obispo County Jail	X			
Santa Barbara County Main Jail			X	
Santa Clara County Main Jail				X
Santa Clara County Elmwood Men's Jail				X
Santa Clara County Elmwood Women's Jail				X
Shasta County Main Jail	X		X	
Siskiyou County Jail			X	
Solano County Main Jail				X
Sonoma County Main Adult Detention	X		X	
Sonoma North County Detention Facility	X		X	
Stanislaus County Main Jail				X
Stanislaus County Public Safety Center				X

Facility	Incident Reports	SME Panel Interviews	Individual SME Interviews	Background Noise Measurements
Sutter County Jail			X	
Tehama County Jail	X		X	
Trinity County Detention Facility			X	
Tulare County Main Jail			X	
Tulare County Adult Pre-trial Facility			X	
Tulare County Bob Wiley Detention Facility			X	
Tuolumne County Jail	X		X	
Ventura County Work Furlough Facility	X			
Yolo County Walter J. Leinberger Mem. Det. Facility				X
Yolo County Monroe Detention Center				X
Yuba County Jail	X		X	