IDA

Force Impact of Expanding the Recruitment of Individuals with Auditory Impairment

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INSTITUTE FOR DEFENSE ANALYSES

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Executive Summary

This paper assesses the feasibility and advisability of permitting individuals with auditory impairment to access as members of the armed forces. This research stemmed from Senate Report 113-85, in which the Appropriations Subcommittee on Defense directed the Department of the Air Force to study the feasibility and advisability of permitting individuals with auditory impairment to access as Air Force officers. In Senate Report 113-211, the Committee expressed its displeasure with the earlier report and called for additional research that would address requirements of the 2015 National Defense Authorization Act. The Institute for Defense Analyses (IDA) conducted this assessment at the request of the Under Secretary of Defense (Personnel and Readiness) (USD (P&R)), Readiness and Force Management, Military Personnel Policy (MPP).

The objectives of this research effort are twofold. First, this research addresses the three questions specified in Senate Report 113-211:

- What, if any, are the barriers that may limit individuals with hearing impairments from serving in the military?

- What is the current state of the art in accommodations (assistive technologies and methods) for those with hearing impairments?

- Are there military occupational specialties (MOS) that may be appropriate for further investigation (e.g., via fitness-for-duty tests) for allowing the enlistment of individuals with hearing impairments?

Second, this research provides a data-driven context for understanding the impact on the force as it relates to the feasibility and advisability of permitting individuals with auditory impairment, or any disability, to access as members of the armed forces. Force impact is considered by testing fundamental assumptions about the nature of current and future military service. As part of this assessment, we examined both the foundational organizing principles of the U.S. Department of Defense (DOD) and the military Services, as well as two primary hypotheses that stem from those principles.

A. Research Approach to Answer Senate Report 113-85 Questions

IDA used literature searches, interviews, and a survey instrument to gather information related to the aforementioned questions. The literature searches focused on accessibility and on careers of individuals with hearing impairments. Interviews were conducted with a range of research participants representing three groups: (1) individuals

with hearing impairments, (2) accessibility experts, and (3) individuals with knowledge unique to the objectives of this study. Interviews with the first group of individuals required use of assistive technologies or methods. Two interviews were conducted in American Sign Language (ASL) supplemented with lipreading. Two interviews were conducted with cochlear implant (CI) users: one was in person, and the other was conducted by telephone. Two interviewees used a frequency modulation (FM) loop system and hearing aids with a telecoil setting. One interviewee used a video relay telephone service. These assistive technologies and methods are discussed further in Section 2.

The second group of individuals included experts in job accommodation and accessibility. Since many of these individuals also have hearing impairments, there was some overlap between the first and second group of research participants. The topics of each interview were based on the specific expertise of the individuals. All research participants in this group were knowledgeable about disability law, and most also were knowledgeable about the employment of the hearing impaired.

A third group of individuals were approached as part of this research because of their unique perspectives on the question of people with hearing impairments in potential military settings or careers previously not open to those with hearing impairments.

This group consisted of approximately 300 individuals who have hearing impairments and participate in the Computer/Electronic Accommodations Program (CAP), which DOD has operated since 1990.[1] CAP provides technical assistance and equipment as reasonable job accommodations for DOD civilian and uniformed personnel. Research participants, who represented a broad range of careers—from facilities engineer to librarian—were asked to complete a survey. Responses were obtained from 25 individuals.

In addition to demographics, the survey asked questions regarding accommodations and barriers. The survey instrument was not intended to be a scientific estimation of a population. It was purely an exploratory tool, and designed to assist in identifying topics for further examination by providing additional insight from individuals with hearing impairments beyond the literature review and interviews.

B. The Foundational Organizing Principles of the Military Services and the DOD Total Force

The DOD Instruction (DODI) 6130.03, "Medical Standards for Appointment, Enlistment, or Induction in the Military Services," states that "individuals under consideration for appointment, enlistment, or induction into the Military Services" should be "[f]ree of contagious diseases"; "[f]ree of medical conditions or physical defects that

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[1] CAP, "Computer/Electronic Accommodations Program," accessed September 2, 2015, http://www.cap.mil/.

may require excessive time lost from duty," or "result in separation from the Service for medical unfitness"; "[m]edically capable of satisfactorily completing required training"; "[m]edically adaptable to the military environment without the necessity of geographical area limitations"; and "[m]edically capable of performing duties without aggravation of existing physical defects or medial conditions."[2]

This guidance informs the military Service's foundational organizing principles, which underlie each Service's fundamental personnel expectations and underlying cultural norms, as tied to their basic roles and missions. Across the Services, these principles emphasize the readiness to deploy worldwide and the ability to engage in standard military duties and tasks.

DOD also includes non-uniformed, civilian personnel. According to the White House website, DOD "is the largest government agency, with more than 1.3 million men and women on active duty, nearly 700,000 civilian personnel, and 1.1 million citizens who serve in the National Guard and Reserve forces. Together, the military and civilian personnel of DOD protect national security interests through war-fighting, providing humanitarian aid, and performing peacekeeping and disaster relief services."[3] This Total Force emphasis—which extends beyond the Active and Reserve Component, to include the DOD civilian workforce—is central to the underlying organizing principle that informs DOD civilian workforce identity.

Civilians employed by the military Services are also considered as "members of the team." The Department of the Army Civilian Service, Army Civilian Corps Creed, states that Army civilians are members "of the Army Team [....] dedicated to our Army, our Soldiers and Civilians." These civilians "always support the mission," and "provide stability and continuity during war and peace."[4] Similarly, the Department of the Navy characterizes civilian service as service to the nation. According to the Navy Civilian Human Resources website, "Where Purpose and Patriotism Unite," "[m]ost of all, as a civilian employee YOU can serve your nation and support America's warfighter."[5]

Much as the military Services' foundational organizing principles inform each Service's expectations regarding uniformed personnel, emphasizing their basic roles and missions, as described above, DOD civilians also have mission statements that articulate their roles and contributions, emphasizing their Service to the nation.

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[2] Department of Defense Instruction (DODI) 6130.03, Apr. 28, 2010, Incorporating Change 1, Sept. 13, 2011, Medical Standards for Appointment, Enlistment, or Induction in the Military Services.

[3] The White House, "The Executive Branch," https://www.whitehouse.gov/1600/executive-branch.

[4] Army Civilian Corps Creed, http://www.army.mil/values/corps.html.

[5] Department of the Navy Civilian Human Resources, "Where Purpose and Patriotism Unite," http://www.secnav.navy.mil/donhr/Pages/Default.aspx.

The DOD civilian population spans every segment of society, to include individuals with disabilities. The Defense Civilian Personnel Advisory Service (DCPAS) on its "Individuals with Disabilities" web page, states that "[a]s civilians in DOD, IwD [Individuals with Disabilities] play an important role in the defense of our Nation and in helping support our men and women in the military."[6]

These organizing principles govern the roles and missions of the Total Force: Active Component, Reserve Component, and civilian. Any examination of the force impact of expanding recruitment of hearing impaired individuals must be considered through this Total Force lens.

C. Research Hypotheses and Approach

Two basic research hypotheses informed our evaluation of the force impact of expanding recruitment of hearing impaired or any other disabled individuals into the military Services. The analyses focused on testing these hypotheses through the lens of recent operational experiences, as well as projections of future demands on the force. These research hypotheses are grounded in the foundational organizing principles of DOD and the military Services:

1. Service members, regardless of MOS, are expected to be worldwide deployment eligible.

   - Service members must be prepared to possibly deploy into an operational area.

   - Service members must be available and qualified to perform assigned missions or functions in any setting.

2. The requirement for deployment eligibility is unlikely to change in the future.

To test the first hypothesis, this analysis drew on a data-driven research approach, leveraging both quantitative and qualitative data. We examined communities within each Service and their deployment and employment in operations over the past two decades to determine the extent to which all Service members must be prepared to deploy to support ongoing and future missions. We examined data that depicted operational demands, and the sourcing against those demands, which provided insights into both unit and individual demands, highlighted when Service supply did not match operational demands, showed how operational burdens were distributed, and suggested assumed risk. Readiness reporting highlights personnel shortfalls, cross-leveling, "over-manning," etc. Non-standard sourcing of demands (Joint sourced, in lieu of, ad hoc) can depict the extent to

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[6] DCPAS, DOD Careers: Individuals with Disabilities,
http://godefense.cpms.osd.mil/individuals_with_disabilities.aspx.

which a Service member is deployed outside of their organizationally designed construct and occupational specialty. The Service data examined included accession, medical evaluation, MOS reclassification, non-deployable figures and personnel accounts data, as well as Defense Manpower Data Center (DMDC) files that depict utilization by grade and specialty in the U.S. Central Command (USCENTCOM) area. To test the second hypothesis, we leveraged IDA's Stochastic Active-Reserve Assessment model (SARA) and Integrated Risk Assessment and Management Model (IRAMM) to consider force requirements for missions the United States may be called upon to perform in the future.

D. Conclusions

In conducting this research, we determined that there was insufficient evidence to reject these two principle research hypotheses. As reflected in the Services' Correspondence and Task Management System (CATMS) inputs, there are no non-deployable occupations or communities. Every uniformed individual in each of the military Services is expected to be worldwide deployable.

Moreover, recent research on medical standards, conducted to make such standards more evidence-based, resulted in revisions to those standards. Some previously disqualifying medical conditions were removed altogether from the medical standards for accession; however, no recent research efforts proposed relaxing audiometric hearing-level accession standards.

Our examination of personnel data from recent operational experiences did not identify non-deploying communities. While there were some individuals who may not have deployed, there were no non-deployable occupations into which individuals could access. Additionally, the personal burden of deployment and risk changes for those who are deployment eligible when there is an increase in the number of military personnel who are non-deployable.

We also considered future demands on the force. Our research confirms that the requirement for worldwide deployment eligibility is unlikely to change. Given these results, and the extraordinarily stressful futures that may be possible, the assumption that disabled service members could be accommodated by exempting them from deployment appears to be questionable.

We examined the current audiometric hearing-level standards of several other militaries. The general pattern observed across these case studies was that the relaxation of medical standards tends to occur when recruiting demands overwhelmingly exceed the supply of medically qualified recruits. Historical case studies reinforced our research findings and indicate that this question regarding the relaxation of medical standards is not new. When there are severe manpower shortages, the expansion of the potential recruitment pool is generally considered.

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Contents

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1. Introduction

A. Background

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conducted with a range of research participants representing three groups: (1) individuals with hearing impairments, (2) accessibility experts, and (3) individuals with knowledge unique to the objectives of this study. A full list of participants interviewed to address the Senate Report 113-85 questions are found in Appendix E.

Interviews with the first group of individuals required use of assistive technologies or methods. Two interviews were conducted in American Sign Language (ASL) supplemented with lipreading. Two interviews were conducted with cochlear implant (CI) users: one was in person, and the other was conducted by telephone. Two interviewees used a frequency modulation (FM) loop system and hearing aids with a telecoil setting. One interviewee used a video relay telephone service. These assistive technologies and methods are discussed further in Section 2.

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A third group of individuals were approached as part of this research because of their unique perspectives on the question of people with hearing impairments in military settings or careers previously not open to those with hearing impairments.

The Computer/Electronic Accommodations Program (CAP) is a DOD program that has been operational since 1990.[7] CAP provides technical assistance and equipment as reasonable job accommodations for DOD civilian and uniformed personnel. A request to complete a survey was sent to the approximately 300 individuals who use the CAP and who have hearing impairments. Responses to the survey were obtained from 25 individuals. Research participants represented a broad range of careers—from facilities engineer to librarian. Most of these individuals could be characterized as office workers (17 of the 25). One respondent currently serves as a member of the armed forces. Seven respondents held supervisory positions. The severity of hearing impairment reported ranged from slight/moderate (10 of the 25) to profound (4 of the 25). Eight individuals could be characterized as having severe hearing loss. Another three individuals reported having a CI. Six individuals reported some familiarity with ASL.

In addition to demographics, the survey asked questions regarding accommodations and barriers. The survey instrument was not intended to be a scientific estimation of a population. It was purely an exploratory tool, and assisted in identifying topics for further

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[7] CAP, "Computer/Electronic Accommodations Program," accessed September 2, 2015, http://www.cap.mil/.

examination by providing additional insight from individuals with hearing impairments beyond the literature review and interviews.

C. The Foundational Organizing Principles of the Military Services and the DOD Total Force

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DOD's guidance informs the military Service's foundational organizing principles, which underlie each Service's fundamental personnel expectations and cultural norms, as tied to their basic roles and missions.

The Army's foundational organizing principle emphasizes that every soldier is a "Warrior." According to Army Field Manual 3-21.75, *The Warrior Ethos and Soldier Combat Skills*, "[t]oday's conflicts are fought throughout the whole spectrum of the battlespace by all Soldiers, regardless of military occupational specialty (MOS)." As warriors, professional soldiers must be "trained, ready, and able to enter combat; ready to fight—and win—against any enemy, any time, any place."[9]

The Navy's foundational organizing principle also emphasizes a Total Force construct, which incorporates Active and Reserve Component Service personnel. According to the Navy's 2014 document, "The Nation's Total Force: At the Right Place, At the Right Time, All the Time," "[t]he evolving dynamics of the 21st century security environment require forces to be ready to deploy globally."[10]

The Air Force also emphasizes the expeditionary nature of Airmen and Airwomen. For example, the Air Force Pamphlet (PAM) 10-100, *Airman's Manual*, states that "[a]s

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[8] Department of Defense Instruction (DODI) 6130.03, Apr. 28, 2010, Incorporating Change 1, Sept. 13, 2011, "Medical Standards for Appointment, Enlistment, or Induction in the Military Services."

[9] Army Field Manual 3-21.75, *The Warrior Ethos and Soldier Combat Skills*, retrieved at https://fas.org/irp/doddir/army/fm3-21-75.pdf.

[10] Department of the Navy Fiscal Year 2014 Annual Financial Report, "The Nation's Total Force: At the Right Place, At the Right Time, All the Time," November 2014.

an expeditionary Airman you must stay ready to deploy anywhere in the world on short notice."[11]

The Marine Corps emphasizes that every Marine is a rifleman. Regardless of their Military Occupational Specialty (MOS), every Marine must be ready to take on a range of basic roles in support of their core missions.[12]

DOD also includes non-uniformed, civilian personnel as part of its Total Force. According to the White House, Executive Branch web site, DOD "is the largest government agency, with more than 1.3 million men and women on active duty, nearly 700,000 civilian personnel, and 1.1 million citizens who serve in the National Guard and Reserve forces. Together, the military and civilian arms of DOD protect national interests through war-fighting, providing humanitarian aid, and performing peacekeeping and disaster relief services."[13] This Total Force emphasis—which extends beyond the Active and Reserve Component, to include the DOD civilian workforce—is central to the underlying organizing principle that informs DOD civilian workforce identity.

For example, according to the Defense Civilian Personnel Advisory Service (DCPAS) website, "There's a Place for You," "[e]very Department of Defense employee plays a vital role in securing our country and preserving our freedoms. We seek applicants from all backgrounds, from students to Veterans. Become a part of our talented, dedicated and diverse workforce!"[14]

Civilians employed by the military Services are similarly considered "members of the team." According to the Department of the Army Civilian Service, Army Civilian Corps Creed, Army civilians are members "of the Army Team [....] dedicated to our Army, our Soldiers and Civilians." These civilians "always support the mission," and "provide stability and continuity during war and peace." Army civilians "consider it an honor to serve our Nation and our Army;" they "live the Army Values of Loyalty, Duty, Respect, Selfless Service, Honor, Integrity, and Personal Courage."[15]

Similarly, the Navy characterizes civilian service as service to the nation. According to the Navy Civilian Human Resources website, "Where Purpose and Patriotism Unite,"

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[11] Air Force PAM 10-100, *Airman's Manual*, 1 March 2009 (incorporating Change 1, 24 June 2011), retrieved at: http://static.e-publishing.af.mil/production/1/af_a3_5/publication/afpam10-100/afpam10-100.pdf.

[12] Marine Corps source: http://www.marines.com/becoming-a-marine/school-of-infantry.

[13] The White House, "The Executive Branch," https://www.whitehouse.gov/1600/executive-branch.

[14] DCPAS, "There's a place for you" http://godefense.cpms.osd.mil/index.aspx.

[15] Army Civilian Corps Creed, http://www.army.mil/values/corps.html.

"[m]ost of all, as a civilian employee YOU can serve your nation and support America's warfighter."[16]

The Department of the Air Force Civilian Service also characterizes the complementary nature of the work and service performed by their Air Force civilians. The Air Force Civilian Service website, "About us," emphasizes: "That's us – the Air Force Civilian Service (AFCS). We don't wear uniforms or have military service obligations, but we do work side by side with active duty Airmen and Airwomen to provide every kind of support service needed to fulfill that Air Force mission."[17]

Much as the military Services' foundational organizing principles inform each Service's expectations regarding uniformed personnel, emphasizing their basic roles and missions, as described above, DOD civilians have mission statements that articulate their roles and contributions, and emphasize their Service to the nation. The DOD civilian population spans every segment of society, including individuals with disabilities. As articulated by DCPAS in "Individuals with Disabilities," "[a]s civilians in DOD, IwD [Individuals with Disabilities] play an important role in the defense of our Nation and in helping support our men and women in the military."[18]

These organizing principles govern the roles and missions of every aspect of the Total Force: Active Component, Reserve Component, and civilian. Any examination of the force impact of expanding recruitment of hearing impaired individuals must be considered through this Total Force lens.

D. Research Hypotheses

Two basic research hypotheses informed our evaluation of the force impact of expanding recruitment of hearing impaired or any other disabled individuals into the military Services. The analyses conducted focused on testing these hypotheses through the lens of recent operational experiences, as well as projections of future demands on the force. These research hypotheses are grounded in the foundational organizing principles of DOD and the military Services.

The first hypothesis was that all military Service members, regardless of MOS, code, or designator, must be worldwide deployment eligible. All Service members must be prepared to deploy into an operational area in support of ongoing and future missions. Service members must be available and qualified to perform assigned missions, to include

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[16] Department of the Navy Civilian Human Resources, "Where Purpose and Patriotism Unite," http://www.secnav.navy.mil/donhr/Pages/Default.aspx.

[17] Air Force Civilian Service, "About Us," http://afciviliancareers.com/content/about-us.

[18] DCPAS, DOD Careers: Individuals with Disabilities, http://godefense.cpms.osd.mil/individuals_with_disabilities.aspx.

roles and functions outside of their occupation, in any setting. To test this hypothesis, we examined communities within each Service and their deployment to and employment in the U.S. Central Command (USCENTCOM) area of operations.

The second hypothesis was that this requirement for deployment eligibility is unlikely to change in the future. To test this hypothesis, we leveraged IDA's Stochastic Active-Reserve Assessment model (SARA) and Integrated Risk Assessment and Management Model (IRAMM) to consider force requirements for missions the United States may be called upon to perform in the future.

E. Research Approach to Hypothesis 1

To examine the first hypothesis—that all Service members, regardless of occupation, must be deployment eligible—this analysis drew on a blended, data-driven research approach, with both quantitative and qualitative data. To determine the extent to which all Service members must be prepared to deploy into an operational area in support of ongoing and future missions, it was necessary to examine communities within each Service and their deployment and employment in operations within the USCENTCOM area from 2002 to 2009.

These analyses drew on Service and Joint data. The Joint data sources included historical data on deployment and hearing; Defense Manpower Data Center (DMDC) personnel, compensation, and activation files; the Hearing Center of Excellence (HCE); Accession Medical Standards Analysis and Research Activity (AMSARA) reports; and Global Force Management (GFM)/Request for Forces (RFF) and readiness data. GFM/RFF and readiness data served as a recent proxy (Operation Enduring Freedom/Operation Iraqi Freedom) for Service member deployment. These data depict operational demands and the sourcing against those demands, provide insights into both unit and individual demands, highlight when Service supply did not match operational demands, show how operational burdens were distributed, and suggest assumed risk. Readiness reporting highlights personnel shortfalls, cross-leveling, "over-manning," etc. Non-standard sourcing of demands (Joint sourced, in lieu of, ad hoc) can depict the extent to which a Service member is deployed outside of their organizationally designed construct and occupational specialty.

The Service data included accession, medical evaluation, MOS reclassification, non-deployable figures and personnel accounts data on trainees, transients, holdees, and students (TTHS accounts), as well as additional data that we obtained and used in conjunction with the DMDC files to depict utilization by grade and specialty.

The literature reviewed for this assessment included articles in peer-reviewed journals; HCE, AMSARA, and Tri-service Disability Evaluation Systems (DES) reports; National Research Council documents; RAND reports; DOD Inspector General (DODIG)

and Government Accountability Office (GAO) reports; and DOD and Service regulations and policies. These documents provided us with (1) additional evidence related to operational availability requirements; (2) insights into how DOD systems historically responded; and (2) information about experiences those individuals with hearing impairment had within the DOD systems. Also, part of our review examined literature that highlighted changes associated with global security, U.S. national strategies, and/or projected future missions or requirements.

IDA also conducted a limited number of targeted interviews to obtain perspectives on how the Services approach operational availability and how the Service personnel systems have historically responded to non-deployable personnel. The discussions also explored changes already underway in operational availability requirements; changes to MOS characteristics/systems (current or projected); and the costs associated with such changes.

Finally, IDA examined a limited number of case studies on other militaries (current and historical) and their hearing level standards, along with the operational availability and utilization of (and experience with) soldiers with hearing impairments. The primary current case studies address the medical standards used by the United Kingdom (UK) Ministry of Defence (MOD), the Israeli Defense Forces (IDF), and the deployment standards from the North Atlantic Treaty Organization (NATO). With limited information available, we also examined the case of the Islamic State and the extent to which their operatives may include individuals with impaired hearing. The historical case studies included the Invalid Corps in the U.S. Civil War and the German experience with the employment of hearing impaired individuals during World War II.

F.   Research Approach to Hypothesis 2

To examine the second hypothesis—that this requirement for deployment eligibility is unlikely to change in the future—we examined Service inputs and operational effectiveness data from existing studies. We also leveraged IDA's Stochastic Active-Reserve Assessment model (SARA) and Integrated Risk Assessment and Management Model (IRAMM) to consider force requirements for missions the United States may be called upon to perform in the future. In particular, we examined changes already being made to operational availability requirements. Such modifications may include changes to MOS characteristics, as well as shifts in the foundational organizing principles of the military Services.

G.   Document Overview

This assessment consists of eight parts that: (1) provide a summary of the research scope and approach; (2) describe hearing impairments and accommodations; (3) document the relevant policies and issuances on audiometric hearing level accession, retention, and deployment standards; (4) highlight the employment of individuals with hearing

impairments and MOS for further consideration; (5) describe recent deployment experiences, associated force management processes and issues, and future demands on the force through the lenses of personnel availability and mission types; (6) summarize some of the recent relevant research on audiometric hearing level standards; (7) provide an overview of other militaries' hearing level standards, with some present-day and historical examples; and (8) provide research conclusions.

2. Overview of Hearing Impairments and Accommodations

A. Hearing Impairment

Sound is a wave described in terms of frequency and amplitude (i.e., loudness). Frequency is the number of cycles a sound wave completes in a second and is measured in hertz. Pitch or tone is the perceptual experience of frequency. Humans are able to hear sounds that have frequencies between 16 and 20,000 Hz.[19] The human voice produces frequencies between 80 and 14,000 Hz; however, most human sounds are primarily in the range of 250 to 8,000 Hz.

Amplitude is the magnitude of the sound wave energy and is measured in decibels. The notation for the amplitude of a sound is dB(SPL), which indicates the sound pressure level on a logarithmic scale. The amplitude is 10 times greater for every 10 dB(SPL), which means that 20 dB(SPL) is 10 times more powerful than a sound at 10 dB(SPL). Normal conversation is typically 60 dB(SPL). On the other end of the scale, a motorcycle is approximately 90 dB(SPL). The Occupational Safety and Health Administration (OSHA) limits sound exposure of 115 dB(SPL) to no more than 15 minutes when hearing protection is not used.

The human ear does not perceive loudness (amplitude) the same at different frequencies. Therefore, a scale that normalizes the difference of "hearing level" across frequencies was developed, dB(HL). The 0 dB(HL) loudness is used as a benchmark for hearing tests and is represented by normal hearing of a particular frequency in a very quiet environment.

In terms of physiology, the pinna, or visible portion of the ear, collects and funnels sound waves to the outer ear. These sound waves travel through the numerous sensory structures within the outer, middle, and inner ear to the auditory nerve. Each of the numerous sensory structures is specialized for assisting in the transfer of the physical sound wave into an electrochemical impulse of the nervous system. The nerve impulses are carried via the auditory nerve to various parts of the brain.

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[19] C. Peres et al., "Auditory Interfaces," in *HCI Beyond the GUI: The Human Factors of Non-traditional Interfaces*, ed. P. Kortum (Burlington, MA: Morgan Kaufman, 2008), 151, doi:10.1016/B978-0-12-374017-5.00005-5.

A problem at any stage could result in a hearing impairment. Conductive hearing loss is when there is a problem with the outer or middle ear (i.e., mechanical structures that pass along the sound energy). Sensorineural hearing loss is when there is a problem with the inner ear (e.g., cochlea) or auditory nerve. A mixed hearing loss is when conductive and sensorineural hearing losses are present.

Traditionally, hearing tests have entailed having individuals listen to a set of frequencies (pure tones) at various amplitudes. At each frequency (Hz) tested, the lowest amplitude (dB(HL)) an individual hears is recorded for each ear. The resulting two-line graph (left and right ears) is called an audiogram (see Figure 1). The specific values and the shape of the lines (i.e., flat, upward slant, downward slant, curve) are used by audiologists to determine the nature and severity of the hearing impairment and the best course of treatment. The specific levels that indicate a hearing impairment are defined differently by different organizations, which will be described in further detail.
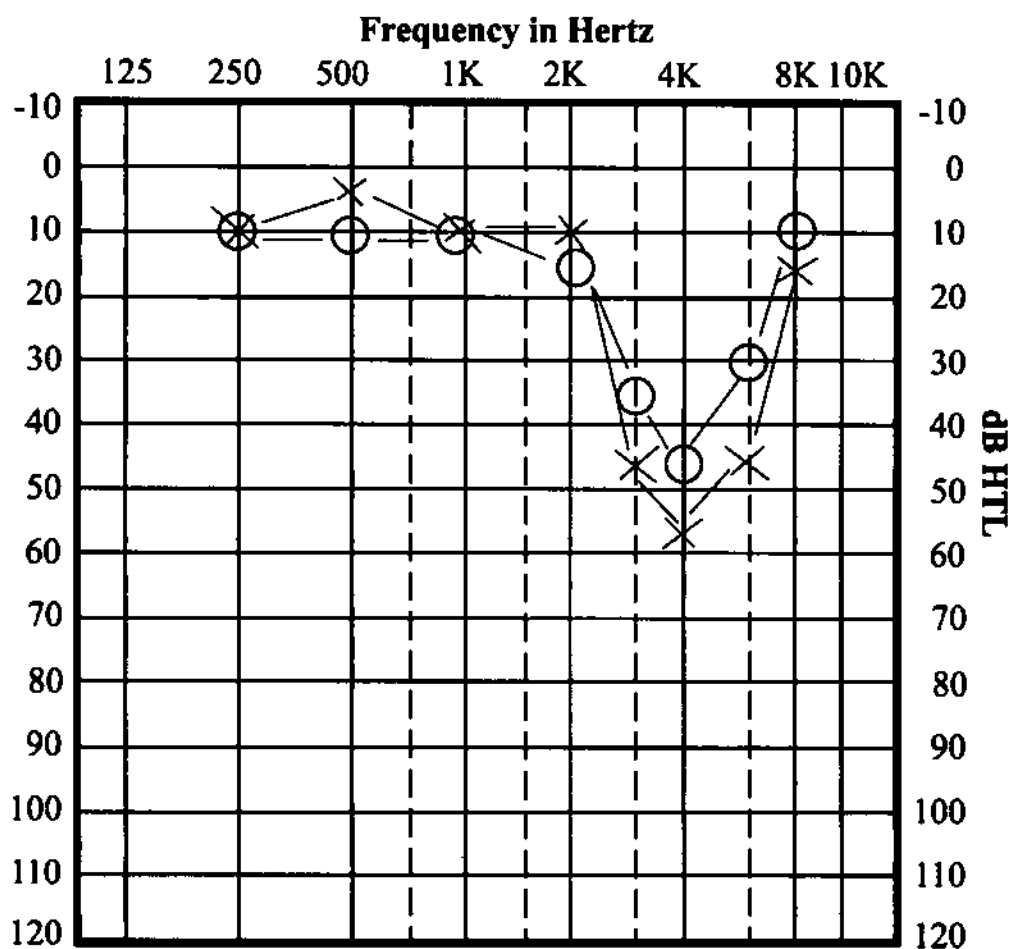
Source: Marshall Chasin, "Music and Audiometric Asymmetries," *Hearing Health & Technology Matters*, May 5, 2011, http://hearinghealthmatters.org/hearthemusic/2011/music-and-audiometric-asymmetries/.
Note: This chart uses dB HTL (hearing threshold level), which is the same as dB(HL).

Figure 1. Sample Audiogram

B. Accommodations

Four Federal laws describe accommodations for those with hearing impairments. The first is Section 508 of the Rehabilitation Act of 1973. A similar section requiring non-Federal employers to provide reasonable accommodations is also in the Americans with Disabilities Act (ADA) of 1990 and amendments. The other two laws are the Assistive Technology Act of 1998 and the 21st Century Communications and Video Accessibility Act (CVAA) of 2010.

The Assistive Technology Act of 1998 and its 2004 amendment allocate money to the states and territories through the Department of Education to provide assistive technologies for individuals with disabilities. The CVAA updates several previous laws that mandated the accessibility of communication technology. The update was necessary since mobile phones and the Internet advanced faster than the legislation. Essentially, these laws enable individuals with disabilities to have full access to civilian communications through universal design of the communication technology or through individual accommodations.

Numerous accommodations are used by individuals with hearing impairments. The variety of accommodations is a result of the variety of tasks typically involving hearing (e.g., alerting, sound discrimination, and communication) and the nature of the impairment. Quite often, individuals with hearing impairments use strategies or general consumer technologies (e.g., mobile phones, email, instant messaging, speech-to-text software) to overcome barriers. Technologies specifically designed for the hearing impaired, many of which are also useful for the general public, have also been developed. In the remainder of this section, the strategies and technologies used by individuals with hearing impairments are described by task.

This section provides a broad overview of the accommodations (assistive technologies and methods) available. Not all of these accommodations may be appropriate for the military, particularly in operational environments. Furthermore, this list is not an exhaustive set of accommodations available or in development.

1. General Hearing Device

The first category of accommodations includes technologies that improve general hearing ability. General hearing devices consist of at least three components: a microphone, a processor, and a transmitter. The microphone picks up sounds, which are then amplified by the processor. In many general hearing devices, the processor amplifies certain sounds while reducing other sounds. The selection of which sounds to amplify and which sounds to reduce is based on the tuning of the processor. The tuning considers the nature of the hearing impairment and the needs of the individual. These processed sounds are then transmitted to the individual in different ways depending on the type of device. It is tempting to describe general hearing devices as the same as wearing glasses or contact

lenses to improve vision. However, unlike vision, it is not possible to replicate normal hearing. Instead, it involves an *augmentation* of the sound stimulus to make it more useful to the user than it would be without the amplification system. These general hearing devices improve hearing based on the individual's specific hearing needs—with the goal of maximizing effectiveness rather than replicating normal hearing.

General hearing devices are divided into two categories: wearable and implanted. Wearable devices are entirely external to the individual and are appropriate for people with moderate or severe hearing loss. Implanted devices require surgery but may also have external components. Some implanted devices are for those individuals with profound hearing loss, and others are for those individuals with moderate or severe hearing loss. Military Service personnel are permitted to deploy with wearable amplification devices if they meet overall deployability guidelines without the device. However, the individual is responsible for the maintenance and logistics of the device (e.g., battery supply).

a. Wearable

The Food and Drug Administration (FDA) makes a distinction between two categories of wearable amplification devices: hearing aids and personal sound amplification products (PSAPs). Per the FDA, hearing aids are for those with hearing impairments, and PSAPs are to help amplify sound.[20] Hearing aids must be dispensed through a licensed audiologist and approved by the FDA. The program(s) within hearing aids are tuned by the audiologist based on the individual's impairment and needs. PSAPs are available in drugstores and are not licensed by the FDA. Any tuning of a PSAP is done by the individual, and this tuning may not be as effective as the tuning done by a trained audiologist with equipment for enhancing tuning.

Hearing aids and PSAPs have many different models from which to choose. Some of the largest differences between models include (1) how they are worn (e.g., behind the ear, on or in the pinna, or in the outer ear/ear canal), (2) whether the device is analog or digital, (3) whether the device is Bluetooth enabled, and (4) whether the device has a telecoil setting.[21] Models of hearing aids and PSAPs also differ in terms of durability, cost, and battery life. Even within a specific model of hearing aid/PSAP, battery life is highly variable. First, the amount of time that the device is on vs. off will affect the battery life. Second, the batteries vary depending upon manufacturer and model. Finally, the way in which batteries are stored can affect their life.

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[20] U.S. Food and Drug Administration, "Regulatory Requirements for Hearing Aid Devices and Personal Sound Amplification Products - Draft Guidance for Industry and Food and Drug Administration Staff," last updated July 27, 2015, http://www.fda.gov/RegulatoryInformation/Guidances/ucm373461.htm.

[21] Telecoil or T-coil is inside many, but not all, general hearing devices. The telecoil processes sound to eliminate background noise and serves as a wireless receiver.

b. Implants

The CI is the most well-known of the hearing implants. However, several other implanted devices are available. These include auditory brainstem implants (ABIs), bone anchored hearing aids (BAHAs), middle ear implants, and semi-implantable devices. Each of these implants is described in the following subsections.

1) CIs

CIs are for those individuals with severe to profound sensorineural hearing loss. CIs bypass the sensory receptors of the outer, middle, and inner ear and transmit sound sensations directly to the nervous system.[22] The parts of a CI include a microphone, processor, transmitter, and a receiver/stimulator with an array of electrodes. The microphone senses the sound from the external world, while the processor divides the sound based on frequency intervals and converts the sound signal into a digital signal of multiple channels. The transmitter sends the multi-channel signal across the skin through electromagnetic induction to the receiver/stimulator, which is surgically implanted under the skin in the bone behind the ear. The receiver/stimulator converts the signal into electric pulses, and the array of electrodes implanted in the cochlea stimulates different regions of the auditory nerve at the cochlea.

Just as with hearing aids, the microphone and processor are worn externally and can be removed. The transmitter is held in place behind the ear with a magnet to keep it aligned with the receiver/stimulator so the signal can cross the skin barrier. Various magnets are available, and preference for a particular individual magnet depends on activity and hair thickness. An individual may also choose to wear a headband designed to keep the magnet in place.

The microphone and processor are not fragile. Microphone protectors increase the durability, particularly by preventing dust from entering. These protectors should be changed every 6 months. The external cables and coils that connect the various components last roughly a year. Waterproof external components, are also available.

Just as with wearable hearing devices, battery life varies. One of the largest factors that affect battery life is the processing program. The current generation of CIs enables an audiologist to establish up to four different processing programs. The individual can switch quickly between these four programs by pressing a button on the external components. Some programs require more power than others. Rechargeable batteries can be recharged multiple times over the course of a year. Disposable batteries are also available, and they last for 24–32 hours of use.

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[22] Hybrid CIs are also available for individuals with some hearing. Frequencies that individuals cannot hear are sensed by the implant. Other frequencies are processed through the acoustic component.

As noted previously, hearing devices do not replicate normal hearing. CIs were originally designed and optimized for speech communication. Technological advancements continue to improve the range and fidelity of sounds heard by individuals with CIs. Since the processor and microphone are external, most of the advancements can be achieved without surgery.

In addition, an individual with a CI has some hearing capabilities that surpass normal hearing capabilities. According to Colonel Mark Packer, MD, and Dr. Douglas Brungart, PhD, of the DOD Hearing Center of Excellence, Walter Reed National Military Center, there is a small study examining the ability of individuals with a CI to exclude some sounds while hearing other sounds (e.g., radio) that are not perceivable by those without a CI.[23] The vocoder, which is one of the technological foundations of the CI function, is also fundamental technology used in World War II to encrypt voice communications.

2) Other implants

Several other implanted technologies, specifically ABIs, BAHA, middle ear implants, and semi-implantable devices are available. Each of these technologies is appropriate for a different hearing impairment and is described briefly in the following paragraphs.

3) ABIs

ABIs are very similar to CIs. The one difference is the ABI connects to the auditory centers of the brain, not the auditory nerve. ABIs are for individuals with sensorineural hearing loss, specifically those individuals whose auditory nerve is damaged. The FDA approved use of ABIs for adults in 2000.

4) BAHAs

BAHAs (also known as osseointegrated or bone-integrated hearing devices) are typically used by individuals with conductive or mixed hearing loss and for whom hearing aids are not effective. BAHAs consist of two components: a titanium post, which is surgically implanted in the temporal bone, and a processor, which his worn externally. Over time, the titanium post fuses with the temporal bone. The processor is worn behind the ear. It translates sound waves to vibrations of the post, which are transmitted to the inner ear via bone conduction. Since a small portion of the post must be external to connect with the processor, the individual risks infection at the site if proper care is not taken. The FDA approved BAHAs in 1997.[24]

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[23] Information obtained during the interview with these two individuals.

[24] Abdulrahman Hagr, "BAHA: Bone-Anchored Hearing Aid," *International Journal of Health Sciences* 1, no. 2 (July 2007): 266, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3068630/.

5) Middle ear implants and semi-implantable devices

As with BAHAs, middle ear implants and semi-implantable devices are chosen by individuals who have found hearing aids ineffective. Unlike BAHAs, these devices are chosen by individuals with sensorineural hearing loss. Middle ear and semi-implantable devices are attached to a bone of the middle ear. The processor translates sound into vibrations that are picked up by the sensory structures of the middle ear. In middle ear implants, the processor is contained in the device that is implanted. In semi-implantable devices, the processor is worn externally. The first semi-implantable device was approved by the FDA in 2000.[25] The first totally implanted middle ear device was approved by the FDA in 2010.[26]

2. Communication

The vast majority of accommodation methods and technologies are designed to support communication. The variety results from the many different types of hearing impairments and the myriad of ways in which we communicate. For this study, communication accommodations have been grouped as follows: communication strategies, interpretation, written communication, interpretation, distance communication, and assistive listening systems/devices (ALS/Ds).

a. Communication Strategies

Many different strategies are available to augment communication and to improve comprehension even for those without hearing impairments. For example, the military uses the phonetic alphabet (e.g., Alpha, Bravo, Charlie, Delta) and says "niner" instead of "nine" to distinguish it aurally from five. Words that consist of phonemes and syllables that are clearly distinct from one another ensure better comprehension.

Studies have shown that unconscious lipreading is an important component of speech perception for everyone and is even more so for those with hearing impairments.[27] Eleven of the 25 survey respondents stated they consciously used lipreading to assist communication. Therefore, ensuring that eye contact is made before speaking is a strategy for improving communication. Similarly, it is important that one keeps his/her hands away from the mouth while talking.

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[25] David S. Haynes et al., "Middle Ear Implantable Hearing Devices: An Overview," *Trends in Amplification* 13, no. 3 (September 2009): 207, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4111438/.

[26] U.S. Food and Drug Administration, "FDA Approves First Totally Implanted Hearing System," FDA News Release, March 17, 2010, last updated April 24, 2013, http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm204956.htm.

[27] Harry McGurk and John MacDonald, "Hearing Lips and Seeing Voices," *Nature* 264, no. 5588 (23 December 1976): 746–748, doi:10.1038/264746a0.

Another strategy to improve communication is to use gestures and facial expressions. Similar to lipreading, body language provides additional signals that aid in interpreting communications. Through body language, one can interpret when something is not clear. In such cases, one could rephrase with simpler sentences.[28]

b. Interpretation

One well-known method for individuals who are hearing impaired to communicate with hearing individuals is through the use of an interpreter. ASL, Signed English, cued speech, and oral interpretation are examples of different forms of interpretation; however, these forms of interpretation are not interchangeable. The communication preference and abilities of those involved determine which type of interpretation should be used.

ASL is the native language of many deaf people in North America. The grammar of ASL is distinct from English.[29] Thus, in some situations, interpreters may use Signed English, in which the words are signed with the grammatical structure of English as they are spoken. A third category of interpretation is cued speech, in which interpreters silently mouth words and use a distinct system of seven hand shapes in five specific positions near the mouth to enhance lipreading. Similar to cued speech, there is oral interpretation, whereby an interpreter silently mouths the words using natural gestures and facial expressions to provide non-verbal information. Finally, sign language interpreters and cued speech or oral interpreters are not interchangeable because they each require a different skill set and most interpreters who can do one method may not be skilled or certified in another method of interpretation.

Interpreters can be used for any communication, but, in many work situations, they may be limited to important presentations or meetings. Most commonly, interpreters are in the same room as the person for whom they are interpreting, but interpretation services can also take place via video-teleconference. Such services enable interpreters to be available with less notice and do not require travel for the interpreter. However, video-teleconference interpreting does have lag time due to the technology, and this lag time may impede the conversation.

When selecting an interpreter, he or she should be familiar with the topic of the conversation. If an interpreter is unfamiliar with the jargon or concepts, he/she will not be

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[28] "How to Speak to Deaf People," (blog) *Deaf News Today* (blog), June 16, 2015, http://deafnewstoday.blogspot.com/2015/06/how-to-speak-to-deaf-people.html.

[29] In the United States, the term "deaf" is sometimes capitalized to indicate people who consider themselves culturally Deaf, with ASL being a key component of their cultural identity. These Deaf individuals distinguish themselves from individuals who are also deaf but are not ASL users and do not associate with deafness as part of their cultural identity.

able to communicate effectively. For this reason, many organizations have interpreters on staff, which also ensures the security of confidential information.

Two other categories of accommodation that are variants of interpretation services are (1) telephone relay services, which are interpretation services for telephone conversations, and (2) automatic-interpretation technologies that are currently being developed.

1) Telephone relay services

Telephone relay services are generally the same as interpreter services but are exclusively for phone conversations. Therefore, many of the same benefits and limitations exist. As with interpreters, multiple types of relay services are available, including teletypewriter (TTY), captioned telephone (CapTel) service, Internet Protocol (IP) Relay, video relay service (VRS), and speech-to-speech. The use of a particular relay service is based on availability and preference.

The oldest of these relay services is the TTY. With such a system, a deaf person with a TTY uses a dedicated telephone line connected to a telephone relay service center. The individual with a hearing impairment reads text of what the non-TTY user says transcribed by the communication assistant (CA). In addition, the individual with hearing impairment types his/her message on a TTY, which is read aloud by the CA to the hearing person.

For those individuals with hearing impairment but clear speech, CapTel is another alternative. This service is a telephone with a large text display. The individual with a hearing impairment speaks to the other party normally. The CA transcribes everything that is said by the other party, which is presented on the display. TTY and CapTel sometimes do not function well when used with Voice over Internet Protocol (VOIP) telephone systems. Since 79% of businesses and nearly half of all residential wireline phones in the United States use VOIP, the TTY is falling out of favor.[30]

CapTel equipment has been modified to better function with VOIP.[31] An alternative to TTY is internet protocol (IP) relay. Just as with CapTel and TTY, IP relay is a captioning relay service. However, the individual with hearing impairment uses a computer connected to the Web. The CA is connected via telephone to the other party. As with TTY, the CA

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[30] Lauren Allen, "Technology Calling: VOIP Systems Becoming More Ubiquitous among Small Business Owners," *MiBiz*, February 2, 2014, http://mibiz.com/item/21284-technology-calling-voip-systems-becoming-more-ubiquitous-among-small-business-owners; David Hamilton, "US Phone Customers Move from Incumbent Carriers to VOIP: FCC Report," *The Whir*, July 21, 2014, http://www.thewhir.com/Web-hosting-news/phone-customers-move-incumbent-carriers-voip-us-fcc-report.

[31] Hamilton CapTel, "What is Hamilton CapTel?," accessed September 23, 2015, http://www.hamiltoncaptel.com/what_is_hamilton_captel/.

transcribes and reads the typed messages. IP relay has several benefits. First, no special equipment is needed. A standard computer with an Internet connection will work. Second, call transmission is usually faster with IP than with TTY or CapTel. Third, a multi-party call is possible with IP relay.

An alternative to caption-based relay services is VRS. This service is preferred by those who communicate primarily in ASL. The individual with a hearing impairment connects to a CA via videophone. The CA connects via telephone to the other party and interprets between ASL and spoken English. One problem with VRS is that videophones have potential problems with bandwidth, and these problems can affect video quality.

Finally, the CAs in speech-to-speech relay services are trained to understand speech impediments and to clearly enunciate over a telephone line. The CA revoices the conversation so that both parties can clearly understand each other. These services are more commonly used by individuals with speech impediments than by individuals with hearing impairments.

2) Technologies in development

Several different organizations are currently developing systems that translate ASL to speech or text. Microsoft has developed a prototype system using the Kinect sensor that translates ASL to speech and vice versa. The source code is freely available.[32]

Motionsavvy's UNI is a two-way communication tool that will be available in 2016.[33] UNI translates gestures into speech and speech into text. It has two versions. One version is a computer application. The other is a specialized tablet, which is portable and has a camera optimized for gesture recognition. Engineering students around the world have separately developed functioning prototypes of an ASL translation system using a glove.[34] The gloves have various sensors that are connected to a processor and a speech synthesizer. The speech synthesizer articulates what has been signed.

c. Written Communication

A wide variety of accommodations use written communication. For example, an alternative to interpretation is the use of Communication Access Realtime Translation

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[32] Kinect Translation, "Kinect Translation Tool: From Sign Language to Spoken Text and Vice Versa," last updated October 24, 2014, https://kinecttranslation.codeplex.com/.

[33] Motionsavvy, "With UNI, You Can:," accessed August 24, 2015, http://www.motionsavvy.com/#learn-more.

[34] Shreya Pareek, "4 Engineering Students Have Developed a Device That Converts Sign Language into Voice and Text," *The Better India*, June 10, 2015, http://www.thebetterindia.com/25217/engineering-students-develop-device-to-convert-sign-language-into-voice-text/; Darren Quick, "Sign Language-to-Speech Translating Gloves Take Out Microsoft Imagine Cup 2012," *gizmag*, July 10, 2012, http://www.gizmag.com/enabletalk-sign-language-gloves/23268/.

(CART) service. A transcriptionist types a transcript of what is being said. This transcription is visible in real time. CART works for large meetings and presentations. Other accommodations using written communication involve technology designed specifically for individuals with hearing impairments.

One technology specifically designed for individuals with hearing impairments is the face-to-face communicator. With this communicator, two people sit across from one another (either side of the machine) and type their communication back and forth. One respondent in the survey said that he had attempted to use it but his coworkers were unwilling. In the survey and interviews, we learned that many people write notes to accomplish this back-and-forth type of communication. One survey respondent said she used a blackboard in her office for this purpose. Individuals whose jobs entail having similar conversations repeatedly maintain a set of pre-written notes to facilitate communication.[35]

Another relevant technology is speech to text. Since speech is a natural way for hearing individuals to communicate, the advances in voice recognition technology are also helpful accommodations for individuals with hearing impairments. Voice recognition technology is used by several companies that offer speech-to-text software for personal computers (PCs) (e.g., Nuance, Media Freeware, PC Treasures). Most mobile phones and tablets also come with speech-to-text capability.

Two technologies are being developed that enhance speech to text specifically for the hearing impaired. The first technology is Captioning on Glass by Google and the Georgia Institute of Technology. Captioning on Glass enables a hearing-impaired individual who is wearing Google Glass to look at a speaker and see the text of what he or she is saying.[36] This device is particularly useful for one-on-one conversation and for events at which an individual is speaking to a group. Captioning on Glass is an application available for the beta testers of Google Glass who have an Android phone or tablet.[37]

The second technology is Transcence, which is a speech-to-text application designed to assist with group conversations. It uses the microphones in smartphones, which have been synced to a PC or the smartphone of an individual with a hearing impairment. The

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[35] FOX 6 News, "Milwaukee Postal Employee Uses UbiDuo for Work," video, 4:12, June 16, 2011, https://www.youtube.com/watch?v=292Y2NTyKZY.

[36] Google Glass is a form of augmented reality glasses.

[37] Michelle Starr, "Real-time, Real-world Captioning Comes to Google Glass," *CNET*, October 2, 2014, http://www.cnet.com/news/real-time-real-world-captioning-comes-to-google-glass/.

PC or smartphone displays a transcription of what is being spoken. This transcription is color coded by speaker.[38] Transcence is still in development.

Captioning is also important for audiovisual presentations, such as training videos. Despite the advancements in speech recognition, some auto-captioning systems are notoriously inaccurate. As such, human captioning is still the preferred method for pre-recorded presentations. For many organizations that create video content for the Web, crowdsourcing captioning is a less costly alternative. People volunteer to type in captions using software, such as Amara, which makes adding the captions simple.[39]

d. Distance Conversations

Modern communication technology enables synchronous conversations to occur at a distance via email, text messaging, instant messaging, telephone, and video teleconference. One of the more common accommodations for the telephone is the relay service. Relay service was described in the subsection on interpretation. For two individuals, both with TTYs, a direct TTY-to-TTY conversation works well.

The following subsections describe videophones, telephone amplification devices, wideband audio/high definition (HD) voice, and Web real-time communication (WebRTC).

1) Videophone

Videophones (also known as Video Tele-Conference (VTC)) are now widely available either as applications on smartphones and tablets, programs using the Web, or systems built into conference rooms. For the hearing impaired, these systems enable the perception of body language and, in some cases, lipreading. Similarly, these systems enable those whose primary language is ASL to speak with each other.

When selecting a VTC system to be used by the deaf or hard of hearing, the frame rate and audiovisual synchronization must be considered. Similarly, when using a VTC, it is important that the lighting of the space is optimized for the camera. If any of these factors are suboptimal, they can impede the ability of individuals to follow the conversation. It is also important to note that not all VTC systems work with relay services. Finally, since those with hearing impairments often have difficulty identifying the speaker, the VTC should incorporate a system that identifies who is speaking.

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[38] Transcense, "Hard Time Following Group Conversations?," accessed August 26, 2015, http://www.transcense.com/.

[39] Amara, "Amara Makes Video Globally Accessible: Captions, Subtitles, and Translation Simplified," accessed August 26, 2015, https://amara.org/en/.

2) Telephone amplification

The telephone is still the primary device for people to communicate at a distance. For those with some hearing ability, amplifying the telephone is effective at improving communication. Such amplification can occur via use of an amplified telephone or an amplification device connected to a phone via wires or wirelessly (e.g., via Bluetooth).

3) Wideband audio/HD voice

Wideband audio (also known as HD voice) is a system of digital telephony that uses sampling techniques to increase the bandwidth. Wideband voice operates in the range of 150–7000 Hz. Analog phones operate in the 300 to 3300 Hz range. Given that the human voice is primarily in the range of 250 to 8000 Hz, greater speech intelligibility is made possible with wideband audio.[40]

4) WebRTC

WebRTC is an open-source project to provide encrypted text, video, and voice applications for mobile devices and browsers. These applications will improve the security of mobile and Internet-based communications and will also increase the communication options for the hearing impaired.[41] This technology is still in development by the World Wide Web Consortium (W3C).

e. Assistive Listening Systems/Devices (ALS/Ds)

ALS/Ds are used mostly when a presentation is using a microphone or sound system; however, they could also be characterized as a connection between a general hearing device and any device that makes sound. The ALS/D amplifies the sound of the presentation while minimizing background noise and reverberation.[42] ALS/Ds are also commonly used in conjunction with hearing aids and CIs. Some individuals with mild hearing loss may choose to use an ALS/D instead of a PSAP or hearing aid. Currently, several different types of ALS are available: infrared, FM, inductive-loop, and Bluetooth.[43]

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[40] "Wideband Audio," *Wikipedia*, last modified September 2, 2015, https://en.wikipedia.org/wiki/Wideband_audio.

[41] WebRTC, "Development," accessed August 26, 2015, http://www.Webrtc.org/Web-apis/development; "WebRTC," *Wikipedia*, last modified September 20, 2015, https://en.wikipedia.org/wiki/WebRTC.

[42] Jin Sook Kim and Chun Hyeok Kim, "A Review of Assistive Listening Device and Digital Wireless Technology for Hearing Instruments," *Korean Journal of Audiology* 18, no. 3 (December 2014): 106, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4285000/.

[43] "Assisted Listening Device," *Wikipedia*, last modified April 24, 2015, https://en.wikipedia.org/wiki/Assistive_listening_device; Kim and Kim, "A Review of Assistive Listening Device and Digital Wireless Technology for Hearing Instruments," 108–109.

1) Infrared

Infrared systems use light-based technology. A transmitter converts the sound into light. This light is received by either a neck loop or headset. Individuals with a telecoil in their general hearing device wear a neck loop. The neck loop converts the light to a magnetic signal that is received by the telecoil. These systems are by far the most secure because there must be line of sight between the receiver and the transmitter.[44]

2) FM

FM systems use radio broadcast technology. As with infrared systems, either the receiver can be a neckloop for those with a telecoil in their general hearing device or a head set. Since FM systems use radio signals, the receiver and the transmitter must be on the same frequency (i.e., any receiver within 300 feet and that is tuned to the signal can pick up what is being transmitted).[45] Therefore, FM systems are the most portable. However, they are not secure. Furthermore, "bleed-over" across frequencies can be a concern.

3) Induction-loop

Induction-loop systems send sound via an electromagnetic field. Thus, individuals who have a general hearing device with a telecoil do not need a receiver. All other individuals would wear a headset. Induction-loop systems can be permanently installed into meeting rooms. Portable versions are also available and can be set up as needed. Since induction-loop systems are electromagnetic, use of electronics will cause interference, most typically a buzzing noise.

4) Bluetooth

Infrared, FM, and induction-loop systems are analog technology. The newest systems are digital. Much development with digital systems is anticipated in the next decade. In addition, proprietary radio frequency (RF) systems are also in development.[46]

Currently, most of the digital systems use Bluetooth. According to respondents in the survey, Bluetooth devices are not compliant with current security regulations, which could be problematic since so many general amplification devices come equipped with Bluetooth receivers. For those devices that are not equipped with Bluetooth receivers, a wearable

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[44] Russell Gentner, "A Comparison of Loop, FM, & IR Technologies for Assistive Listening," *Listen Technologies* (blog), January 5, 2012, http://www.listentech.com/blog/a-comparison-of-loop-fm-ir-technologies-for-assistive-listening/.

[45] Kim and Kim, "A Review of Assistive Listening Device and Digital Wireless Technology for Hearing Instruments," 106.

[46] Kim and Kim, "A Review of Assistive Listening Device and Digital Wireless Technology for Hearing Instruments," 109–110.

device called a Bluetooth streamer is available. This device connects Bluetooth-enabled transmitters to the general hearing device.

Most smartphones and tablets come equipped with Bluetooth transmitters. Several smartphone applications are being developed to enable the individual to alter the processing of signal to noise based on the situational demands (e.g., ReSound[47] and Halo[48]). Similarly, a range of devices, such as portable microphones, are equipped with Bluetooth transmitters. Finally, Bluetooth transmitters that can be plugged into televisions and sound systems that are not pre-equipped with Bluetooth transmitters are available.

C. Alerting

Communication is not the only activity for which humans use sound. Alerting is the act of capturing someone's attention to notify of a condition. Alerts may be built into technology to provide notification of certain states. Individuals with hearing impairments have several different alternatives for auditory alerts.

1. Mirrors

One of the lowest tech solutions for alerting the hearing impaired is expanding the field of view through mirrors. Mirrors are used routinely for this purpose for all individuals.

2. Hearing Dogs

Hearing dogs are trained to alert their human companion to specific sounds. Some sounds, such as sirens, smoke detectors, and doorbells, are universally trained. The dog can also be trained to react to any sound that the individual with hearing impairments chooses. Typically, upon hearing a trained sound, the dog makes physical contact with the human companion and then walks the human to the sound. The training of hearing dogs typically begins after the dog has had general obedience training. The sound training requires an additional 4 to 6 months.[49] To maintain high performance levels, semi-annual follow-up training is highly recommended.[50]

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[47] ReSound, "Hearing Aids > ReSound LiNX²," accessed August 31, 2015, http://www.resound.com/en-US/hearing-aids/resound-linx2#.VckQevlVhBc.

[48] Starkey Hearing Technologies, "Halo," accessed August 31, 2015, http://www.starkey.com/hearing-aids/technologies/halo-wireless-hearing-aids.

[49] Dogs for the Deaf, "Hearing Dogs," accessed August 31, 2015, http://www.dogsforthedeaf.org/hearing-dogs.

[50] Canine Assistants, "FAQs," accessed August 31, 2015, http://www.canineassistants.org/faq.html.

3. Electronic Alerting

Electronic alerts are those alerts that are designed into systems. System designers typically choose auditory alerts because auditory alerts are the most salient for individuals with normal hearing.[51] However, alerts can also be visual or vibrotactile.

a. Visual alerts

Any visual display of information can be considered a visual alert. Visual alerts are used when sight of the alert is not impeded. Typically, visual displays are used for status information that does not change frequently (i.e., for information of a less urgent nature). However, the saliency or urgency of the display can be increased by (1) increasing the size of the information displayed, (2) increasing the brightness of the information displayed, (3) flashing the information, or (4) altering the color of the information.

Numerous visual alerts are in technologies used every day. The urgency of the alert is conveyed by color or flashing. In terms of military systems, Raytheon developed Boomerang to assist infantry in locating the source of small arms fire. Numerous similar systems that track larger weapons have also been developed.

Many visual alerts are developed specifically for the hearing impaired. One example is the strobe lights attached to fire alarms in public buildings. Another example is the kits that hotels offer to hearing-impaired guests. These kits include a light that flashes when someone knocks on the door and when the telephone rings.

b. Vibrotactile alerts

Alternatively, an individual can be alerted by vibration or other tactile sensation. Vibrotactile displays are typically used when a person's ability to see a visual alert may be impeded or when it is desired to only alert specific individuals without capturing the attention of others. A vibrotactile alert must be close to the body to be sensed. Individuals with hearing impairments use vibrotactile alerts via smartphone applications, and other specialized devices designed for the hearing impaired.

Vibrotactile alerts are also being developed for military use. A few of these alerts were described by Hancock and for purposes such as including threat location in aircraft, spatial awareness in aircraft, spatial awareness when operating unmanned vehicles, and communicating covertly.[52]

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[51] Christopher D. Wickens, Sallie E. Gordon, and Yili Liu, *An Introduction to Human Factors Engineering* (New York: Addison Wesley Longman, 1998).

[52] Peter A. Hancock et al., "Tactile Cuing to Augment Multisensory Human-Machine Interaction," *Ergonomics in Design* 23, no. 2 (April 2015): 4–9, doi:10.1177/1064804615572623.

D. Sound Discrimination

Sound discrimination is not just challenging for the hearing impaired, since human ears also evolved for speech perception. Systems that visually display sounds exist for a wide variety of applications. For the military, passive sonar (sound navigation and ranging) systems present the operator visual information about the environment based on the sounds sensed.

E. Summary

Table 1 summarizes the accommodations reviewed. Many of the devices and methods were developed for the general public (e.g., text messaging, speech to text, electronic alerting) but also enhance the abilities of individuals with hearing impairments. Some of these accommodations were specifically designed for the hearing impaired but may also be useful for others (e.g., Captioning on Glass is being leveraged as a translation device).[53] Not all of these accommodations will be appropriate for a military context, although some are already being used by the military.

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[53] Starr, "Real-time, Real-world Captioning Comes to Google Glass."

Table 1. Accommodations Available or in Development

Group	Name	Technology Availability	Issues Related to Deployment	Intended Population
General Hearing Device	Hearing aid	Wide availability	None – already allowed	Slight to severe
	PSAP	Wide availability	None – already allowed	Slight to moderate
	CI	Available	Unknown	Severe to profound – conductive
	ABI	Available	Unknown	Profound – sensorineural or mixed
	BAHA	Available	Yes – potential health concerns	Moderate to severe – conductive or mixed
	Middle Ear Implant	Available	Unknown	Moderate to severe – sensorineural
	Semi-implantable	Available	Unknown	Moderate to severe – sensorineural
Communication (General)	Communication strategies	No technology needed	No	All
	Interpretation services and CART	No technology Needed	Yes – additional personnel burden	Moderate to profound
	ASL translation tools	R&D	Unknown	Profound
	Tactile speech translator	R&D	Unknown	Severe to profound
Communication (Written)	Writing notes	No technology needed	No	All
	E-mail; text/instant messaging	Wide availability	No	All
	Face-to-face communicator	Wide availability	Yes – logistics burden	Severe to profound
	Speech to text	Wide availability	Unknown	All
	Captioning on Glass	Beta test	Unknown	Slight to profound
	Transcence	R&D	Unknown	Slight to profound
	Video captioning	Wide availability	None – already in use	All

Table 1. Accommodations Available or in Development concluded

Group	Name	Technology Availability	Issues Related to Deployment	Intended Population
Communication (Distance)	Telephone amplification	Wide availability	None	Mild to severe
	Telephone relay services	Wide availability	Yes – potential security issues	Moderate to profound
	Videophones	Wide availability	None – already used	All
	Wideband audio	Limited availability	Unknown	None to severe
	WebRTC	Limited availability	Unknown	All
Assistive Listening Devices	FM	Wide availability	Unknown	All
	Infrared	Wide availability	None	Slight to profound
	Induction	Wide availability	Unknown	Slight to profound
	Bluetooth/ streamers	Wide availability	Yes – potential security issues	Slight to profound
Alerting	Mirrors	Wide availability	None	All
	Hearing dogs	Wide availability	In some contexts	All
	Electronic alerting	Wide availability	None – already Used	All
Sound Discrimination	Many sound-discrimination technologies exist for different contexts and hearing impairments. The availability and appropriateness is technology specific.			

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3. DOD Audiometric Hearing Level Standards and Deployment Eligibility Requirements

A. Introduction

This section summarizes DOD's audiometric hearing level standards and focuses on the issuances that govern accession, retention, and deployment audiometric standards that have evolved over time. The factors that drive revisions of these medical standards are: wartime quotas exceeding the supply of medically qualified recruits; medical advances (including improved medical and diagnostic screening, advances in preventative medicine, as well as adaptive technologies); cost-benefit analyses (to include attrition and disability prediction); and economic and marketing conditions.[54]

B. Accession Standards

1. DODI 6130.03, Medical Standards for Appointment, Enlistment, or Induction in the Military Service

DODI 6130.03 establishes medical standards, to include audiometric hearing level standards, for accession. This instruction articulates the following standard for accession:

1. Current hearing threshold level in either ear greater than that described in subparagraphs 7.b.(1)-(3) of this enclosure does not meet the standard:

    a. Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 decibels (dB) on the average with no individual level greater than 35 dB at those frequencies.

    b. Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear.

    c. There is no standard for 6000 cycles per second.

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[54] James G. Jolissaint, MD; Sean A. Swiatkowski, DO; Sandeep S. Mangalmurti, MD; and Gregory D. Gutke, MD, MPH, "History of Recruit Medicine in the United States Military Service," *Recruit Medicine*, Office of The Surgeon General at Textbooks of Military Medicine Publications, Borden Institute, Walter Reed Army Medical Center, Washington, DC, 2006, 4-7, 24.

2. Current or history of hearing aid use (V53.2).[55]

The Services' and the Coast Guard's basic accession standards are modeled on this DODI.

2. Revisions to the Medical Standards for Appointment, Enlistment, or Induction

This DODI establishing medical standards for accession was first published in 1986 as DODI 6130.4, "Criteria and Procedure Requirements for Physical Standards for Appointment, Enlistment, or Induction in the Armed Forces." As described in *Recruit Medicine*, these standards "were developed largely from the expert opinions of medical specialists, as opposed to well-designed research."[56,57]

The medical standards became more evidence-based with the 2005 DODI 6130.4, entitled "Medical Standards for Appointment, Enlistment, or Induction in the Armed Forces."[58,59] *Recruit Medicine* characterizes this process as "an exhaustive 3-year review undertaken by the Accession Medical Standards Working Group (AMSWG), composed of representatives from each office of the Medical-Personnel (MED-PERS) Executive Steering Committee."[60] Over the last two decades, organizations across DOD have conducted significant research on medical standards for accession. These research efforts have informed subsequent revisions to the DODI, now DODI 6130.03, "Medical Standards for Appointment, Enlistment, or Induction in the Military Services."

Prominent among those organizations is the Accession Medical Standards Analysis and Research Activity (AMSARA). Established in 1996, AMSARA has supported "the development of evidence-based medical standards by guiding the improvement of medical and administrative databases, conducting epidemiologic analyses, and integrating relevant operational, clinical, and economic considerations into policy recommendations."[61]

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[55] DODI 6130.03, Medical Standards for Appointment, Enlistment, or Induction in the Military Services, April 28, 2010, Incorporating Change 1, September 13, 2011, Enclosure 4, paragraph 7-1, 15.

[56] David W. Niebuhr, Timothy E. Powers, Yuanzhang Li, and Amy M. Millikan, "The Enlisted Accession Medical Process," *Recruit Medicine*, Office of The Surgeon General at Textbooks of Military Medicine Publications, Borden Institute, Walter Reed Army Medical Center, Washington, DC, 2006, 46.

[57] Ramy A. Mahmoud, MD, MPH; Kathryn L. Clark, MD, MPH; Laurel May, MD, MPH, "Evolution of Military Recruit Accession Standards," *Military Preventive Medicine: Mobilization and Deployment*, Vol. 1, Office of The Surgeon General at Textbooks of Military Medicine Publications, Borden Institute, Walter Reed Army Medical Center, Washington, DC, 2003, 155.

[58] DOD Instruction 6130.4, "Medical Standards for Appointment, Enlistment, or Induction in the Armed Forces," January 18, 2005.

[59] Niebuhr, et al., "The Enlisted Accession Medical Process," 47.

[60] Ibid.

[61] Accession Medical Standards Analysis and Research Activity, 2013 Annual Report, Walter Reed Army Institute of Research, 2013, abstract.

Other relevant research efforts include the National Research Council's (NRC) Committee on Youth Population and Military Recruitment: Physical, Medical, and Mental Health Stand. The committee examines "trends in the youth population relative to the needs of the military and the standards used to screen applicants to meet these needs."[62] The context for this research was the challenging recruiting environment of 2005. In "Assessing Fitness for Military Enlistment: Physical, Medical, and Mental Health Standards" (2006), the committee summarized findings regarding both current trends and medical accession standards. The committee recommended revisions of some medical standards for accession and called for additional research. The committee regarded deafness as justified "prima facie," based on an "incontrovertible link between the standard and fitness for service."[63]

Also during this timeframe, the Defense Health Board (DHB) examined evidence-based standards for accession, deployment, and retention. The Evidence-Based Accession, Deployment, and Retention Standards Subcommittee (2007) examined medical standards and waivers, emphasizing "evidence-based standards," as "the application of objectively derived data in the development of criteria for optimal operations."[64] DHB recommended the development of tools and methods for identifying "individuals at high risk for early separation or failure to maintain deployment-readiness, as well as those possessing an increased likelihood to return early from an area of responsibility."[65] DHB also documented that scientific research from organizations such as AMSARA had resulted in changes to accession standards, including the elimination of more than 50 medical standards "not supported by scientific evidence."[66]

Some recent relevant revisions of accession standards are Service specific. For example, the April 2014 Memorandum for Commander Navy Medicine, "Guidance on the Disposition of Active Duty and Reserve Accessions Failing to Meet Hearing Requirements," which stated, "Individuals seeking to serve in the Navy or Marine Corps are required to meet minimal health standards as specified in DODI 6130.03. Occasionally, the services may elect to waive certain conditions in order to meet manpower requirements.

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[62] National Research Council, *Assessing Fitness for Military Enlistment: Physical, Medical, and Mental Health Standards*. Committee on the Youth Population and Military Recruitment: Physical, Medical, and Mental Health Standards, Paul R. Sackett and Anne S. Mavor, editors. Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press, 2006, 11.

[63] Ibid.

[64] Defense Health Board (DHB) Evidence-Based Accession, Deployment, and Retention Standards Subcommittee (2007), 2.

[65] Ibid, 4.

[66] Ibid, 3.

Hearing loss, however, is not a condition that may be considered for waiver."[67] In light of recent research, as well as budgetary issues, evidence suggests that the Services are moving towards fewer waivers and more stringent accession requirements.[68]

3. Overview of the Services' Audiometric Hearing Level Standards

The Services articulate their audiometric hearing level standards for accessions in a series of manuals and issuances. Table 2 summarizes these standards.

Table 2 Services' Audiometric Hearing Level Standards, Accession

Service	Medical Standards
Army	Hearing threshold level may not exceed: (1) Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 decibels (dB) on the average, with no individual level greater than 35 dB at those frequencies. (2) Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear. (3) Current or history of hearing aid use is disqualifying.
Navy / Marine Corps	Hearing threshold level may not exceed: (1) Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 dB on the average with no individual level greater than 35 dB at those frequencies. (2) Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear. (3) Current or history of use of hearing aids is disqualifying.
Air Force	Audiometric hearing levels not more than the standards for the H2 Hearing Profile—not more than 35 dB at 500, 1000, 2000 Hz; not more than 45 dB at 3000 Hz; not over 55 dB at 4000.
Coast Guard	Hearing threshold level may not exceed: (1) Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 dB on the average with no individual level greater than 35 dB at those frequencies. (2) Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear. (3) Current or history of use of hearing aids is disqualifying.

Sources: Army Regulation 40–501, Medical Services Standards of Medical Fitness, 14 December 2007, Rapid Action Revision (RAR) Issue Date: 4 August 2011; AFI48-123_AFGM2014-01 31 October 2014, AFI 48-123, Medical Examinations and Standards; NAVMED P-117, Manual of the Medical Department, U.S. Navy, 3 May 2012; COMDTINST M6000.1F, Coast Guard Medical Manual (August 2014), Chapter 3, Section D, 7.

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[67] 21 April 2014 Memorandum for Commander Navy Medicine, "Guidance on the Disposition of Active Duty and Reserve Accessions Failing to Meet Hearing Requirements."

[68] Accession Medical Standards Analysis and Research Activity, 2013 Annual Report, Walter Reed Army Institute of Research, 2013, 43-44.

These audiometric hearing level standards correlate to the Services' hearing profile categories. Using the physical profile functional capacity guide from the Army "Standards of Medical Fitness" regulation as an example. Table 3 identifies the four hearing profiles and corresponding hearing level description provided for each profile.[69]

Table 3. Hearing Profile Categories

Profile	Hearing Level Description
H1	Audiometer average level for each ear not more than 25 dB at 500, 1000, 2000 Hz with no individual level greater then [sic] 30 dB. Not over 45 dB at 4000 Hz.
H2	Audiometer average level for each ear at 500, 1000, 2000 Hz, or not more than 30 dB, with no individual level greater than 35 dB at these frequencies, and level not more than 55 dB at 4000 Hz; or audiometer level 30 dB at 500 Hz, 25 dB at 1000 and 2000 Hz, and 35 dB at 4000 Hz in better ear. (Poorer ear may be deaf.)
H3	Speech reception threshold in best ear not greater than 30 dB HL, measured with or without hearing aid; or acute or chronic ear disease.
H4	Functional level below H3.

Sources: Headquarters Department of the Army, Army Regulation (AR) 40–501, Medical Services: Standards of Medical Fitness, 14 December 2007/RAR 23 August 2010, 83.

Certain communities within the Services—for example, Aviators, Air Traffic Controllers, Unmanned Aerial Systems Operators, Divers, Special Operations Forces (SOF), Nuclear Field Duty, Explosives Handlers and Motor Vehicle Operators, Landing Craft Air Cushion (LCAC) crew, Academy cadets and midshipmen—have higher audiometric hearing level standards for accession.

Figure 2 from the DOD Hearing Center of Excellence (HCE) illustrates the functional and audiometric differences between the H2 and H3 profiles.

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[69] Army's physical profile functional capacity guide from the Headquarters, Department of the Army, Regulation (AR) 40–501, Medical Services: Standards of Medical Fitness, 14 December 2007/RAR 23 August 2010, 83.

What a Hearing Profile Means...
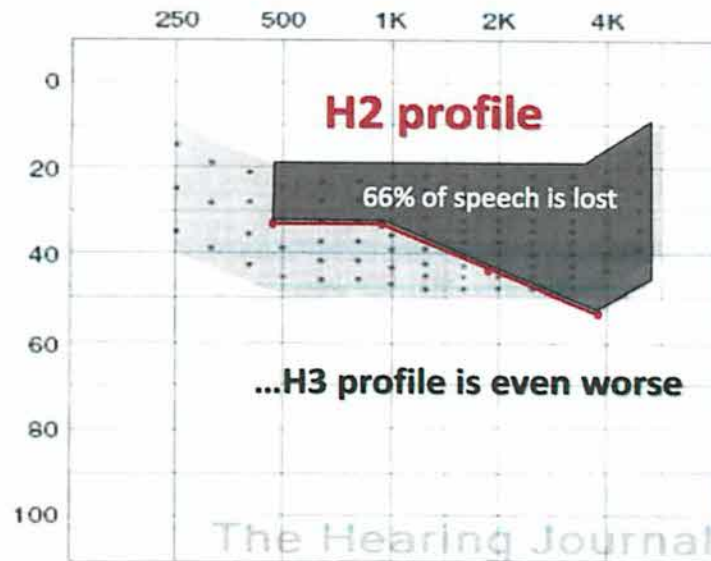
Figure 2. HCE, What a Hearing Profile Means

Individuals with H3 profiles have speech reception thresholds such that they do not accurately receive 66 percent of speech.[70]

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[70] Lynn W. Henselman, PhD, Deputy Director, DOD HCE, "Preserving and Improving Warrior and Veteran Hearing Health," 17 April 2015, 19.

C. Retention Standards

1. DODI 1332.18, Disability Evaluation System

DODI 1332.18, Disability Evaluation System (DES), establishes standards "for determining unfitness due to disability or medical disqualification."[71] The "general criteria" for making this determination centers on a Service member's ability to "perform duties of his or her office, grade, rank, or rating." The DODI terms "reasonable performance of duties" to include:

1. Common Military Tasks. Whether the Service member can perform the common military tasks required for the Service member's office, grade, rank, or rating [...]. Examples include routinely firing a weapon, performing field duty, or wearing load-bearing equipment or protective gear.

2. Physical Fitness Test. Whether the Service member is medically prohibited from taking the respective Service's required physical fitness test. [...]

3. Deployability. Whether the Service member is deployable individually or as part of a unit, with or without prior notification, to any vessel or location specified by the Military Department. [...]

4. Special Qualifications. For Service members whose medical condition disqualifies them for specialized duties, whether the specialized duties constitute the member's current duty assignment; the member has an alternate branch or specialty; or reclassification or reassignment is feasible.

This DODI also establishes roles and responsibilities for the DES.

The Department of the Army Physical Profile form highlights the core functional activities that underlie common military tasks and is used across the Services. The following figures, Figure 3 and Figure 4 depict that form and identify the specific activities.[72]

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[71] Source: DODI 1332.18, Disability Evaluation System (DES), August 5, 2014, 28.

[72] AR 40-501, DA Form 3349 September 2010.

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PHYSICAL PROFILE

For use of this form, see AR 40-501; the proponent agency is the Office of the Surgeon General.

1. MEDICAL CONDITION: *(Description in lay terminology)*	INJURY? Or ILLNESS/DISEASE?	2. CODES *(Table 7-2 AR 40-501)*	3. Temporary Permanent	P	U	L	H	E	S

4. PROFILE TYPE			YES	NO
a. TEMPORARY PROFILE *(Expiration date YYYYMMDD)*		*(Limited to 3 months duration)*		
b. PERMANENT PROFILE *(Reviewed and validated with every periodic health assessment or after 5 years from the date of issue)*				

5. FUNCTIONAL ACTIVITIES THAT EVERY SOLDIER REGARDLESS OF MOS MUST BE ABLE TO PERFORM. IF SOLDIER CANNOT PERFORM ANY ONE OF THESE TASKS, THEN THE PULHES MUST CONTAIN AT LEAST ONE "3" AND SOLDIER MUST BE REFERRED TO A MEB. CAN THE SOLDIER:

FUNCTIONAL ACTIVITY:	YES	NO
a. Carry and fire individual assigned weapon?		
b. Evade direct and indirect fire?		
c. Ride in a military vehicle for at least 12 hours per day?		
d. Wear a helmet for at least 12 hours per day?		
e. Wear body armor for at least 12 hours per day?		
f. Wear load bearing equipment (LBE) for at least 12 hours per day?		
g. Wear military boots and uniform for at least 12 hours per day?		
h. Wear protective mask and MOPP 4 for at least 2 continuous hours per day?		
i. Live in an austere environment without worsening the medical condition?		
j. Move 40lbs (for example, duffle bag) while wearing usual protective gear (helmet, weapon, body armor and LBE) at least 100 yards?		

6. APFT	YES	NO	ALTERNATE APFT *(If a out of unable to do APFT run otherwise N/A)*	N/A	YES	NO
2 MILE RUN			APFT WALK			
APFT SIT-UPS			APFT SWIM			
APFT PUSH UPS			APFT BIKE			

7. DOES THE SOLDIER MEET RETENTION STANDARDS IAW CHAPTER 3 AR 40-501?

YES ☐ NEEDS MMRB   NO ☐ NEEDS MEB

8. FUNCTIONAL LIMITATIONS AND CAPABILITIES AND OTHER COMMENTS:

☐ This temporary profile is an extension of a temporary profile first issued on _____

Source: AR 40-501, DA Form 3349 September 2010.

Figure 3. Department of the Army Physical Profile Form

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Functional Activity
a. Carry and fire individual assigned weapon?
b. Evade direct and indirect fire?
c. Ride in a military vehicle for at least 12 hours per day?
d. Wear a helmet for at least 12 hours per day?
e. Wear body armor for at least 12 hours per day?
f. Wear load bearing equipment (LBE) for at least 12 hours per day?
g. Wear military boots and uniform for at least 12 hours per day?
h. Wear protective mask and NOPP 4 for at least 12 hours per day?
i. Move 40 lbs. (for example, duffle bag) while wearing usual protective gear (helmet, etc.)
j. Live in an austere environment without worsening the medical condition?

Source: AR 40-501, DA Form 3349 September 2010.

Figure 4. Department of the Army Physical Profile Form, "Functional Activity" Section

2. The Services' Audiometric Hearing Level Retention Standards

For retention in most occupations, the Services require a minimum hearing profile of H2.[73] Table 4 summarizes those audiometric hearing level retention standards.

Table 4. Overview of the Services' Audiometric Hearing Level Retention Standards

Service	Medical Standards
Army	Most MOSs require H2 or better (in other words, H1)
Navy/ Marine Corps	Minimal hearing performance standards as specified in DODI 6130.03 and the Manual of the Medical Department are: (1) Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 dB on the average with no individual level greater than 35 dB at those frequencies. (2) Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear.
Air Force	Audiometric hearing levels not more than the standards for the H2 Hearing Profile
Coast Guard	Hearing threshold level may not exceed: (1) Pure tone at 500, 1000, and 2000 cycles per second for each ear of not more than 30 dB on the average with no individual level greater than 35 dB at those frequencies. (2) Pure tone level not more than 45 dB at 3000 cycles per second or 55 dB at 4000 cycles per second for each ear. (3) Current or history of use of hearing aids is disqualifying.

Sources: Army Regulation 40–501, Medical Services Standards of Medical Fitness, 14 December 2007, Rapid Action Revision (RAR) Issue Date: 4 August 2011; AFI48-123_AFGM2014-01 31 October 2014, AFI 48-123, Medical Examinations and Standards; U. S. Navy Aeromedical Reference and Waiver Guide, April 30, 2015 , NAVMED P-117, Manual of the Medical Department, U.S. Navy, 3 May 2012; COMDTINST M6000.1F, Coast Guard Medical Manual (August 2014), Chapter 3, Section D, 7.

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[73] Army Regulation 40–501, Medical Services Standards of Medical Fitness, 14 December 2007, Rapid Action Revision (RAR) Issue Date: 4 August 2011; AFI48-123_AFGM2014-01 31 October 2014, AFI 48-123, Medical Examinations and Standards; U. S. Navy Aeromedical Reference and Waiver Guide, April 30, 2015, http://www.med.navy.mil/sites/nmotc/nami/arwg/Documents/Complete_Waiver_Guide_150430.pdf, NAVMED P-117, Manual of the Medical Department, U.S. Navy, 3 May 2012; COMDTINST M6000.1F, Coast Guard Medical Manual (August 2014), Chapter 3, Section D, 7.

3. The Services' Hearing Waivers

The Services have some latitude with waivers, both for recruits and for trained personnel. The likelihood that a Service may consider a waiver is especially high for trained individuals, who, as a result of their time in service, develop conditions that affect their medical profile but not their ability to perform their essential duties.[74]

As with accession standards, certain communities within the Services—Aviators, Air Traffic Controllers, Unmanned Aerial Systems Operators, Divers, Special Operations Forces, Foreign Area Officers, Nuclear field duty, Explosives Handlers and Motor Vehicle Operators, Landing Craft Air Cushion crew—have higher audiometric hearing level standards for retention (H1). These standards affect the ability of Service personnel to receive waivers.

D. Deployment Eligibility Requirements

1. DOD Audiometric Hearing Level Standards—Deployment

DOD issuances relevant to deployment eligibility emphasize a Service person's ability to perform duties safely. For example, DODI 6490.07, Medical Conditions Usually Precluding Contingency Deployment, states:[75]

> In general, DOD personnel with any of the medical conditions in Enclosure 3, and based on a medical assessment, shall not deploy unless a waiver is granted. Consideration should be made for the nature of the disability and if it would put the individual at increased risk of injury or illness, or if the condition is likely to significantly worsen in the deployed environment.

DODI 6490.07 specifically addresses individuals with auditory impairment and deployment: "Sensory Disorders (1) Hearing Loss. The requirement for use of a hearing aid does not necessarily preclude deployment. However, the individual must have sufficient unaided hearing to perform duties safely."[76]

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[74] The Army uses the Speech Recognition in Noise Test (SPRINT) as part of the audiological evaluation for soldiers with unaided hearing at the H-2 or H-3 profile level standards. This Army regards this test as a valid predictor of communication abilities. Army Regulation 40–501, Medical Services Standards of Medical Fitness, 14 December 2007, Rapid Action Revision (RAR) Issue Date: 4 August 2011, 2, 115; AFI48-123_AFGM2014-01 31 October 2014, AFI 48-123, Medical Examinations and Standards; AFI 36-2101 Section 3.7.4, 21; U. S. Navy Aeromedical Reference and Waiver Guide, April 30, 2015, http://www.med.navy.mil/sites/nmotc/nami/arwg/Documents/Complete_Waiver_Guide_150430.pdf, NAVMED P-117, Manual of the Medical Department, U.S. Navy, 3 May 2012; COMDTINST M6000.1F, *Coast Guard Medical Manual* (August 2014), Chapter 3, Section D, 7.

[75] DODI 6490.07, Medical Conditions Usually Precluding Contingency Deployment, February 5, 2010, Enclosure 2, 7.

[76] DODI 6490.07, Medical Conditions Usually Precluding Contingency Deployment, February 5, 2010, Enclosure 3, 11.

DODI 6025.19, Individual Medical Readiness (IMR), likewise emphasizes a Service person's ability to perform duties in that environment. That DODI states "[a] deployment limiting medical condition includes any physical or psychological condition that may interfere with the Service member's ability to perform duties while deployed.[77]

2. Combatant Command Deployment Requirements

In addition to DOD guidance, deployment requirements are articulated by each Combatant Commander. For example, the following minimum standards for "[a]ll personnel (uniformed service members, government civilian employees, volunteers, and DOD contractor employees)" were articulated for the USCENTCOM area of operations (AOR) in the "Personnel Policy Guidance for Contingency Operations in Support of GWOT" [Global War on Terror]:[78]

> Fitness specifically includes the ability to accomplish tasks and duties unique to a particular operation and the ability to tolerate environmental and operational conditions of the deployed location.
>
> Personnel who have existing medical conditions may deploy if all of the following conditions are met:

- The condition(s) is/are not of such a nature that an unexpected worsening or physical trauma is likely to have a medically grave outcome.

- The condition(s) is/are stable [....]

- Any required ongoing health care or medications must be available in-theater within the military health system [....]

- No need for significant duty limitation or restriction is imposed by the medical condition. [....]

The USCENTCOM deployment requirements are continually updated. For example, these theater-level requirements were modified in 2012 by the "PPG-Tab A: Amplification of the Minimal Standards of Fitness for Deployment to the CENTCOM AOR; To Accompany MOD Eleven to USCENTCOM Individual Protection and Individual/Unit Deployment Policy." The document added an additional condition that must be met by personnel with existing medical conditions who are to deploy to that theater of operations: "There is no need for routine evacuation out of theater for continuing diagnostics or other

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[77] DODI 6025.19, Individual Medical Readiness (IMR), June 9, 2014, ENCLOSURE 3 b, 9-10.

[78] Department of the Army, Personnel Policy Guidance for Contingency Operations in Support of GWOT, 13 Feb 2008.

evaluations. (All such evaluations must be accomplished before deployment.)"[79] That document also addressed auditory impairment and deployment in greater detail than the previous personnel policy guidance documents governing deployment into the USCENTCOM AOR.[80]

3. Hearing Loss

The requirement for use of a hearing aid does not necessarily preclude deployment. However, the individual must have sufficient unaided hearing to perform duties safely IAW Service guidelines. If individuals meet the following criteria, unaided, no waiver is required to deploy:

- A hearing level no greater than 30dB for either ear (the average of hearing levels at 500, 1000, and 2000 Hz), with no individual level greater than 35dB at these frequencies and no greater than 55dB at 4000 Hz; OR

- A hearing level no greater than: 30dB at 500 Hz; 25dB at 1000 and 2000 Hz; and 35dB at 4000 Hz in the better ear.

- An audiogram may not necessarily correlate with an individual's ability to perform duties as determined by an occupational health exam. Waiver requests should be accompanied by a provider's evaluation and assessment of speech recognition and ability to hear and wake up to emergency alarms and hear instructions in the absence of visual cues such as lipreading. Extreme ranges (over 75 dB either ear, at any frequency) of hearing loss should be accompanied by an audiologist's assessment of functionality and Speech Recognition In Noise Test (SPRINT).

Figure 5 depicts the U.S. Army Forces Command (FORSCOM) Operation Iraqi Freedom (OIF) training tasks for units rotating in theater.

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[79] PPG-Tab A: Amplification of the Minimal Standards of Fitness for Deployment to the CENTCOM AOR; To Accompany MOD Eleven to USCENTCOM Individual Protection and Individual/Unit Deployment Policy, 1.

[80] PPG-Tab A: Amplification of the Minimal Standards of Fitness for Deployment to the CENTCOM AOR; To Accompany MOD Eleven to USCENTCOM Individual Protection and Individual/Unit Deployment Policy, 5-6.

OIF Training Tasks
Combat Operations

- Individual tasks (as required)
  - OTT
  - Land Navigation
  - Individual movement techniques
  - Troop leading procedures
  - UXO TTP
  - IED Recognition TTP
  - Counter Sniper Operations
- Crew/Team/Squad
  - Team/squad movement
  - Crew served weapons gunnery
  - Squad attack
  - Patrolling TTP
  - Combat Life Saver
  - IED Recognition and TTPs
  - MOUT squad lane
- Platoon
  - Formations
  - Cross danger area
  - Deliberate attack
  - Actions on contact
  - Employ/reduce obstacles
  - Break contact
  - React to ambush
  - Knock out bunker
  - Enter building /Clear room
  - Initial breach of wire/mine obstacle
  - Enter/Clear trench
  - Heavy/Lt Ops
  - MOUT
  - Convoy Operations

- Company
  - Hasty & Deliberate defense
  - Counter recon
  - Hasty Attack / Assault
  - Clear trench
  - Breach
  - Advance Guard
  - Support by Fire
  - Heavy/Light Op
  - MOUT
  - Air Ground Coordination
- Battalion
  - Defense in Sector
  - Deliberate Attack
  - Movement to Contact
  - Air Ground Coordination
- Brigade
  - MDMP/BCBST (BDE CMD Battle Staff TNG)
    - Deliberate Defense (SIM)
    - Movement to Contact (SIM)
    - Deliberate Attack (SIM)
  - Stability & Support Ops Urban Environment LTP/CPX
  - Air Ground Coordination
  - Coalition Synchronization Operations
    - LNO's
    - Cross TNG, Force Prot., ROE, Fire Coord.
    - Logistics Support Operations

Source: Colonel Frank "Del" Turner, Chief, G-3 Training Division, HQs FORSCOM, "Preparing Units for OIF/OEF Rotations," 2004.

Figure 5. OIF Training Tasks

This articulation of critical tasks for units deploying into theater further validates the requirements from the CENTCOM Personnel Policy Guidance.

E. Conclusion

This section summarized the doctrine regarding audiometric hearing level standards across DOD. The focus of this section was on the issuances that govern accession, retention, and deployment audiometric standards. The next section addresses recent deployment experiences.

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4. Employment of Individuals with Hearing Impairments and Military Occupations

A. Introduction

In this section we examine current enlisted occupations within the military that may be considered viable for individuals with hearing impairments. The occupations identified have qualities and characteristics that make them potentially viable for individuals with hearing impairments in general; further review is necessary to determine which specific accommodations would maximize the probability of success for specific individuals with particular hearing conditions/abilities.

The first level of analysis was to assess positions based on the Services' descriptions of the positions. Each of the Services describes its occupations differently, so each will be analyzed independently.[81] Since the ability to deploy was identified as a barrier to military service, the deployment rates of the identified occupations were examined. After the Service-specific analyses, some cross-Service analysis was conducted to see whether similar positions across the Services might be made available to individuals who have hearing impairments. Only enlisted positions were assessed as part of this study.

1. Army

As described in the previous section, the Army identifies physical requirements of Military Occupational Specialties (MOSs) using the PULHES[82] criteria, where each characteristic is rated on a scale of 1 (best) to 4 (worst). For Army enlisted MOSs, the lowest acceptable hearing-level rating for any position given is H-3, which indicates that less than optimal hearing would be acceptable in that position. We reviewed Department of the Army Pamphlet (DA PAM) 611-23 to identify the enlisted positions with H-3 ratings. There are five enlisted positions in the Army where an H-3 rating would potentially be acceptable (see Table 5). Analysis of the position descriptions for each of these MOS

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[81] Occupations within the Army, Navy, and Air Force were examined and provide sufficient examples of military positions that warrant further analysis. Occupations within the Marine Corps were not examined due to the significantly smaller number of individuals within the Marine Corps combined with the high deployability rates.

[82] PULHES – p, physical capacity or stamina; u, upper extremities; l, lower extremities; h, hearing and ears; e, eyes; s, psychiatric.

indicates that for all of these positions, a person with poorer than normal hearing might possibly be successful, especially if job accommodations for individuals who with hearing impairments were implemented.

**Table 5. Enlisted Positions in the Army Where an
H-3 Rating Would Be Acceptable**

MOS Code	MOS Title
12T	Technical Engineer
36B	Financial Management
68J	Medical Logistics Specialist
68M	Nutrition Care Specialist
92G	Food Service Specialist

Source: United States Army, "Implementation of the Changes to the Military Occupational Classification and Structure," Department of the Army Pamphlet 611-23 (Washington, DC: Headquarters, Department of the Army, 31 December 1998).

Separate from the analysis for this report, Buchanan et al. analyzed positions in the armed services that required hearing critical tasks.[83] Their analysis assessed whether the position contained a hearing-critical task and characterized those hearing requirements along a dimension that included sound detection, sound identification, sound localization, and speech recognition. They identified many positions that did not meet their threshold of hearing-critical tasks. There was some overlap in the findings of our current analysis and in Buchanan et al., with both Financial Management (36B) and Food Service Specialist (92G) being positions identified—an indication that those positions warrant further review to determine whether an individual with hearing impairment could perform them successfully.[84]

Using Defense Manpower Data Center (DMDC) data, deployment rates of Army MOSs over the period of 2001–2009 were calculated as the amount of sum total number of days that individuals with a particular MOS were deployed, divided by the sum total of all days served by everyone in the particular MOS. Overall, for enlisted Army positions, the average deployment rate was 12.8%. For Technical Engineers (12T), specific data were not available, but, for the average of similarly classified positions (12x), the deployment rate was 6%. This finding suggests that, on average, 6% of all 12x personnel were deployed at a given time. For Nutrition Care Specialists (68M), the deployment rate was also fairly

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[83] Kari Buchanan et al., "Military Hearing Critical Task Review by Service," SURVIAC-TR-13-4548 (Wright-Patterson AFB: OH, Survivability/Vulnerability Information Analysis Center, September 23, 2013).

[84] Ibid.

low, at 8%. For Medical Logistics Specialists (68J) and Food Service Specialists (92G), the deployment rate of 16% and 18%, respectively, was more moderate. Finally, for Financial Management (36B), the deployment rate of 33% was relatively high.

2. Navy

The Navy describes positions in the *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*.[85] The Occupational Standards express the Navy's minimum requirements for enlisted positions, and these standards were analyzed to identify positions where it does not appear that critical hearing skills such as active listening and abilities such as auditory attention were described. Table 6 includes the positions where it might be possible for an individual with hearing impairment with reasonable job accommodations to adequately perform in the position.

Table 6. Potentially Viable Navy Occupations for Individuals with Hearing Impairment

Job Code	Job Title
001362	Aviation Machinist's Mate Organizational Level
001472	Aviation Electrician's Mate Intermediate Level Technician
002000	Armament Weapons Support Equipment Technician
001955	Aviation Structural Mechanic Intermediate Level 001805 & Aviation Environmental and Egress Technician
003699	Electrical Systems Maintainer
003004	Hull Systems Maintainer
003005, 003177	Steam Plant Auxiliary Systems Maintainer & Steam Plant Auxiliary Systems Technician
003156, 003381	Machinery Repair Maintainer & Machinery Repair Technician
002609	Culinary Specialist

Source: Department of the Navy, *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, Vol. I Navy Enlisted Classifications (NECs).

As described for Army positions, Buchanan et al. also assessed Navy positions for critical hearing tasks.[86] Both the current study and Buchanan et al. identified Culinary Specialist, indicating that this would be a position where an individual with hearing impairment may be able to perform successfully and should warrant further review.[87] There was partial agreement/overlap in aviation maintenance positions, where Buchanan et al

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[85] Department of the Navy, *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, Vol. I Navy Enlisted Classifications (NECs).

[86] Buchanan et al., "Military Hearing Critical Task Review by Service."

[87] Ibid., B-1–B-2

identified Aviation Maintenance Administration, while we identified similar maintenance-like positions of Aviation Machinist's Mate and Electrician's Mate, Aviation Structural Mechanic, and Aviation Environmental and Egress Technicians.[88]

Using the deployment rates of individuals in particular occupational classification codes over the period of 2001–2009, we analyzed the positions identified in Table 6. Overall, for enlisted Navy positions, the average deployment rate was 6.6% into the US Central Command area of operations. These data do not highlight deployments to other regions of the world. For Aviation Machinist's Mate (AD), Aviation Electrician's Mate (AE), Aviation Structural Mechanic (AM), Electrical Systems Maintainer (EM), Hull Systems Maintainer (HT), Machinery Repair Maintainer (MR), and Culinary Specialist (CS) the deployment rates were fairly low at 8%, 8%, 9%, 7%, 7%, 7%, and 8% respectively. For Steam Plant Auxiliary Systems Maintainer and Steam Plant Auxiliary Systems Technician specific data were not available, but, for the occupational classification codes of which they are a part, Machinist's Mate (MM), the deployment rate was 7%. For Armament Weapons Support Equipment Technician (AO) and Aviation Environmental and Egress Technician (AME), the deployment rate of 11% and 10%, respectively, was more moderate.

3. Air Force

For the Air Force enlisted occupations, we reviewed job requirements described in the *Air Force Enlisted Classification Directory*.[89] The Air Force uses an alphanumeric Air Force Specialty Code (AFSC) to label positions. The first character is a number that relates to a career group (e.g., operations, logistics, medical, finance); the second character is a letter representing the career field; the third character is a further breakdown to career field subdivision; the fourth character is a number to indicate the position's skill level (e.g., helper, apprentice, journeyman, superintendent); and the fifth character is a number to specify the position name if there are multiple positions in a particular career field subdivision.

For this analysis, we only list the lowest level of skill identifier since a new enlistee would enter service at that level. We grouped occupations by career subdivision; therefore, if more than one AFSC is listed, this indicates that more than one related/similar position appears to have minimal hearing requirements. Table 7 shows the occupations where the description did not identify critical hearing tasks.

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[88] Ibid., B-1.

[89] United States Air Force, *Air Force Enlisted Classification Directory (AEFCD): The Official Guide to the Air Force Enlisted Classification Codes* (Schertz, Texas: HQ, Air Force Personnel Center/Directorate of Personnel Services (AFPC/DPS), 31 October 2013), http://www.132dwing.ang.af.mil/shared/media/document/afd-130822-028.pdf.

Table 7. Air Force Occupations Where the Description Did Not Identify Critical Hearing Tasks

AFSCs	Job Title
1C012	Aviation Resource Management+
1N111	Geospatial Intelligence *
1P011	Aircrew Flight Equipment (NA)
1W011	Weather*
2A011	Avionics Test Station and Components**
2A313, 2A318	Tactical Aircraft Maintenance, Remotely Piloted Aircraft Maintenance**
2A511, 2A512, 2A514	Airlift/Special Mission Aircraft Maintenance,** Helicopter/Tiltrotor Aircraft Maintenance,** Refuel/Bomber Aircraft Maintenance+
2A611, 2A613, 2A614, 2A615, 2A616	Aerospace Propulsion,* Aircrew Egress Systems,** Aircraft Fuel Systems,** Aircraft Hydraulic Systems,** Aircraft Electrical and Environmental Systems**
2A711, 2A712, 2A713, 2A715	Aircraft Metals Technology,** Nondestructive Inspection,** Aircraft Structural Maintenance,** Low Observable Aircraft Structural Maintenance*
2A912	Bomber/Special Integrated Instrument and Flight Control Systems (N/A)
2F011	Fuels+
2M011, 2M012	Missile and Space Systems Electronic Maintenance, Missile and Space Systems Maintenance**
2P011	Precision Measurement Equipment Laboratory**
2R011	Maintenance Management Analysis**
2R111	Maintenance Management Production**
2S011	Materiel Management**
2T011	Traffic Management++
2T211	Air Transportation++
2T317	Vehicle Management and Analysis**
2W111	Aircraft Armament Systems**
2W211	Nuclear Weapons*
3D011, 3D014	Knowledge Operations Management,** Computer Systems Programming**
3E011, 3E012	Electrical Systems++, Electrical Power Production++
3E111	Heating, Ventilation, Air Conditioning, and Refrigeration+
3E211	Pavements and Construction Equipment++
3E311	Structural++
3E411, 3E413	Water and Fuel Systems Maintenance++, Pest Management
3E511	Engineering++
3M011	Services++
3S313	Manpower**
4A111	Medical Materiel**
4A211	Biomedical Equipment**
4D011	Diet Therapy**
4R011	Diagnostic Imaging**
4T011, 4T012	Medical Laboratory, Histopathology**
4V011	Optometry**
4Y011, 4Y012	Dental Assistant, Dental Laboratory**

Source: United States Air Force, *Air Force Enlisted Classification Directory (AEFCD): The Official Guide to the Air Force Enlisted Classification Codes* (Schertz, Texas: HQ, Air Force Personnel Center/Directorate of Personnel Services (AFPC/DPS), 31 October 2013).

Note: For ease of presentation, a coding system was applied to the codes listed in the table whereby "*" indicates a deployment rate of less than 1%, "**" indicates a deployment rate of 1-5%, "+" indicates a deployment rate of 5.5–10%, "++" indicates a deployment rate of greater than 10%, and "NA" indicates that a deployment rate was not identified for the specific code.

As described previously for Army and Navy positions, Buchanan et al. also assessed Air Force positions for critical hearing tasks.[90] The current study and Buchanan et al. identified 12 positions where an individual with hearing impairment may be able to perform successfully and should warrant further review.[91] The positions identified in both the current analysis and Buchanan et al.[92] are Aviation Resource Management (1C012), Geospatial Intelligence (1N111), Weather (1W011), Vehicle Management and Analysis (2T317), Knowledge Operations Management (3D011), Computer Systems Programming (3D014), Pest Management (3E413), Services (3M011), Manpower (3S313), Medical Materiel (4A111), Medical Laboratory (4T011), and Dental Laboratory (4Y012).

Using the deployment rates of individuals in particular Air Force occupational classification codes over the period of 2001–2009 into the US Central Command area of operations, we analyzed the positions identified in Table 7. Overall, for enlisted Air Force positions, the average deployment rate was 5.0%. While "Helper" positions were identified in Table 7, the deployment rates include the Apprentice and Journeyman levels to provide a representative perspective of people in similar positions.

B. Summary

One of the reasons that DOD has established its current hearing standards is that the military service is a profession where hearing loss is common.[93] For an individual to maintain sufficient hearing, he/she must begin military service with outstanding hearing. If hearing is already poor and continues to degrade, the individual may no longer be able to perform his or her job. This analysis did not look specifically for positions where noise-induced hearing injury is likely, but a casual review of the positions listed in this section indicate that at least some of these positions appear to be in relatively quiet settings. For individuals who are profoundly deaf, the risk of further noise-induced injury may be unlikely. This situation also may be true for individuals with CIs, but a longitudinal study would be needed to confirm it. Further analysis of positions may identify occupations where hearing is not critical (or where appropriate accommodations are in place) and where risk of hearing injury is elevated. Those positions might be suitable for already profoundly deaf individuals who would not be at risk of further hearing loss but not for individuals with mild hearing loss who may be at elevated risk for additional hearing loss.

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[90] Buchanan et al., "Military Hearing Critical Task Review by Service."

[91] Ibid.

[92] Ibid., D-1–D-7.

[93] Marlene E. Gubata et al., "Pre-enlistment Hearing Loss and Hearing Loss Disability among US Soldiers and Marines," *Noise & Health* 15, no. 66 (September–October 2013): 289–295, http://www.amsara.amedd.army.mil/Documents/DES_Publication/1.%20Gubata_M%20-%20Noise%20Health_2013.pdf.

Additional analysis would be needed to functionally validate these findings, which is beyond the scope of this study. The development of auditory fitness for duty evaluation protocols for specific positions[94] would be needed with particular accommodations in place to determine whether individuals with hearing impairment would be fit for the specific occupations identified in this section. This process includes an in-depth job analysis where acceptable job accommodations could be used.

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[94] Jennifer B. Tufts, Kristin A. Vasil, and Sarah Briggs, "Auditory Fitness for Duty: A Review," *Journal of the American Academy of Audiology* 20, no. 9 (October 2009): 539–557, http://www.audiology.org/sites/default/files/journal/JAAA_20_09_02.pdf.

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5. Recent Deployment Experiences and Future Demands on the Force

A. Introduction

This section considers deployments to the USCENTCOM region after 2001 as a means to understand the operational demands placed on uniformed Service members who are deployed, as well as how they are employed once in a contemporary operational environment. Additionally, we consider the impact on deploying forces and other organizations when populations of Service members are ineligible to be deployed. We conclude the section by considering future demands that could be placed on the DOD and each service member, thus testing our second research hypothesis.

## B. Overseas Assignment and Deployment

Combatant commands, as part of the operational chain of command to the President, place mission demands on the military Services who organize, train, equip, and provide forces as part of the administrative chain of command. To prioritize supply and demand, DOD relies on its global force management process, managed by the Joint Staff. Some operational demands are met by organizations and individuals that are assigned to the combatant commands or other organizations within global regions. When operational demands exceed forces assigned in a region, the combat command requests that additional forces be allocated for a finite period, in accordance with 10 United States Code, section 162. To consider the magnitude of these demands, we analyzed the Defense Manpower Data Center (DMDC) deployment data to the USCENTCOM region from 2002 to 2009.

The Services, in response to the official data call for this research, each indicated that they had no non-deployable occupational specialties into which individuals can access (See Appendix F). To verify these responses—and thus affirm our first study hypothesis that all military Service members, regardless of occupational specialty, must be deployment eligible and prepared to deploy into an operational area in support of ongoing and future missions—we considered deployments of each Service into the USCENTCOM area of responsibility (AOR). The original DMDC data consisted of two datasets spanning 2002-2009: a deployment dataset with records for each Service member deployment and a yearly record dataset containing Service member occupational specialty, among other variables. These datasets were merged and aggregated for analysis. Specifically, the number of records in the yearly Service member record dataset was counted, generating an

approximation of the number of man years in each occupational code. Next, deployment days were summed and then merged with the other Service member dataset, creating a deployment ratio for each occupation.

These data from all Services permit a look at the operational demands placed on the individuals within each occupational specialty, for both officers and enlisted personnel. For each Service, we consider both the occupations with the highest and then lowest deployment rates.

Figure 6 shows the 25 Army Active Duty occupations with the highest deployment rates into the USCENTCOM AOR. While the high deployment rates for some occupational specialties seem intuitive (i.e., armor and cavalry), the high deployment rates for administrative occupations are not as intuitive.

Army Active Duty Deployment Rate and Size, Highest Deployment Rates, 2002-2009
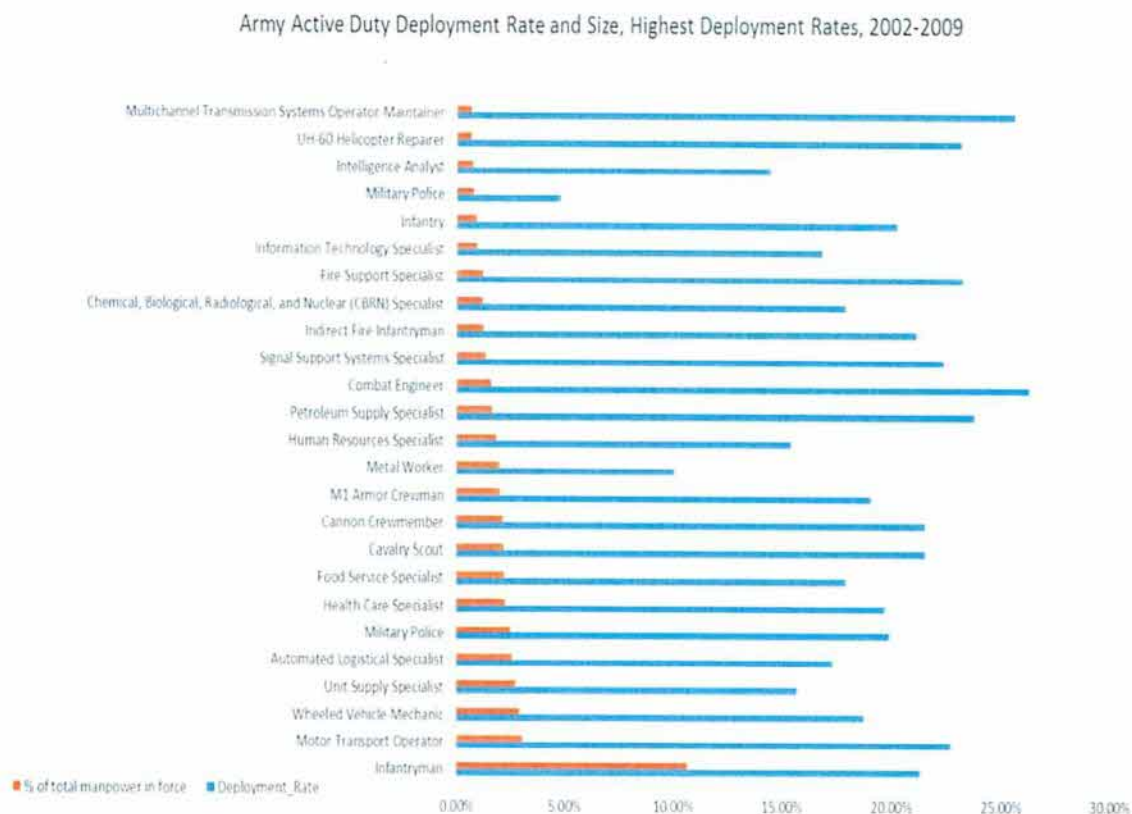
Source: IDA analyses of DMDC datasets.

Figure 6. Top 25 Army Deployment Rates by Occupation

Deployment data for the Air Force Active Duty are depicted in Figure 7. According to these DMDC data, Air Force deployment rates are dominated by occupations involving craftsmen and journeymen skill levels of various Air Force Specialty Codes.

Air Force Active Duty Deployment Rate and Size, Highest Deployment Rates, 2002-2009
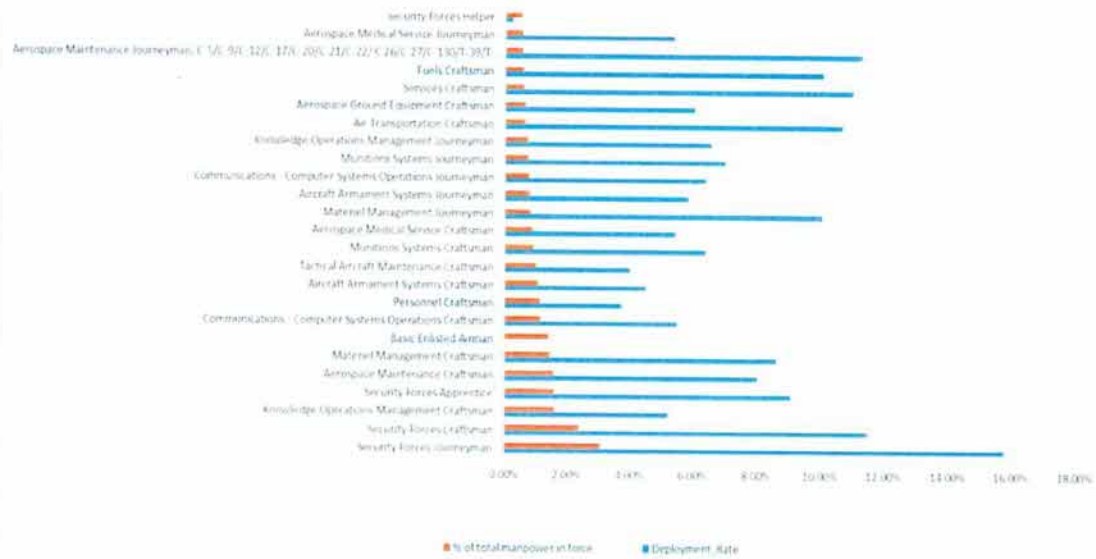
Source: IDA analyses of DMDC datasets.

Figure 7. Top 25 Air Force Active Duty Deployment Rates by Occupation

Deployment data for the Navy are depicted in Figure 8.

Navy Active Duty Deployment Rate and Size, Highest Deployment Rates, 2002-2009
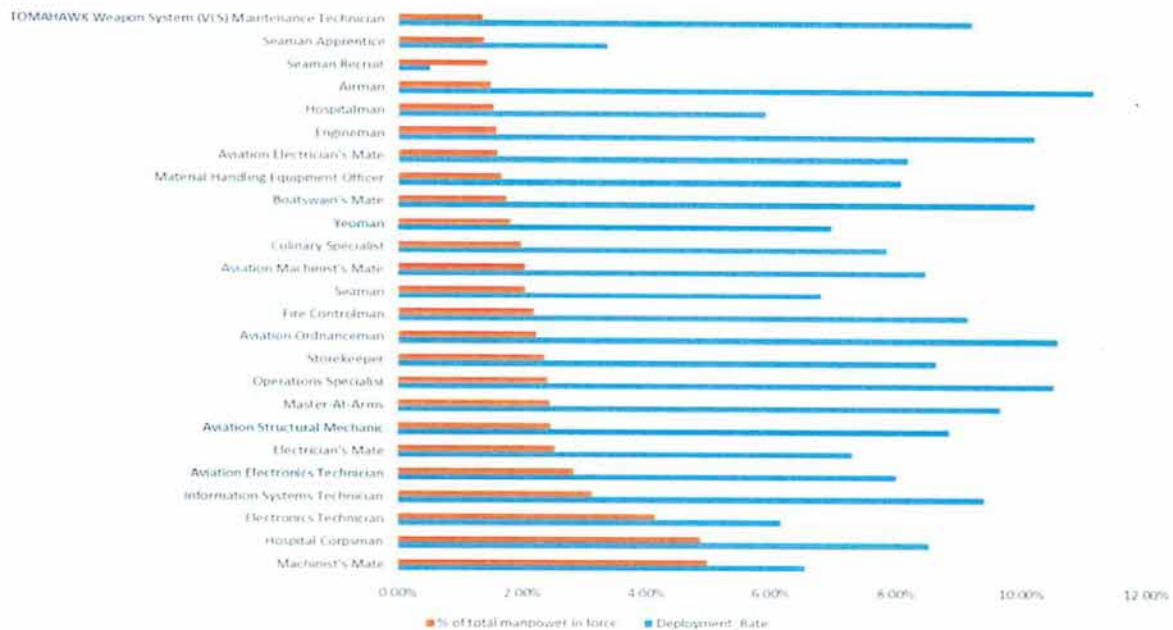
Source: IDA analyses of DMDC datasets.

Figure 8. Top 25 Active Duty Navy Deployment Rates by Occupation

Navy data also depict a variety of occupations that experienced deployment rates into the USCENTCOM area, as well as other global deployment requirements.

Deployment data for the Marine Corps are depicted in Figure 9. Marine Corps data depict higher deployment rates by certain officer communities, but also by operators, clerks, specialists, gunners, and engineers.
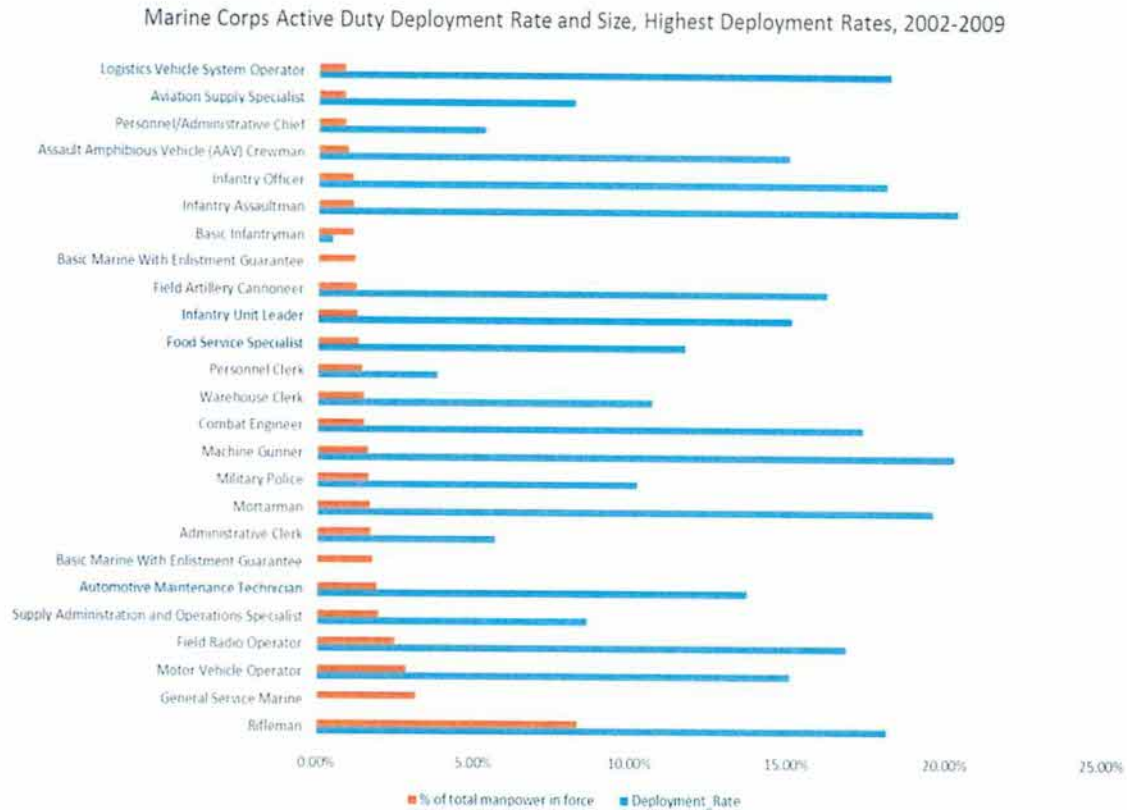
Source: IDA analyses of DMDC datasets.

Figure 9. Top 25 Active Duty Marine Corps Deployment Rates by Occupation

Because we were testing the hypothesis that all military Service members, regardless of occupational specialty, must be deployment eligible and prepared to deploy into an operational area, we also considered the same USCENTCOM deployment data, and examined the occupational specialties that deployed least. While some occupations experienced a higher operational demand than others, and there were no deployment rates for populations of Service members in their initial entry training because they could not deploy until they obtained an occupational specialty, we did not identify any operational communities that did not deploy. While these data considered deployment into the USCENTCOM AOR, deployments that regularly occur in other regions place additional deployment demands on military personnel and the management process.

C. Non-Standard Sourcing

While the DMDC deployment data presented in the previous section depicts which Service members deployed to the USCENTCOM area by occupation, the data does not depict what members were asked to perform once deployed. Data on how each Service member was employed once deployed must be considered via proxy information from other sources.

Previously, we described how combatant commands request forces to be allocated to meet mission demands, and how these forces are provided by the military Services. When a combatant command request is met by sourcing the requirement with the Service and capability requested, it is called a standard sourcing solution.

Often, however, demands are not met via standard sourcing. Non-standard sourcing can occur when demands exceed available supply from the Services, whether Active Duty or Reserve Component, or when the capability requested does not exist in Service inventories.

Non-standard sourcing can take three forms. The first non-standard sourcing solution entails taking an existing Service capability from one Service that is similar to what is being requested by another Service; this is referred to as Joint sourced. Another non-standard sourcing solution is referred to as in-lieu-of sourcing and consists of an existing Service organization being re-missioned to perform something entirely different from their doctrinal organizationally designed mission. The final non-standard sourcing solution takes place when a capability does not exist in the military Services and a provisional organization is assembled from individuals and smaller organizations. This type of sourcing is referred to as ad hoc and is used to create provincial reconstruction teams, agricultural development teams, and other provisional organizations that would disband upon return from the USCENTCOM AOR. Table 8 illustrates examples of standard and non-standard sourcing.

Table 8. Force Sourcing Solutions—Illustrative Examples

Category	Requested	Received
Standard	Army Brigade	Army Brigade
Non-Standard—Joint Sourced	Army Military Police	Air Force Security
Non-Standard—In Lieu of	Convoy Security Police	Artillery Unit
Non-Standard—Ad Hoc	Provincial Reconstruction Teams (PRT)	Provisional PRT

Source: Joint Publication 5-0, Joint Operation Planning, 11 August 2011.

When non-standard sourcing of combatant command demands occur, Service members may be required to deploy outside of their occupational specialty, learn new skills, and operate in different environments.[95] According to the Government Accountability Office (GAO), DOD could not ensure that all forces filling non-standard deployment requirements were being used consistent with the tasks, conditions, and standards for which they have been trained.[96] The GAO report highlighted how, for certain Navy and Air Force occupations, non-standard force deployments challenged the Services' abilities to (1) balance the amount of time their forces are deployed with the amount of time they spend at home, and (2) meet other standard mission requirements.[97]

In a 2007 hearing before the Readiness Subcommittee on the Committee on Armed Services, Congressional committee members expressed concern that service members were not being trained on combat proficiency, and concern about the strain on readiness and an increased risk to national security created by taking Service members out of their core Service roles.[98] During the discussion of in-lieu-of sourcing requirements, the DOD highlighted a requirement of 17,376 personnel for non-standard sourcing solution for fiscal year 2008 alone.[99] The Air Force testified that of the 25,453 Airmen and Airwomen deployed to USCENTCOM, 6,293 or roughly 25% were considered to be filling in-lieu-of tasks, and that since 2004 approximately 22,000 Airmen and Airwomen were deployed to perform such tasks.[100] According to the Air Force, these in-lieu-of tasks drew from across specialty codes, to include civil affairs, public affairs, judge advocate, chaplain, intelligence, counterintelligence, medical, communications, logistics, engineering, security forces, and operations.[101]

Additional Service members were deployed out of their doctrinal occupation when they were part of Joint sourced and ad hoc solutions. The Navy, for example, testified during the hearing that more than 46,000 sailors were transferred from their usual jobs to augment joint Service requirements in the USCENTCOM area.[102] Augmentees, or individually deploying Service members, fulfilled requirements associated with ad hoc

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[95] GAO-08-670, *Joint Policy Needed to Better Manage the Training and Use of Certain Forces to Meet Operational Demands*, May 2008.

[96] Ibid.

[97] Ibid.

[98] Hearing before the Readiness Subcommittee on the Committee on Armed Services, House of Representatives, The Use of In Lieu Of, Ad Hoc and Augmentee Forces in Operations Enduring Freedom and Iraqi Freedom, July 31, 2007.

[99] Ibid.

[100] Ibid.

[101] Ibid.

[102] Ibid.

sourcing, because an existing organization was not used as part of the non-standard solution. For example, according to 2009 Joint manning documents, 7,724 individual augmentee requirements were levied on the military Services for sourcing.[103]

Due to concerns related to the contemporary operational environments in Iraq and Afghanistan, where "the entire country can be considered a combat area" and that the DOD should prepare all deploying Service members "for the worst possible scenario, which is combat," the Army established basic combat skills training (CST) that members from all Services can attend.[104] The Navy, for example, required all deploying individual augmentees to attend this three-week program in which Army drill instructors provided training in a range of subjects, including basic rifle marksmanship, crew served weapons, improvised explosive devices, and quick/reactive fire.[105] The Air Force also sent "thousands" of Airmen and Airwomen every year to the Army CST to "help them succeed while deployed" as they stepped outside their traditional roles and skills.[106]

D. Impact of Increased Numbers of Personnel Unavailable for Deployment

While the 2002-2009 DMDC deployment data did not depict any operational communities that did not deploy in support of USCENTCOM mission requirements, these data did highlight the numbers of individuals that were not deployed. As previously described, both officer and enlisted individuals who were not certified in an occupation or branch and who newly enter the military Services each year, are part of the non-deployable populations. Service response to an official data call (Appendix F) highlight the relationship between the numbers of individuals unavailable for assignment and the ability of the Service to fill organizational billets. In this section we consider the impact of non-deployable military personnel and the force impact when those numbers increase.

When a military unit is selected as a sourcing solution to fulfill a combatant command requirement, whether as an emergent requirement or to fill an ongoing rotational requirement, the unit leadership prepares the organization to be ready for the mission. One critical component of the unit readiness calculation consists of personnel readiness—having personnel of the right occupational specialties and grades in all required billets. When Service members assigned to the organization cannot deploy, the leadership must

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[103] United States Joint Forces Command briefing on the Joint Individual Augmentee Sourcing Process, April 2010.

[104] Hearing Before the Readiness Subcommittee on the Committee on Armed Services, House of Representatives, *The Use of In Lieu Of, Ad Hoc and Augmentee Forces in Operations Enduring Freedom and Iraqi Freedom*, July 31, 2007.

[105] http://www.public.navy.mil/ia/Pages/faq.aspx#13.

[106] http://fortblissbugle.com/combat-skills-training-army-training-for-today%E2%80%99s-airmen/.

find replacement individuals who can deploy, which places demands on the Service's human resource management systems. The intent is to have the correct number of Service members, by occupation, skill level, and grade, within the organization so that they can undergo training leading up to deployment.

Until a Service member is detached from their unit of assignment, the organization cannot request a deployable replacement. Ultimately, deploying commanders are responsible both for processing any non-deployable Service members, and for the deployment readiness of the entire unit. If they cannot conduct personnel processing in a timely manner, operational readiness for mission deployment is negatively affected.[107]

This system of substituting non-deployable Service members for those who are deployment eligible can be referred to as personnel cross-leveling; such cross-leveling provides an indicator of personnel turbulence within an organization. A 2013 RAND study cited that Army Reserve Component organizations selected for deployment averaged 23 percent personnel cross-leveling.[108] When a deploying unit requires Service members that are deployment eligible, they take them from other organizations, which then are called "donor" organizations. To improve the readiness of the deploying unit, the donor units instantly become less ready themselves for any ongoing missions or any potential global deployment. Figure 10 depicts the impact of cross-leveling.
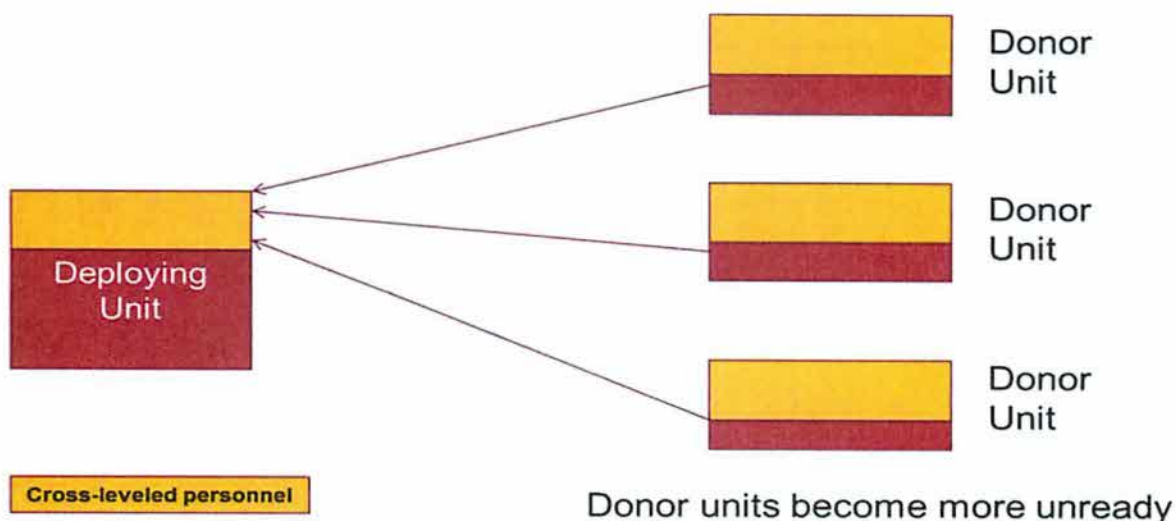
Source: IDA Briefing, 2015.

Figure 10. Cross-Leveling and Readiness Illustration

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[107] John E. Sena, *Non-Deployables: An Increasing Challenge for the Army*, US Army War College, Carlisle Barracks, PA, 2010.

[108] Thomas Lippiatt and J. Michael Polich, *Leadership Stability in Army Reserve Component Units*, 2013, 22-23.

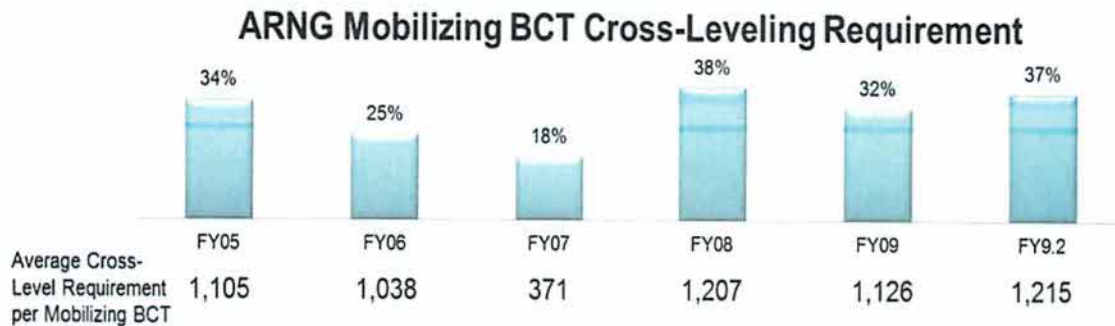Figure 11 illustrates the cross-leveling that took place in the Army National Guard (ARNG) Brigade Combat Teams (BCTs) from FY 2005 through FY 2009. In data provided by ARNG, in fiscal year 2008, there was an average of 38 percent personnel cross-leveling for mobilizing and deploying BCTs, and 37 percent in 2009.[109]

ARNG Mobilizing BCT Cross-Leveling Requirement

	FY05	FY06	FY07	FY08	FY09	FY9.2
	34%	25%	18%	38%	32%	37%
Average Cross-Level Requirement per Mobilizing BCT	1,105	1,038	371	1,207	1,126	1,215

Source: Army National Guard Readiness presentation, October 2009.

Figure 11. Cross-Leveling in Army National Guard Brigade Combat Teams

To meet the requirements associated with recent contingency operations, and to compensate for the number of potential Service members that would be unable to deploy, the Services attempted to assign more than the authorized number of personnel to the deploying organizations. According to a representative of the Marine Corps, it was not uncommon to provide deploying units with 5 percent more personnel.[110] In a 2009 Soldier Deployability briefing, the Army described an active duty BCT non-deployable personnel percentage of 13 percent, with a plan to compensate deploying units by providing them with 105 percent authorized fill in order to hopefully achieve 90 percent personnel available for the deployment.[111] The increasing rate of non-deployable Service members had a strategic impact on the Army and became a top priority for Army leaders and its human capital enterprise.[112] Additionally, when Service members deploy and then do not meet medical deployment fitness standards, there is risk for inadequate treatment within the operational theater, personal risk due to potential inability to perform combat required

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[109] Army National Guard Readiness presentation, October 2009.

[110] Discussion with USMC Manpower and Reserve Affairs, Quantico, VA, June 2015.

[111] Headquarters Department of the Army briefing entitled, *Soldier Deployability*, 6 July 2009.

[112] Scott Arnold, Christopher Crate, Steve Drennan, Jeffrey Gaylord, Arthur Hoffman, Donna Martin, Herman Orgeron, Monty Willoughby, *Non-Deployable Soldiers: Understanding the Army's Challenge*, U.S. Army War College, Carlisle Barracks, PA, 2011.

skills, and the potential to be sent home from the deployment and render the deployed unit with less manpower.[113, 114]

The personal burden of deployment and risk changes for those who are deployment eligible when there is an increase in the number of military personnel who are non-deployable. As combatant command mission demands persist over time, as they did in the USCENTCOM (AOR), deployment eligible personnel were sent to combat theaters repeatedly. While we did not delve into the impacts of repeated deployments (injuries, accidents, casualties, divorce rates, suicides, etc.) as part of this research, we did use the DMDC deployment data for 2002 to 2009 and noted the occupational specialties where some personnel experienced high deployment rates and others with none at all. For example, if we look at ARNG infantry, approximately 35 percent did not deploy in 2002-2009, while there were those within some specialties that had deployment rates up to about 50 percent. As an example, Figure 12 illustrates the ARNG Infantry Deployment Rates.
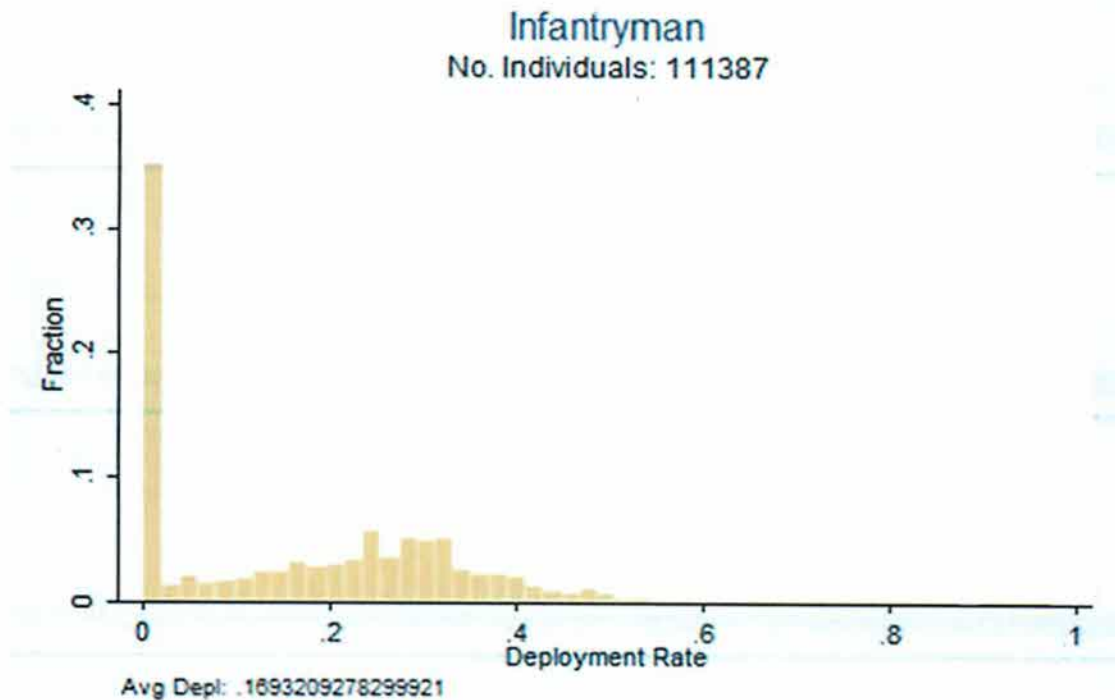
Source: David R. Graham, *Self-Selection as a Tool for Managing the Demands on Department of Defense (DOD) Personnel.* Institute for Defense Analyses paper P-4606, Alexandria, VA, 2010.

Figure 12. Army National Guard Infantry Deployment Rates

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[113] Gregg Zoroya, "US Deploys More than 43,000 Unfit for Combat," *USA Today*, May 7, 2008.

[114] Ed Offley, *One Soldier Hobbles Through a Year of Hell*, Military.Com, August 23, 2014.

This is an example from one specific occupation; the subject was further researched and explained in a 2010 IDA paper that looked at self-selection as a possible means to reduce deployment demands on the force.[115] However, the example does numerically depict how the burden of deployment unfolds between those individuals who do not deploy and those who are deployment eligible.

E. Recent Deployment Experiences through the Lens of Specific Communities

One of the underlying questions at the core of this research effort regards the existence of non-deploying communities. The extent to which there are occupations or communities not called upon to deploy into areas where contingency operations are taking place is the extent to which there may be some flexibility about deployment limiting conditions. We examined the following communities as case studies: military medical specialties, Judge Advocate General's Corps (JAGs), DOD civilians, Service band members, and the deployment experiences of military women.

1. Military Medical Specialties

Historically, the Services' estimates of medical Service personnel deployment requirements significantly exceed actual deployment levels and staffing requirements for deployable units.[116] According to Whitley et al, "Medical Total Force Management":

- Service-identified active duty medical force military essential requirements can be divided into direct operational requirements (e.g., requirements to staff deployable units) and non-operational requirements. The non-operational requirements constitute a substantial portion of total requirements and vary significantly by specialty.

- Examples of these non-operational requirements include beneficiary care in isolated and overseas MTFs [Military Treatment Facilities], Graduate Medical Education (GME), and similar activities that are likely not military essential according to DOD guidance.

- Medical specialties deploy less than non-medical specialties, averaging one-fifth to one-third the deployment level of the primary combat arms specialties.

- Significant variation exists for deployment experience across specialties and Services

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[115] David R. Graham et al., *Self-Selection as a Tool for Managing the Demands on Department of Defense (DOD) Personnel*, Institute for Defense Analyses Paper P-4606, Alexandria, VA, 2010.

[116] Whitley et al, *Medical Total Force Management*, IDA P-5047, May 2014, v.

One study finding was that medical specialties that did not deploy were identified for conversion to civilian positions.

2. Judge Advocate General's Corps

Across DOD, JAG eligibility requirements entail that applicants must:[117]

- Be a United States citizens

- Be age 21 or older, not exceeding age 42 by the time of commissioning

- Be physically fit, meeting the Army's weight and medical entrance standards

- Possess high moral character and leadership potential.

- Hold a Juris Doctor (J.D.) from an ABA-approved law school and must be a member in good standing of the bar of the highest court of a state or federal court

- Be eligible for a security clearance

Using the Army as an example, these individuals must meet the following obligations:

- Four years active-duty service

- Reserve Component (RC) JAG—eight-year service obligation

Additionally, JAG training has multiple components. Individuals must first take the Judge Advocate Officer Basic Course (JAOBC) and complete a two-phase, five-month training program. Phase one is a Direct Commissioned Course (DCC) at Fort Benning, GA, a "rigorous six-week course in leadership and tactics designed to challenge all new Army officers physically and mentally." (West Point, ROTC, and Officer Candidate School graduates attend similarly designed courses.) The curriculum features:[118]

> physical fitness training, foot marches, combat training, land navigation training (similar to orienteering), rifle marksmanship, training with night-vision equipment, weapons training, training in nuclear, biological and chemical operations, practical exercises in leadership, and several confidence courses featuring difficult obstacles to challenge students to overcome personal fears and work with a team.

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[117] Department of the Army, Judge Advocate Recruiting Office, "The U.S. Army Judge Advocate General's Corps Frequently Asked Questions," Revised January 2014; https://www.jagcnet.army.mil/sites/jaro.nsf/xsp/.ibmmodres/domino/OpenAttachment/Sites/jaro.nsf/C07 CD9644C10A90585257B35004610B8/Attachments/Frequently%20Asked%20Questions%20(Jan%2020 14).pdf;; RC JAG information: Judge Advocate Recruiting Office, RC JAG, FAQ, https://www.jagcnet.army.mil/sites/jaro.nsf/homeContent.xsp?open&documentId=FFFE5698B7BEC5D 585257B2D004EFDCD.

[118] Ibid.

Phase two is a ten-and-a-half-week, classroom-based, training regimen in "military law topics at The Judge Advocate General's Legal Center and School (TJAGLCS) in Charlottesville, VA."[119]

For assignments, "Active Component Judge Advocates must be available for worldwide assignment." According to the Department of the Army, Judge Advocate General Corps' Frequently Asked Questions:[120]

> Over 400 Judge Advocates are currently assigned overseas in over 20 countries including some in active combat zones. They perform legal duties in support of Soldiers and combat operations. Typically, Judge Advocates are not directly involved in active combat, but they may perform some non-legal functions as needed. Judge Advocates assigned to combat zones are entitled to combat pay and to the federal combat zone tax exclusion for income earned during months spent in the combat zone.

Reserve Component JAG officers "typically serve as Individual Mobilization Augmentee (IMA)" and are "assigned to active duty agencies or installations" Ultimately, JAG officers, both Active and Reserve Component, must be able to deploy anywhere, including into active combat zones.[121]

3. Civilian Expeditionary Workforce

Members of the DOD Civilian Expeditionary Workforce (CEW), formerly called Emergency-Essential (E-E) DOD U.S. Citizen Civilian Employees, must meet the same physical and medical standards established for the respective theater.[122] According to the DODI, members of the CEW: [123]

> shall be organized, trained, cleared, equipped, and ready to deploy in support of combat operations by the military; contingencies; emergency operations; humanitarian missions; disaster relief; restoration of order; drug interdiction; and stability operations of the Department of Defense.

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[119] Ibid.

[120] Ibid.

[121] The other Service's JAG Corps have similar requirements, see, for example the U.S. Air Force Judge Advocate General website, http://www.airforce.com/jag/; and the "Guide to the U.S. Navy JAG Corps," May 2012, http://www.jag.navy.mil/careers_/careers/docs/JAG_Guide(May%202012).pdf.

[122] DODD 1404.10, Emergency-Essential (E-E) DOD U.S. Citizen Civilian Employees, 10 April 1992, https://www.hsdl.org/?view&did=395; DODD 1404.10, DOD Civilian Expeditionary Workforce, 23 January 2009, http://www.dtic.mil/whs/directives/corres/pdf/140410p.pdf.

[123] DODD 1404.10, DOD Civilian Expeditionary Workforce, 23 January 2009, http://www.dtic.mil/whs/directives/corres/pdf/140410p.pdf.

Figure 13 depicts a recent cadre of CEW participants conducting training prior to deployment into the USCENTCOM AOR.

Figure 13. Civilians in Recent Training Prior to Deployment into the CENTCOM AOR

4. Members of Military Bands

Across the Services, individuals seeking to serve as members of military bands must "meet established standard requirements for enlistment with regard to physical fitness and medical screenings."[124] Even individuals seeking to become part of "The President's Own," the U.S. Marine Band and Marine Chamber Orchestra, must meet the standard requirements. According to The President's Own website, "Career Information":[125]

> Disqualifying conditions may include, but are not limited to, failure to meet height/weight standards at time of enlistment; serious vision and auditory

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[124] U.S. Army Music, "Serving the Nation through Music," FAQs, http://www.music.army.mil/careers/faq/#28; U.S. Navy Band, Career Information Frequently Asked Questions, http://www.navyband.navy.mil/career_information.shtml; Air Force Bands Program, Auditions and USAF Band Career Information http://www.bands.af.mil/careers/regionalbandfaq.asp; http://www.usafband.af.mil/questions/topic.asp?id=954; The President's Own, United State Marine Band and Marine Chamber Orchestra, "Career Information," http://www.marineband.marines.mil/Portals/175/Docs/Career%20Information/Career%20Info_15_book let.pdf.

[125] The President's Own, United State Marine Band and Marine Chamber Orchestra, "Career Information," http://www.marineband.marines.mil/Portals/175/Docs/Career%20Information/Career%20Info_15_book let.pdf.

problems; hypertension; diabetes; heart defects; seizure; inflammatory bowel syndrome; loss of an eye or kidney; cancer within five years; anorexia; treatment for asthma during the past five years; allergy immunotherapy during the past two years; and physical limitations due to injury or congenital conditions.

Again, members of military bands also deploy into combat zones, performing duties assigned to their band. Figure 14 depicts the New York Army National Guard's 42nd Infantry Division Band performing during an Iraqi Army Training Center graduation in Tikrit, Iraq in 2005.[126]

Source:
https://s3.amazonaws.com/attachments.readmedia.com/files/60714/original/photo_9140_0_9140_0.jpg?140
7343270.

Figure 14. The 42nd Infantry Division Band, Tikrit, Iraq in 2005.

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[126] U.S. Army Music, "Serving the Nation through Music," FAQs, http://www.music.army.mil/careers/faq/#28; U.S. Navy Band, Career Information Frequently Asked Questions, http://www.navyband.navy.mil/career_information.shtml; Air Force Bands Program, Auditions and USAF Band Career Information http://www.bands.af.mil/careers/regionalbandfaq.asp; http://www.usafband.af.mil/questions/topic.asp?id=954; The President's Own, United State Marine Band and Marine Chamber Orchestra, "Career Information," http://www.marineband.marines.mil/Portals/175/Docs/Career%20Information/Career%20Info_15_book let.pdf.

5. The Deployment Experiences of Military Women

Women have a long history of serving in the military Services. There is an equally long history of women being formally barred from combat roles. The 1994 Secretary of Defense Memorandum, Direct Combat Assignment Rule, specifically excluded women from assignments "to units below the brigade level whose primary mission is to engage in direct combat on the ground."[127]

Despite that rule, and the use of personnel assignment tools, such as the Army's Direct Ground Combat Position Coding system (DGCPC—"p" ratings designated positions as open or closed to women), women soldiers in OIF/OEF performed tasks outside their MOS based on mission requirements. In recent contingency operations, women were among those killed in action (KIA), wounded in action (WIA), and also received combat awards.[128] In OIF, the number of female Service personnel KIA was 110, 627 were WIA. In OEF, the number of female Service personnel KIA was 51, 376 were WIA. In OND, the number of female Service personnel KIA was 0, 12 were WIA.[129] Thousands of female Service personnel have received military combat awards, including the Silver Star (awarded to an Army National Guard Medic and Army Military Police.)[130]

The 2013 CJCS/SECDEF memorandum, Women in the Service Implementation Plan, calls for the three-year integration process to be complete by 2016. Each Service, and U.S. Special Operations Command (USSOCOM), submitted its plan. Special exemptions were possible if "the assignment of women to a specific position or occupational specialty is in conflict with our stated principles."[131] The memorandum emphasized "gender-neutral" occupational performance standards and effectively rescinded ground combat restrictions for women.[132] Ultimately, combat exclusion based on distinctions between forward and rear operating areas had become incongruous with the nonlinear nature of recent contingency operations.[133]

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[127] SECDEF memo, Direct Ground Combat Definition and Assignment Rule, January 1994.

[128] Martin E. Dempsey, Task Force IAD, "Women's Roles in Combat Seminar," March 2004.

[129] Female soldiers have been awarded Combat Action Badges, Purple Hearts, and one Silver Star. CRS, American War and Military Operations Casualties: Lists and Statistics, December 2014.

[130] Women in Military Service for America Memorial Foundation, "Voices of Valor, An American Hero: Army Woman Earns Silver Star and Makes History," Women In Military Service For America Memorial Foundation's website, March 2008, http://www.womensmemorial.org/Education/PDFs/WHM08USA.pdf.

[131] CJCS Memo, Women in Service Implementation Plan, January 2013.

[132] Ibid.

[133] Restrictions on Assignments of Military Women, A Brief History, National Women's Law Center, http://www.nwlc.org/sites/default/files/pdfs/women_in_military_assignments_a_brief_history_revised_jan_2014.pdf.

F. Future Demands on the Force

To test the second hypothesis, we leveraged IDA's Stochastic Active-Reserve Assessment model (SARA) and Integrated Risk Assessment and Management Model (IRAMM) to consider future force requirements for missions the United States may be called upon to perform. A detailed description of this effort is located in Appendix G, where results from simulating senior leaders indicate that current policy makers implicitly anticipate the possibility of a severely challenging future (3 to 6 simultaneous operations). Results from simulating pseudo-Subject Matter Experts (SMEs) based on the senior leaders indicate that the potential for human errors in estimating the numerical probability of possible futures leaves us with the more robust planning assumption that an even more challenging future (8 simultaneous operations) is quite possible. Results from simulations informed by history confirm this view. Results from simulating unrestricted pseudo-SMEs based on a fairly conservative algorithm suggest that even this assumption may be over-optimistic and that extraordinarily stressful futures may be possible and should be considered in our decisions. Given these results, indications are that uniformed individuals in each of the military Services will be globally deployed during periods of challenging futures where the number of deployable personnel will dictate how constrained DOD is in its ability to meet these challenges.

G. Conclusions

This section addressed deployment experiences over the last two decades. Given that one of the underlying questions at the core of this research effort and hypotheses focused on the existence of non-deploying communities, we examined whether there were occupations not called upon to deploy into areas where contingency operations took place. In this case, data did not identify any non-deploying operational communities. Additionally, when the number of individuals not available for deployment increased, organizations had to cross-level to fill their deployment personnel requirements. An increase in non-deployable personnel also shifts the personal burden of deployment and risk to those who are deployment eligible.

To assess our second hypothesis, we also considered future force requirements for missions the United States may be called upon to perform. A detailed description of this effort is in Appendix G, where results from simulating senior leaders indicate that current policy makers anticipate the possibility of a severely challenging future where uniformed individuals in each of the military Services will be globally deployed during challenging periods.

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6. Overview of Current and Recent Research

A. Introduction

Just as medical standards have evolved over time, research on medical standards and deployment/employment eligibility has been ongoing for decades. Historically, such research focused on addressing wartime demands that exceeded the supply of medically qualified recruits; such research focused on how the standards could be adjusted to enable the greatest pool of eligible recruits in times of extreme national need or existential threat.[134] The most recent research is evidence-based, focused on accession and retention standards through the lens of performance data, attrition statistics, and disability prediction.

Since the creation of the all-volunteer force, there has been continuing discussion regarding medical standards, in general.[135] An extensive literature review is outside the scope of this research effort. See Appendix H for references to relevant literature related to the feasibility and advisability of permitting individuals with auditory impairment to access as members of the armed forces.

The research highlighted in this section focuses on some of the recent, evidence-based efforts to examine audiometric hearing-level standards and the effect of auditory impairment on attrition, performance, and disability status. The DOD Hearing Center of Excellence (HCE), the Accession Medical Standards Analysis and Research Activity (AMSARA) at the Walter Reed Army Institute of Research, Walter Reed National Military Medical Center, the U.S. Army Public Health Command (APHC), and Tri-service Disability Evaluation System Analysis and Research are among the most prominent research organizations examining auditory impairment through this lens.

Much of the recent research on medical standards for accession has been conducted to inform revisions of DOD issuances on medical standards, such as DODI 6130.03,

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[134] See, for example, Jack Sternberg, Frank S. Greenberg, Edmund F. Fuchs, "Enlisted MOS Suitable for the Physically Handicapped," Personnel Research Branch, The Adjutant General's Office, Department of the Army, December 1958. The authors concluded that of the 401 MOSs listed in AR 611-201, "250 MOS were identified with at least one duty position which could be performed satisfactorily" by a handicapped individual. Hard of hearing was one of the handicaps included in this study. The authors defined hard of hearing as "hearing loss sufficient to disqualify by current minimum standards up to the point where the person is still able to receive individual verbal instructions at close range." (14) The authors stated that "Deafness was deleted as being too serious a handicap in a military setting." (7).

[135] See, for an early example, Chu, et al, "Physical Standards in an All-Volunteer Force," the Rand Corporation, R-1347-ARPA/DDPAE, April 1974.

Medical Standards for Appointment, Enlistment, or Induction in the Military Services. As described in Section 3, AMSARA, the National Research Council, and the Defense Health Board have been conducting research to inform "the development of evidence-based medical standards."[136]

B. Auditory Impairment and Attrition

In "Attrition of U.S. Military Enlistees with Waivers for Hearing Deficiency, 1995-2004," Niebuhr et al. summarized their research findings regarding enlistees granted waivers for hearing deficiency. The authors compared military retention of enlistees granted hearing-loss related medical waivers with the retention of "a matched comparison group" of medically qualified enlistees.[137] According to this study, the Army had the highest number of enlistees granted such waivers (3,674), followed by the Navy (1,605). The numbers of enlistees granted hearing-loss related medical waivers in the Marine Corps (584) and Air Force (78) resulted in a smaller sample size and affected the statistical significance of the comparison.[138] The authors found that the "likelihood of early attrition, both all-cause and medical reason-related, is noticeably higher among enlistees entering the Army and the Navy with" hearing-loss related medical waivers compared to the comparison group.[139] The difference in medical attrition in the Marine Corps was only marginally significant. The Air Force's small sample size rendered that data of no utility. The authors concluded that the "increased likelihood of medical attrition in enlistees with a waiver for hearing loss provides no evidence to make the hearing accession standard more lenient and validates a selective hearing loss waiver policy."[140]

One of HCE's areas of emphasis is the costs associated with the career development of Service personnel with the potential for auditory impairment.[141] Figure 15 depicts DOD retention costs and potential savings given that individuals with the potential for hearing impairment are not provided with specialized, expensive training and education.

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[136] Accession Medical Standards Analysis and Research Activity, 2013 Annual Report, Walter Reed Army Institute of Research, 2013, abstract.

[137] Lieutenant Colonel David W. Niebuhr, "Attrition of U.S. Military Enlistees with Waivers for Hearing Deficiency, 1995-2004," Military Medicine, Vol. 172, January 2007, 63.

[138] Ibid, 64.

[139] Ibid, 67.

[140] Ibid, 63.

[141] Source: DOD HCE, Department of Defense Military Health System Perspective, April 27, 2015.
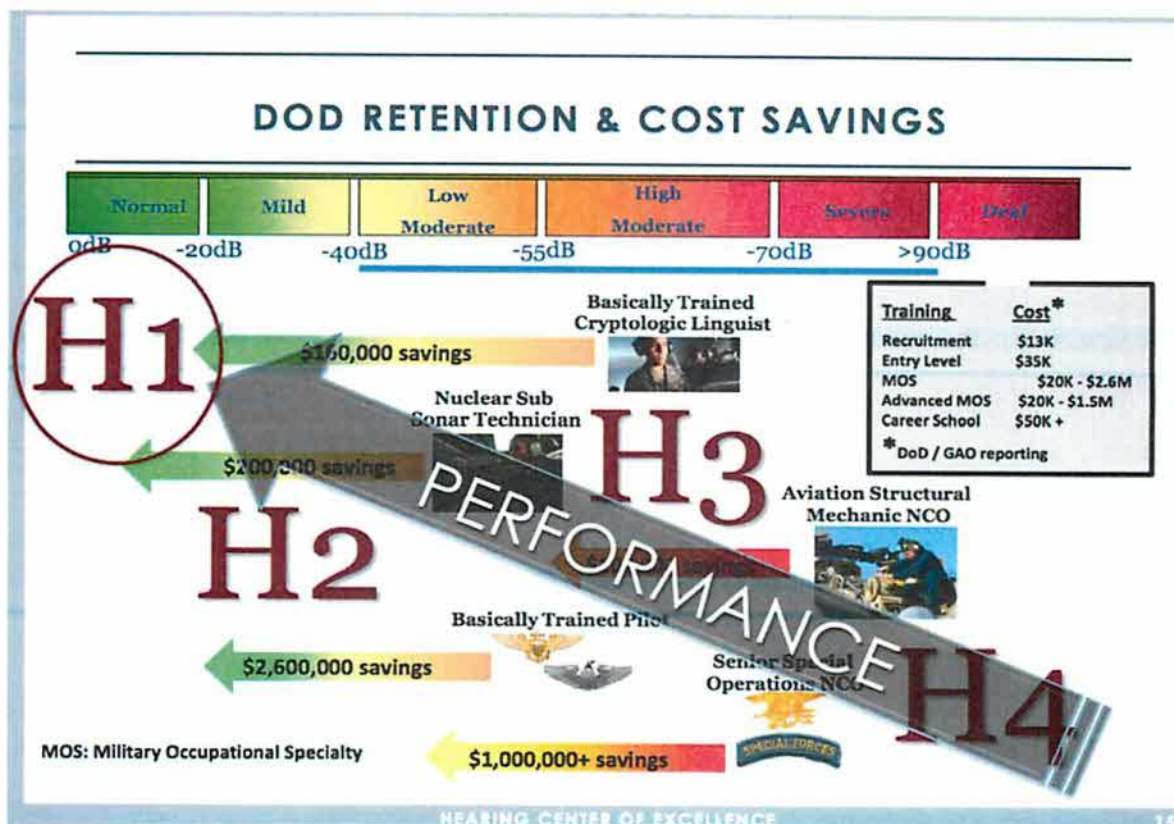
Source: Lynn W. Henselman, PhD, Deputy Director, DOD HCE, "Preserving and Improving Warrior and
Veteran Hearing Health," April 17, 2015.

Figure 15. DOD Retention and Cost Savings

The return on investment given the high training costs is not realized if these
individuals develop hearing impairment such that they can no longer perform effectively
in their occupations.[142]

C. Costs Associated with Auditory Impairment

Much of the recent research on auditory impairment has been conducted by
consortiums, drawing on researchers and medical professionals from a range of
organizations. For example, Gubata et al. in "Pre-enlistment Hearing Loss and Hearing
Loss Disability among US Soldiers and Marines," documents a "case-control analysis of
generally young" U.S. Army and Marine Corps personnel evaluated for a hearing-related
disability by their Service within the DOD Disability Evaluation System between Fiscal
Years 2003 to 2010.[143] This research sought to "identify accession and service-related risk

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[142] Lynn W. Henselman, PhD, Deputy Director, DOD HCE, "Preserving and Improving Warrior and
Veteran Hearing Health," April 17, 2015.

[143] Marlene E. Gubata (Department of Epidemiology, Preventive Medicine Branch, Walter Reed Army
Institute of Research), Elizabeth R. Packnett (Allied Technology Group, Inc.), Xiaoshu Feng (Allied

factors for hearing-related disability."[144] The authors concluded that "poor performance on the pre-enlistment audiogram and hearing loss medical disqualification/waiver are substantial risk factors for hearing loss disability later in a military career."[145] The authors stated that these findings point to the need for (1) "more conservative pre-enlistment audiogram thresholds," and (2) more strict policies regarding hearing loss medical waivers.[146]

HCE's research also addresses the long-term costs associated with auditory injury. Figure 16 summarizes the associated costs in terms of the magnitude of the injury among veterans.

AUDITORY INJURY

Magnitude of Injury

- FY 2013 VA Annual Benefits Report: Auditory injuries are the two most prevalent disabilities in Veterans – up 17% from 2012 (222,139)
    - **2.12 M** Veterans - compensation for auditory body system conditions (w/ 1,121,709 tinnitus, 854,855 hearing loss)
    - **764K** Gulf War Era Veterans w/ hearing loss and tinnitus disability
    - Most prevalent service-connected disabilities for Veterans who began receiving compensation during FY 2013:
        - **#1** = tinnitus, **#2** = hearing loss
    - Hearing loss is insidious, cumulative, progressive, invisible
- **READINESS** – Hearing is critical to Military function
- **POPULATION HEALTH** – Loss is endemic in industrial nations

HCE is UNIQUELY responsible for ensuring total force hearing capability despite a ubiquitous invisible ENVIRONMENTAL THREAT

HEARING CENTER OF EXCELLENCE

Source: Lynn W. Henselman, PhD, Deputy Director, DOD HCE, "Preserving and Improving Warrior and Veteran Hearing Health," April 17, 2015.

Figure 16. Auditory Injury and Veteran Hearing Health

Technology Group, Inc.), David N. Cowan (Allied Technology Group, Inc.), David W. Niebuhr (Department of Epidemiology, Preventive Medicine Branch, Walter Reed Army Institute of Research), "Pre-enlistment Hearing Loss and Hearing Loss Disability among US Soldiers and Marines," Noise & Health, September-October 2013, Volume 15:66, 289-95. (293).
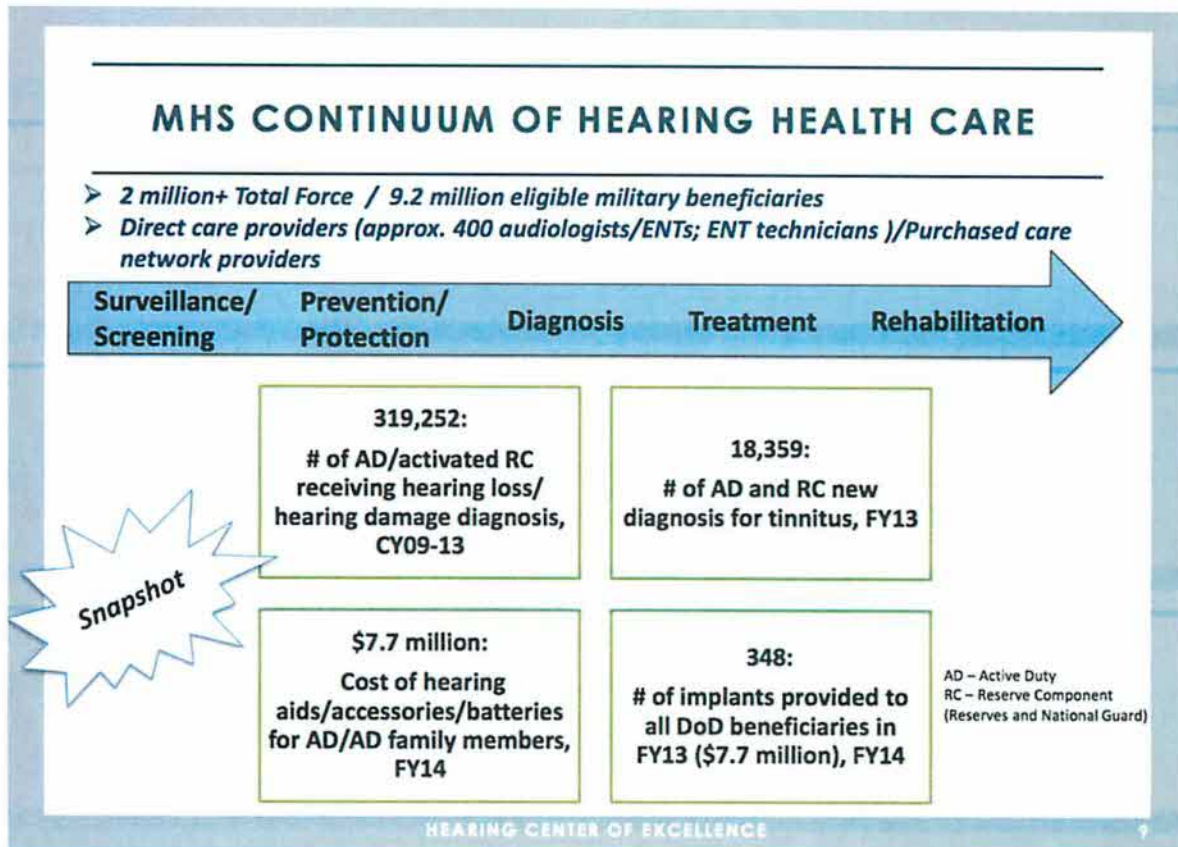
[144] Gubata ME, Packnett ER, Feng X, Cowan DN, Niebuhr DW. "Pre-enlistment Hearing Loss and Hearing Loss Disability among US Soldiers and Marines," *Noise Health* 2013: 294.

[145] Ibid.

[146] Ibid.

In recent years, there has been a significant increase in the number of veterans who have claimed compensation because of auditory injuries (including tinnitus and hearing loss).

Additionally, HCE focuses on DOD's costs associated with hearing health care. As depicted in Figure 17, according to a recent presentation from HCE, some examples of the costs associated with hearing impairment for the Total Force, to include all individuals eligible for benefits, include diagnosis and testing, as well as adaptive technologies.[147]

MHS CONTINUUM OF HEARING HEALTH CARE

➤ 2 million+ Total Force / 9.2 million eligible military beneficiaries
➤ Direct care providers (approx. 400 audiologists/ENTs; ENT technicians)/Purchased care network providers

| Surveillance/ Screening | Prevention/ Protection | Diagnosis | Treatment | Rehabilitation |

319,252:
# of AD/activated RC receiving hearing loss/ hearing damage diagnosis, CY09-13

18,359:
# of AD and RC new diagnosis for tinnitus, FY13

Snapshot

$7.7 million:
Cost of hearing aids/accessories/batteries for AD/AD family members, FY14

348:
# of implants provided to all DoD beneficiaries in FY13 ($7.7 million), FY14

AD – Active Duty
RC – Reserve Component
(Reserves and National Guard)

HEARING CENTER OF EXCELLENCE

Source: Mark Packer, Colonel, MD, USAF, Executive Director, Lynn W. Henselman, PhD, VA, Deputy Director, DOD HCE, *Department of Defense Military Health System Perspective*, April 27, 2015.

Figure 17. Military Health Services (MHS) Continuum of Care of Hearing Health Care

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[147] Lynn W. Henselman, PhD Deputy Director, DOD HCE, "Preserving and Improving Warrior and Veteran Hearing Health," April 17, 2015.

D. Noise Induced Hearing Loss (NIHL)

According to the American Hearing Research Foundation, NIHL:[148]

> is a permanent hearing impairment resulting from prolonged exposure to high levels of noise. One in 10 Americans has a hearing loss that affects his or her ability to understand normal speech. Excessive noise exposure is the most common cause of hearing loss.

NIHL is an area of focus for the full range of research organizations that focus on auditory impairment, including HCE, AMSARA, APHC, the Tri-service Disability Evaluation System Analysis and Research, and the National Center for Rehabilitative Auditory Research (NCRAR), among others.

In December 2009, the University College London Ear Institute hosted a symposium entitled "A Modern Approach to Noise-Induced Hearing Loss from Military Operations."[149] With wide attendance (from the UK armed forces and government, academia, as well as the U.S. DOD and Veterans Administration), the focus of the symposium was on the operational impact of NIHL, its prevention and management, and associated long-term healthcare issues.

A U.S. Office of Naval Research speaker at this symposium cited NIHL as a significant problem for the U.S. Navy given both the environments in which Navy personnel general operate and "poor compliance with hearing protection."[150] The speaker also stated that there is evidence of performance issues associated with hearing loss. [151]

A symposium presentation by the NCRAR director described "auditory dysfunction [a]s the most prevalent service-connected disorder," with 25 percent of Service personnel who served in OEF/OIF complaining of "hearing loss and/or tinnitus."[152] The speaker emphasized the need for the adoption of improved strategies to prevent NIHL and the associated auditory disabilities.

E. Auditory Impairment and Military Operations

An example of one of the most widely cited research efforts on the effect of auditory impairment and military operations is Garinther, et al, "Toward a Measure of Auditory Handicap in the Army." Using sound propagation and auditory detection models, the

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[148] American Hearing Research Foundation, "What is Noise Induced Hearing Loss?," american-hearing.org, October 2012, http://american-hearing.org/disorders/noise-induced-hearing-loss/#whatis.

[149] D. C. Brown and R. S. Milner, "General: A Modern Approach to Noise Induced Hearing Loss in Military Operations," *Journal of the Royal Naval Medical Service*, Vol. 96.1, 2010, 25-33.

[150] Ibid, 28.

[151] Ibid, 28.

[152] Ibid, 31.

authors examined the impact of auditory handicap on mission performance. Based on the research results, the authors assessed that even modest hearing loss "and/or the wearing of hearing protectors" "can have profound effects on military performance," for example, noise detection (whether personnel or equipment) and ability to communicate.[153] Some examples include:[154]

> a normal ear can monitor four to 36 times as much area as the ears with poorer sensitivity, or can provide two to six times as much warning time of the approach of enemy troops.

> a normal ear is capable of detecting the sound of a rifle bolt closing at almost 1000 m in a [lower rural] background noise...In contrast, a poor ear with a [temporary threshold shift, TTS] can manage the same detection at only 46 m, more than a 20-fold decrease... In practical terms, the soldier with a normal ear would have almost 2 minutes' warning of the approach [of someone walking in leaves], the person with a poor ear would hear the approach when the enemy was five steps away, and the same individual with a TTS would not hear it at all. For such sounds, a normal ear can monitor an area 200 to 400 times as great as an impaired ear, or provide 13 to 20 times as much warning of the enemy's approach. The soldier with a poor ear and a TTS indeed would be a detriment to the unit if it had to rely on him or her to warn of the enemy's approach.

> For both normal and poor ears, the background noise limits detection of a moving tank to somewhat more than 6 km. A poor ear with TTS would detect it at about 1.8 km...

> ...a normal ear detects at more than 3.5 times the distance of the impaired ear. The same general pattern holds for both the noise of the tank idling and the generator.

The authors concluded that the "inability to hear, for any reason, may well be an operational liability affecting accomplishment of the mission and should be factored into the consideration of operational requirements for all systems in which the human being is an element."[155]

One of HCE's research areas of emphasis is the impact of auditory impairment on military operations.[156] According to HCE, "[h]earing is a critical sense for Service members, important for survival and mission success." HCE emphasizes the "chaotic"

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[153] George R. Garinther, Joel T. Kalb, and G. Richard Price, "Toward a Measure of Auditory Handicap in the Army," Technical Memorandum 9-89, Aberdeen, MD: US Army Human Engineering Laboratory, Aberdeen Proving Ground, August 1989, 42 [Reprinted from *Annals Of Otology, Rhinology & Laryngology*, Volume 98, Number 5, Part 2, Supplement 140, May 1989].

[154] Ibid, 47-48.

[155] Ibid, 42.

[156] DOD HCE, Department of Defense, *Military Health System Perspective*, April 27, 2015.

nature of military operations and the criticality of hearing and communication for personal and unit safety, command and control, mission accomplishment, and a "key consideration in Force Management."[157]

In "Evaluating the Operational Impact of Hearing Impairment," Brungart et al, examined the operational importance of hearing acuity.[158] To control for the wide variety of variables (variations in missions, environmental differences, and variances in skill levels), Brungart et al proposed recruiting individuals with H1 level hearing, systematically degrading their hearing via "hearing loss simulation systems," and then measuring their "operational hearing as a function of simulated hearing acuity."[159] This research involved the use of a Hearing Loss Simulator (HLSim), a wearable hearing loss simulation system that is designed to simulate the increased audibility thresholds associated with NIHL in listeners with normal hearing. The results of this research were as follows: "Hearing had a modest impact on 'survivability,'" hearing loss "severely impaired lethality," "overall victory was very difficult with more than a mild hearing loss."[160]

F. Conclusion

The research highlighted in this section focused on the recent efforts to examine audiometric hearing level standards and the effect of auditory impairment on attrition, performance, and disability status. None of this research would support increased leniency with regards to revisions of audiometric hearing level standards.

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[157]Ibid.

[158] Douglas Brungart, PhD, Benjamin Sheffield, MS, Walter Reed National Military Medical Center LTC Marjorie Grantham, PhD. US Army Public Health Command, "Evaluating the Operational Impact of Hearing Impairment," 2013, http://c.ymcdn.com/sites/www.hearingconservation.org/resource/resmgr/imported/Brungart_DouglasN HCA2013v5.pdf.

[159] Brungart et al., "Evaluating the Operational Impact of Hearing Impairment," 2013, http://c.ymcdn.com/sites/www.hearingconservation.org/resource/resmgr/imported/Brungart_DouglasN HCA2013v5.pdf, 12-15.

[160] Ibid.

7. Other Militaries' Hearing Level Standards and Historical Examples

A. Introduction

This section canvases examples of hearing level standards in use by other militaries. First, we address the hearing level standards in use by Allied nations and alliances, focusing on the United Kingdom, Israel, as well as NATO. Then we examine the Islamic State of Iraq and the Levant (ISIL) and their approach to recruiting hearing impaired individuals. Finally, we provide two historical examples of extreme situations during which medical standards were relaxed.

B. Contemporary Hearing Level Standards in Use by Other Militaries

1. United Kingdom

The Ministry of Defence (MOD) establishes guidelines on acceptable hearing level thresholds for individuals accessing, as well retention standards for those individuals already serving in uniform. While there are Service, occupational, and branch variations in these accession standards, the highest hearing level threshold standards are established for pilots and aircrew.[161] With current force reduction initiatives, medical and fitness standards for entry are becoming more stringent across all occupations and branches.[162]

MOD also establishes guidelines on the recommended frequency of audiometric testing of Service personnel. In recent years, the testing intervals have become more frequent. This increasing frequency of audiometric testing is part of an initiative to identify individuals with progressive NIHL who may be at risk of further high-frequency hearing loss given the variety of settings such individuals are regularly exposed to, to include training, deployments, and time spent on a number of military platforms.[163] In fact, NIHL

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[161] Annex 58G, Joint Medical Employment Standard, 58G-1 February 2015; PULHHEEMS Administrative Pamphlet 2010.

[162] Nick Owens, "Soldier booted out of the Army because he lost "6% of his hearing, but can't get compensation," *Mirror Online*, 5 February 2012, http://www.mirror.co.uk/news/uk-news/soldier-booted-out-of-the-army-because-674666.

[163] Army Hearing Conservation Programme, ANNEX A TO D/AMD/508/04 DATED 01 SEP 06; Command of the Defence Council, Ministry of Defence, Royal Air Force Manual, Assessment of Medical Fitness, AP 1269A, 3rd Edition (February 1998), Date of Publication: 20/10/14.

is now a major MOD/Department of Health concern.[164] The impetus behind these initiatives to reduce NIHL among Service personnel is twofold: public scrutiny over (1) the numbers of Service personnel with hearing-loss, and (2) the high number of hearing-loss associated medical discharges.[165] In addition to increasing the frequency of the audiometric screening, in 2009 MOD also introduced the Personal Interfaced Hearing Protection (PIHP) system, which provides a hearing conservation device that protects against NIHL without impairing hearing.[166]

2. Israeli Defense Forces

As cited by the *Jerusalem Post*, according to a "high-ranking officer in the [Israeli Defense Force] IDF Human Resources Department," in 2006, IDF created a new minimum medical eligibility profile that was ten points lower than the previous minimum profile. The "35 medical profile," was established due to the "sharp drop in birthrates and immigration numbers" and the projected impact on recruitment.[167] This lower profile permitted individuals with several medical conditions that previously disqualified them to enlist in IDF. For example, individuals with celiac disease or with some degree of hearing impairment were now eligible for compulsory service.[168] In fact, IDF has sought to expand the conscription pool to other segments of Israeli society, to include the Haredi and Christian Arabs.[169]

The IDF's policies on the recruitment of individuals with hearing impairment vary depending on the type of hearing loss and the extent of the impairment. According to IDF's Occupational Medicine Department, Office of the Surgeon General, "IDF distinguishes between sensorineural, conductive, and mixed hearing loss. Recruits with hearing

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[164] T. Biggs, Department of Ear, Nose and Throat Surgery, Southampton General Hospital, Southampton, Hants, and A. Everest, Senior Medical Officer, British Army Training Regiment, Sir John Moore Barracks, Winchester, UK.

[165] Defence Statistics (Health), Annual Medical Discharges in the UK Regular Armed Forces 2008/09 - 2012/13, 11 July 2013.

[166] MOD Common Law Claims & Policy Division, RE: Request for Information – Release of Information under the Freedom of Information Act 2000, 12 June 2012.

[167] Yaakov Katz, "Sharp drop in birth rate and immigration brings IDF to define new category of fitness for service." *Jerusalem Post*, Nov 19, 2007, http://www.jpost.com/Israel/IDF-creates-new-medical-profile-of-35; Hillel Fendel, "New IDF Medical Profiles Provide Social Message," 5 January 2007, http://www.israelnationalnews.com/News/News.aspx/122298#.Vhapj5iFNaQ.

[168] Katz, "Sharp drop in birth rate and immigration brings IDF to define new category of fitness for service." *Jerusalem Post*, Nov 19, 2007.

[169] Ruth Levush "Israel: Supreme Court Decision Invalidating the Law on Haredi Military Draft Postponement," March 2012, http://www.loc.gov/law/help/haredi-military-draft.php; Lea Speyer, "IDF Begins Actively Recruiting Christian Arabs," *Breaking Israel News*, 22 April 2014, http://www.breakingisraelnews.com/14028/idf-begins-actively-recruiting-christian-arabs/#kzw3vZ50KTwUvd5w.97.

impairment undergo audiometry to determine their pure tone average (PTA) and speech audiometry to determine their functional capacity (SRT [Speech Recognition Test]/discrimination)."[170] Individuals with sensorineural hearing loss involving only high-tone frequencies may qualify for combat units, to include infantry and IDF Special Forces. Individuals with mild hearing impairment at all frequencies may qualify for combat units in combat support, non-infantry occupations. Individuals with moderate hearing impairment may qualify for maintenance units or, if the impairment is bilateral, may perform clerical tasks.[171] Individuals with severe or profound hearing impairment are disqualified from service; such individuals fall below the standards established for the "35 medical profile."[172] The IDF categorizes hearing loss severity as depicted in Table 9.

Table 9. IDF Hearing Loss Severity

Normal hearing	up to 25dB HL
Mild hearing loss	26 to 46dB HL
Moderate hearing loss	41 to 71dB HL
Severe hearing loss	71-90dB HL
Profound hearing loss	+91dB HL

Source: Occupational Medicine Department, Office of the Surgeon General, Israel Defense Forces.

Given this new profile and the presence of hearing impaired individuals in uniform, IDF has introduced several adaptations. In addition to making sign language interpreters available, in 2012, the IDF introduced a sign language course, "Signs of Change," which is open to all interested IDF personnel. "Signs of Change" consists of "eight two-hour-long meetings over the span of two months," with the goal of teaching "commanders and soldiers the Israeli sign language and exposes them to a world without sound."[173]

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[170] Email exchange from March 2015, with LTC Oren Giber, Israeli Defense Forces, Embassy of Israel, and Maj. (Dr.) Oren Zack, Head, Occupational Medicine Department, Office of the Surgeon General, Israel Defense Forces.

[171] Ibid.

[172] *Jerusalem Post*, "IDF to let low-profile draftees serve," 2 January 2006, http://www.jpost.com/Israel/IDF-to-let-low-profile-draftees-serve; Katz, "Sharp drop in birth rate and immigration brings IDF to define new category of fitness for service." *Jerusalem Post*, Nov 19, 2007.

[173] Rotem Pesso, "IDF sign language course to better accommodate deaf soldiers: First ever 'Signs of Change' course teaching IDF soldiers and commanders sign language allows for more service opportunities for deaf soldiers," 13 February 2012, http://www.idf.il/1283-14886-en/Dover.aspx.

As with the MOD, the IDF is concerned about NIHL. To reduce the risk of continued hearing loss and to ensure continued fitness for service, the IDF seeks to limit exposure to hazardous noise levels for hearing impaired soldiers.[174]

3. NATO

NATO does not dictate medical standards for accession or retention of Service personnel to its member nations. Each member nation employs its own "criteria and approaches to assessing an individuals' medical fitness for deployment."[175] What NATO does articulate are the deployment standards for NATO missions.[176]

The "NATO Guide for Assessing Deployability for Military Personnel with Medical Conditions" was developed as an "evidence-based approach to deciding in the pre-deployment setting whether or not individual military members are medically fit to deploy on these missions." The goal of this document was to decrease the number of[177]

> individuals being deployed with pre-existing medical conditions that have a high likelihood of exacerbation or which, in their chronic, stable state, have the potential to impair unit capability. Additionally, achievement of this goal would reduce the risk to the health of the individual, enhance the safety of their unit members, contribute to the success of the mission and decrease the demand on deployed medical resource.

Under NATO's hearing level standards, a service member assessed as having severe or profound hearing loss would not be considered fit for NATO deployment if any one of the following is true. The individual has an:[178]

> Inability to do one's occupational and military duties safely and effectively without use of a hearing aid;
>
> or
>
> poor speech recognition capability in settings with significant background noise, as may be found in a deployment environment;
>
> or
>
> recent progressive hearing loss that has not yet been investigated and stabilized.

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[174] Email exchange from March 2015, with LTC Oren Giber, Israeli Defense Forces, Embassy of Israel, and Maj. (Dr.) Oren Zack, Head, Occupational Medicine Department, Office of the Surgeon General, Israel Defense Forces.

[175] "A NATO Guide for Assessing Deployability for Military Personnel with Medical Conditions," STO-TR-HFM-174, June 2014, ES-1.

[176] Ibid.

[177] Ibid.

[178] Ibid, 3-3.

Again, the emphasis is on the individual's ability to perform their duties in whatever setting.

4. The Islamic State of Iraq and the Levant

The Islamic State of Iraq and the Levant provides an additional lens through which to look at the recruitment of individuals with hearing impairment. According to an article from the New York Post, "[i]n their latest recruitment video, titled 'From Who Excused To Those Not Excused,' a pair of deaf and mute fighters brandishing machine guns issued threats and urged Westerners to join their campaign of terror."[179] Figure 18 depicts ISIS's approach to recruiting hearing-impaired individuals.

ISIS using sign language to recruit deaf terrorists

By Chris Perez

March 9, 2015 | 10:59am

في الموصل ورأيت مشاهد مروعة للأطفال والنساء وهم قتلى وجرحى

w the horrific scenes of women and children who were injured and killed

In a new propaganda film, ISIS militants communicate with potential terrorists using sign language.

Source: Chris Perez, "ISIS using sign language to recruit deaf terrorists," *New York Post*, 9 March 2015, http://nypost.com/2015/03/09/isis-using-sign-language-to-recruit-deaf-terrorists/.

Figure 18. "We, the deaf and mute, direct our message to the Islamic world"

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[179] Chris Perez, "ISIS using sign language to recruit deaf terrorists," *New York Post*, 9 March 2015, http://nypost.com/2015/03/09/isis-using-sign-language-to-recruit-deaf-terrorists/

An NBC News article described the ISIS video as "an attempt by the group to recruit other physically or otherwise impaired individuals."[180]

C. Historical Examples of Hearing Impairment and Military Service

1. The Invalid Corps in the Civil War

During the U.S. Civil War, as "America's ability to field vast armies" was tested, both the Union and Confederate armies "tinkered with medical enlistment qualifications."[181] In April 1863, the Adjutant General's Office issued War Department General Orders Number 105, which authorized the creation of the Invalid Corps. The National Archives and Records Administration described this new corps as:[182]

> officers and enlisted men unfit for active field service because of wounds or disease contracted in the line of duty, but still capable of performing garrison duty;

> officers and enlisted men in service and on the Army rolls otherwise absent from duty and in hospitals, in convalescent camps, or otherwise under the control of medical officials, but capable of serving as cooks, clerks, orderlies, and guards at hospitals and other public buildings; [and]

> officers and enlisted men honorably discharged because of wounds or disease and who wanted to reenter the service.

In 1864, the Confederacy also established an Invalid Corps. As with the Union Invalid Corps, this corps consisted of officers and enlisted men rendered unfit due to their impairment.[183]

2. Germany in World War II

Prior to 1933, the National Socialist German Workers' Party (*Nationalsozialistische Deutsche Arbeiterpartei* (NSDAP)) leveraged the political and economic support of almost any segment of society, to include Germans with hearing impairment. By the time Hitler became chancellor in 1933, approximately 1,000 Germans with hearing impairments were already party members of the NSDAP.[184] The NSDAP established separate units for

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[180] M. Alex Johnson, "Sign-Language ISIS Video Looks to Snare Deaf, Mute Recruits in Europe," *NBC News*, 8 March 2015, http://www.nbcnews.com/storyline/isis-terror/sign-language-isis-video-recruits-deaf-mute-europe-n319631.

[181] R. Gregory Lande, "Invalid Corps," *Military Medicine*, Vol. 173, June 2008, 525.

[182] National Archives and Records Administration, "Veteran Reserve Corps (VRC), 1863–1865," December 2010, http://www.archives.gov/research/military/civil-war/veteran-reserve-corps.pdf.

[183] R. Gregory Lande, "Invalid Corps," *Military Medicine*, Vol. 173, June 2008.

[184] "Gehörlose im Dritten Reich, Bericht Deutsche Gehörlosen-Zeitung," 2004, 104, http://www.taubenschlag.de/cms_pics/DGZBericht.pdf.

Germans with hearing impairment in the Hitler Youth (the "Bann G"—"G" for Gehörlos, or deaf), the Storm Detachments (Sturmabteilungen, SA), and League of German Girls (Bund Deutscher Mädel, BDM).[185] Initially established in 1927 as an independent support and advocacy group, the Reich Association of the Deaf of Germany (Reichsverband der Gehörlosen Deutschlands, REGEDE) became the NSDAP umbrella organization for Germans with hearing impairment.[186] Under the leadership of Fritz Albreghs, REGEDE advocated to its members with hereditary deafness that they should seek sterilization.[187]

Initially, Germans with hearing impairments were barred from joining the Wehrmacht. Over time, as the recruiting pool shrank and the existential threat grew, policies changed. By the end of the war, Germans initially rejected from the Wehrmacht received personal invitations to serve. By mid-1944, the Kranken-Battalionen (or "Sick" Battalions) was formed, including at least five Ohren-Battalionen (Ear Battalions).[188] Most of the individuals who served in these battalions were veterans with hearing impairments. Initially, such battalions were in the rear echelon. As distinctions between forward and rear operating areas blurred, such individuals often found themselves operating in the combat environment.[189] At the same time, especially in Germany's Eastern provinces, deaf and hard of hearing individuals were prominent in the Volkssturm (the People's "Storm" or militia); such individuals served as Germany's final defense against the existential threat posed by the Allies and Soviet Union.[190]

D. Conclusion

This section provided an overview of several examples of hearing level standards in use by other militaries, with both current and historical examples. The general pattern observed across these case studies was that the relaxation of medical standards tends to occur when recruiting demands overwhelmingly exceed the supply of medically qualified

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[185] Malin Büttner, Nicht minderwertig, sondern mindersinnig...: der Bann G für Gehörgeschädigte in der Hitler-Jugend, Frankfurt am Main, Peter Lang, 2005, 74-78; Donna F. Ryan and John S. Schuchman, eds. Deaf People in Hitler's Europe. Washington, D.C.: Gallaudet University Press, published in association with the United States Holocaust Memorial Museum, 2002, 84-87.

[186] Donna F. Ryan and John S. Schuchman, eds. Deaf People in Hitler's Europe. Washington, D.C.: Gallaudet University Press, published in association with the United States Holocaust Memorial Museum, 2002, 106.

[187] Ibid, 80-82.

[188] Militärmedizin: Letztes Aufgebot, Der Spiegel, Issue 43, 1981, http://www.spiegel.de/spiegel/print/d-14339960.html.

[189] Ibid.

[190] Rudi Riskowski, Als Soldat im "Volkssturm" an der Ostfront bei Königsberg 1945, Taubwissen, 2011, http://www.taubwissen.de/content/index.php/geschichte/gehoerlose-in-der-zeit-des-nationalsozialismus/2-weltkrieg-und-die-zeit-nach-1945/669-rudiriskowskisoldat.

recruits. Generally, the recruits considered for accession under policies involving a relaxation of hearing level standards are fully trained and/or experienced veterans.

8. Conclusions

This report assessed the feasibility and advisability of permitting individuals with auditory impairment to access as members of the armed forces. First, this assessment answered the three questions specified in the Senate Report:

- What, if any, are the barriers that may limit individuals with hearing impairments from serving in the military?

- What is the current state of the art in accommodations (assistive technologies and methods) for those with hearing impairments?

- Are there military occupational specialties (MOS) that may be appropriate for further investigation (e.g., via fitness-for-duty tests) for allowing the enlistment of individuals with hearing impairments?

Second, this research provided a data-driven context for understanding the impact on the force as it relates to the feasibility and advisability of permitting individuals with auditory impairment or any other disability to access as members of the armed forces. Force impact is considered by testing fundamental assumptions about the nature of current and future military service. As part of this assessment, we examined both the foundational organizing principles of DOD and the military Services, as well as two primary hypotheses that stem from those principles.

Our assessment consisted of eight parts. Following our introduction, Section 2 provided an overview of hearing impairments and accommodations. In Section 3, we documented the relevant policies and issuances on audiometric hearing level accession, retention, and deployment standards. In Section 4, we summarized the employment of individuals with hearing impairments and considered certain MOSs for additional review. In Section 5, we tested our research hypotheses by considering Service responses to an official data call (Appendix F), by assessing recent individual deployment experiences and associated force management processes and issues, and finally by considering future demands on the force through the lenses of personnel availability and mission types. Section 6 summarized some of the recent relevant research on audiometric hearing level standards. Section 7 provided an overview of other militaries' hearing level standards, featuring some present-day and historical examples, and in this final section we offer our research conclusions.

This research effort provided a data-driven context for understanding how accessing Service personnel with auditory impairment or any other disability would affect personnel and force management, challenging fundamental assumptions about the nature of current and future military service. As part of this assessment, we examined both the foundational

organizing principles of DOD and the military Services, as well as two principle hypotheses that stem from those principles.

1. Service members, regardless of MOS, are expected to be worldwide deployment eligible.

   - Service members must be prepared to possibly deploy into an operational area.

   - Service members must be available and qualified to perform assigned missions or functions in any setting.

2. The requirement for deployment eligibility is unlikely to change in the future.

These two research hypotheses informed our evaluation of the force impact of expanding recruitment of hearing impaired or other disabled individuals into the military Services. The analyses conducted focused on testing these hypotheses through the lens of data provided by the Services, recent operational experiences, as well as projections of future demands on the force.

In conducting this research, we determined that there was insufficient evidence to reject these two principle hypotheses. As reflected in the Services' CATMS inputs (Appendix F), there are no non-deployable operational occupations or communities. Every uniformed individual in each of the military Services is expected to be worldwide deployable.

Moreover, recent research on medical standards, conducted to make such standards more evidenced-based, has resulted in revisions to those standards. Some previously disqualifying medical conditions have been removed from the issuances guiding medical standards for accession; however, we located no recent research efforts that proposed relaxing audiometric hearing level accession standards.

In our examination of personnel data from recent operational experiences, we were unable to identify non-deploying accessed communities. While there were some individuals who may not have deployed, there were no non-deployable occupations into which individuals can access. Additionally, the personal burden of deployment and risk changes for those who are deployment eligible when there is an increase in the number of military personnel who are non-deployable.

We also considered projections of future demands on the force. Our research confirmed that the requirement for deployment eligibility is unlikely to change in the future. Given these results, and the extraordinarily stressful futures that may be possible; the assumption that disabled service members could be accommodated by exempting them from deployment appears to be questionable.

We examined the current audiometric hearing level standards of several other militaries. The general pattern observed across these case studies was that the relaxation of medical standards tends to occur when recruiting demands overwhelmingly exceed the supply of medically qualified recruits.

The historical case studies reinforced our research findings: Fundamentally, this is not a new research question. As was the case with the Invalid Corps and the *Wehrmacht Ohren-Battalionen* (Ear Battalions), in times of extremes and severe manpower shortages, the expansion of the potential recruitment pool has been generally considered. The experience of the *Wehrmacht Ohren-Battalionen* also demonstrates the artificiality of distinctions between forward and rear operating areas, given the nonlinear nature of combat operations.

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Appendix A
List of Operation Types

The following table shows the full list of operation types for use in the SARA demand model based on the IRAMM elicitations. For each operation type, there is also a corresponding historical analog or potential future scenario on which the new operation types were based.

Table A-1. SARA Demand Model Based on IRAMM Responses

Operation Type	Historical Analog or Potential Scenario
Total Mobilization	World War III
Theater Air-Sea Battle Campaign	Major naval/air battle with China
Theater Land Combat Campaign:	
Major Ground War	Operation Desert Storm
Allied Response	Hypothetical Russian invasion of the Baltics
Tactical Nuclear Escalation	North Korean tactical nuclear strike on South Korea
Minor Contingency:	
Air Centric	Air strike on Iranian nuclear facilities
Naval Centric	Gulf of Tonkin incident
Ground Centric	US ground response to ISIS in Iraq
Air + Naval Mix	US-China skirmish in the South China Sea
Counterinsurgency Campaign:	
Extended	Iraq, Afghanistan, Vietnam
Limited	
Humanitarian Aid/Foreign Disaster Relief	
Domestic Disaster Relief	
Domestic Attack:	
CBRN, Cyber	
"Other"	Breakdown of gov't authority; 9-11 style "conventional" terrorist attack

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Appendix B
20 SME Results

Table B-1. 20 SME Results

Operation Title	# of Simultaneous Operations in Most Stressful Case For: SME 1	SME 2	SME 3	SME 4	SME 5	SME 6	SME 7	SME 8	SME 9	SME 10	SME 11	SME 12	SME 13	SME 14	SME 15	SME 16	SME 17	SME 18	SME 19	SME 20
Theatre Engagement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Mobilization	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Theater Air-Sea Battle Campaign	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Theater Land Combat Campaigns: Major Ground War	1	0	1	0	0	0	0	1	1	1	0	0	1	1	1	0	1	0	1	0
Theater Land Combat Campaigns: Allied Response	1	0	2	1	1	1	1	0	0	1	0	0	0	1	0	0	0	1	1	0
Theater Land Combat Campaigns: Tactical Nuclear Escalation	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	0	0
Minor Contingency: Air	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0
Minor Contingency: Naval	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minor Contingency: Ground	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Minor Contingency: Air + Naval	0	1	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0
Counterinsurgency Campaign: Extended	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HA/DR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Disaster Relief	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic CBRN Attack: Chemical	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Domestic CBRN Attack: Biological	1	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
Domestic CBRN Attack: Radiological	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Domestic CBRN Attack: Nuclear	1	0	1	0	1	1	0	0	0	0	1	1	1	0	0	1	1	1	0	0
Domestic Cyber Attack	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Domestic "Other" Attack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Existential Thermonuclear Attack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Simultaneous Operations (of Any Type)	4	3	6	3	6	4	4	3	5	3	5	4	5	5	3	4	3	5	4	3

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Appendix C
Service Data Call Response

This appendix summarizes the Services' formal responses, submitted in accordance with the CATMS official request for information tasked by ODASD MPP. The request for data focused on Service-specific information related to accession waivers, retention waivers, force structure, and, where applicable, specifics related to higher requirements for some communities and occupations. Each of the CATMS submissions varied in granularity. As reflected in the CATMS responses, a common theme across the military Services is that there are no non-deployable occupations or communities. Every uniformed individual in each of the military Services is expected to be worldwide deployable.

A. Army

The Army's CATMS inputs emphasized that there are no non-deployable MOSs or communities and indicated that all MOSs within the Army have the potential for deployment.[191]

The Army's CATMS input also included information about personnel or trainees, transients, holdees, and students (TTHS) accounts.[192] The "How the Army Runs: A Senior Leader Reference Handbook," describes the TTHS accounts as encompassing "those personnel unavailable to fill spaces in units. The six sub-accounts are trainees, officer accession students, transients, holdees, students, and U.S. Military Academy cadets."[193] The category of "holdee" is the most relevant for this research effort. According to the Headquarters, Department of the Army, "Army Mobilization Operations Planning and Execution System (AMOPES)," a holdee is a soldier assigned to medical-holding detachments, personnel control facilities (for example prisons), or other types of control facilities.[194]

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[191] Army, Deployment Data, "IDA – Data Query Response (Army Response – 9 July)," CATMS UPR002207-15.

[192] U.S. Army War College, "How the Army Runs: A Senior Leader Reference Handbook," 2013-2014, 29th edition, 13-3.

[193] Ibid.

[194] Headquarters Department of the Army, "Army Mobilization Operations Planning and Execution System (AMOPES)," 22 February 2008, E-7.

The Army's TTHS data reflects monthly snapshots of each category by percentage, over 84 months.[195] Table C-1 summarizes the information available, providing both the lowest and highest percentages for each category.

Table C-1. Army TTHS, by percentage, June 2008-May 2015

TTHS Category	Low	High
Transferees	5.9%	23.5%
Trainees	37.6%	52.5%
Holdees	3.3%	11.7%
Students	23.8%	41.2%

Source: Army, "IDA – Data Query Response (Army Response – 9 July)."

The total number of personnel in TTHS categories varies throughout the year. The size of the TTHS accounts also varies as a result of day-to-day events and personnel policies. As described in "How the Army Runs: A Senior Leader Reference Handbook," the size of the TTHS account is affected by "[s]oldier casualties, fill of projected deploying units, and training requirements and policies." The handbook also describes the impact of TTHS on the Army's Force Structure Allowance (FSA).[196]

> Since TTHS has a direct effect on the faces available for FSA manning, these same policies have a direct impact on the number of units and organizations which the Army can field. Thus, manpower and personnel managers face a constant challenge to ensure a balance exists between the use of authorized spaces and the acquisition, training, and distribution of personnel assets to meet the needs of the Army. The stated personnel needs of the Army as expressed in its various organizational documents change on a daily basis as different units and organizations are activated, inactivated, or changed. However, the process of providing personnel to meet these changing needs is much slower.[197]

Thus, an increase in one of the TTHS categories affects the overall size of the TTHS, as well as the number of units and organizations that can be fielded with available personnel.

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[195] Army, "IDA – Data Query Response (Army Response – 9 July)," CATMS UPR002207-15.

[196] Force Structure Allowance is "The sum of authorized spaces contained in all Modification Tables of Organization and Equipment (MTOE) units and Table of Distribution and Allowances (TDA) type organizations." U.S. Army War College, "How the Army Runs: A Senior Leader Reference Handbook," 2013-2014, 29th edition, 13-3.

[197] U.S. Army War College, "How the Army Runs: A Senior Leader Reference Handbook," 2013-2014, 29th edition, 13-5.

B. Navy

The Navy's CATMS inputs emphasized that there are no non-deployable designators, ratings, or communities. Every uniformed individual in the Navy is expected to be worldwide deployable.

The Navy's CATMS input also provided information about personnel accounts. Over the past 22 months, 10.24 percent of the force were in the following personnel accounts categories: Enlisted Operation Deferment, Limited Duty, Temporary Duty under treatment, HIV, Permanent Limited Duty, Temporary Duty awaiting Medical Evaluation Board (MEB) or Physical Evaluation Board (PEB), Assignment Limited, Humanitarian Reasons, Safe Harbor/Wounded Warrior, Dental Class 3 and 4, Substance Abuse Treatment, and Physical Fitness Assessment Failure.[198]

C. Air Force

The Air Force's CATMS inputs emphasized that there are no non-deployable Air Force Specialty Codes (AFSCs) or communities. Every uniformed individual in the Air Force is expected to be worldwide deployable.

According to the Air Force's inputs, "[t]he only occupational groups that track medical waivers are the aviation and special duty career fields (including pilots, missile operators, Pararescue, etc.). These groups must meet a much higher standard (H-1) than those for accessions (H-2 standard)."[199]

- Of the requested waivers for the H-1 hearing level requirement, trained assets "represent a significant time and financial investment, and are more likely to receive an H-1 waiver." [200]

In their CATMS submission, the Air Force stated that the "[c]urrent DOD and USAF standards preclude service for individuals with significant hearing loss due to concerns for individual safety, safety of the mission and increased risks to mission completion. Waivers for minor hearing deficits are considered on a case-by-case basis."[201]

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[198] Navy "Consolidated Response," 5 June 2015, 3-4.

[199] Major Miller, "Bullet Background Paper on USAF Accessions with Hearing Disabilities," 13 May 2015.

[200] Ibid.

[201] Ibid.

D. Marine Corps

The Marine Corps' CATMS inputs emphasized that there are no non-deployable Marine Corps MOSs or communities. Every uniformed individual in the Marine Corps is expected to be worldwide deployable.

The CATMS inputs also stated that the Marine Corps does not track Marines in TTHS categories by disability. They also do not track MOS/deployment of individuals employed outside MOS.

Appendix D
Future Demands on the Force
and Other Considerations

A. Introduction

Any case for a relaxation of audiometric hearing level standards rests partly on the argument that some military specialty communities will not have to deploy to foreign combat zones. As described in Sections 2 and 4, evidence both from the Services' inputs to an official request for information, and deployment data from the Defense Manpower Data Center (DMDC), indicates that there are no non-deployable occupations or communities; uniformed individuals in each of the military Services are expected to be worldwide deployable. If populations within the military Services are non-deployable due to disability, this may constrain DOD's ability to respond to future demands. This section addresses the range of missions that the military may be called upon to undertake. This wide range of possible futures illustrates some of the challenges associated with any attempt to reliably predict the future demands on U.S. military forces.

To consider force requirements for missions the United States might be called upon to perform in the future, we leveraged two existing IDA planning tools, the Stochastic Active-Reserve Assessment model (SARA) and the Integrated Risk Assessment and Management Model (IRAMM). Integrating outputs from these tools enabled the incorporation of insights from history, opposing senior leader viewpoints, and computer-generated "Black Swan" possibilities to inform this discussion of future force requirements for the range of missions.

B. Integrating IRAMM and SARA

Predicting the demand for U.S. military forces to deploy and respond to worldwide contingencies is an inherently difficult task, made more difficult by the underlying uncertainty of global dynamics and events. Two IDA models provide a means to address demands associated with that uncertainty through the range of scenarios that could occur over a specified time period.

The SARA model was originally developed for the Office of the Secretary of Defense, Cost Assessment and Program Evaluation (OSD CAPE). SARA takes inputs from a demand model and simulates a range of 10,000 possible futures based on the subjective frequencies of a set of contingency operations, including humanitarian aid responses to full-scale land war.

The second model, IRAMM, approaches the problem in another way. Rather than rely on the simulation of random variables to generate a range of possible futures, IRAMM

elicits responses from an array of experts in the fields of national security, defense policy, and international diplomacy by asking them to describe their views of particular challenge areas over the next ten years.

The following sections describe how each model addresses the problem of generating the possible future demands for military deployments based on the types of operations that may occur. Additionally, to generate a new set of possible futures and explore the associated demands for military forces, IRAMM elicitations were integrated into the SARA model.

C. Deriving Operation Types from the IRAMM Elicitations

1. Original Operation Types in the SARA Model

The original version of the SARA model defined seven baseline operation types and their expected frequencies to input into a stochastic simulation.[202] The first four operation types—Theater Air-Sea Battle Campaign, Theater Land Combat Campaign, Counter-Insurgency Campaign, and Minor Contingency—refer to overseas contingencies with an emphasis on combat operations. The next two, Humanitarian Relief and Defense Support to Civil Authorities, are not combat operations but rather responses to natural disasters and other civil emergencies. The final operation type, Theater Engagement, accounts for the U.S. military's constant worldwide presence as part of the five geographical combatant commands.

2. IRAMM Elicitations

The IRAMM project interviews asked experts in national security strategy and defense policy to describe what they believed to be potential conflict scenarios confronting the United States in the next decade, and to predict the likelihood that they would occur.[203] Their responses fell into four categories, called Challenge Areas, designed to address a broad range of national security issues including Major Combat Operations (MCOs), Irregular Warfare, Homeland Defense-Weapons of Mass Destruction, and Homeland Defense-Cyber. The respondents then went through each challenge area in greater detail, including a quantitative assessment for each category.

The respondents also were asked to predict whether the probability that the United States would become involved in at least one major combat operation in the next decade. Then, given the probability of at least one MCO, they broke down their predicted

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[202] Doyle et al. *The Stochastic Active-Reserve Assessment (SARA) Model: Force Planning under Uncertainty,*" IDA Document NS D-5470, Alexandria, VA: Institute for Defense Analyses, 2015, 14.

[203] NSD-4883 IDA Risk Assessment Integrated Risk Assessment and Management Model (IRAMM).

probabilities for MCOs against specific actors. Figure D-1 shows an example probability tree taken from one of the elicitations.
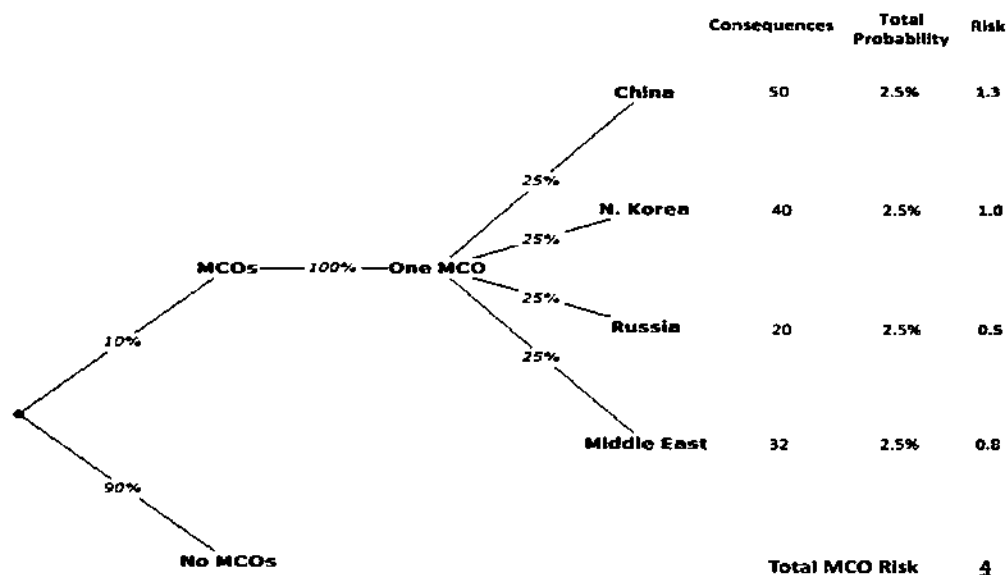
Figure D-1. Example Probability Tree from an IRAMM Elicitation

IRAMM respondents also gave a consequence score for each MCO scenario which, when multiplied by the total probability, yields a numerical value for risk. For this analysis, which is focused on the operation type and the probability of occurrence as opposed to consequences and risk, we did not use these additional values.

For the Homeland Defense challenge areas, respondents also provided total probabilities and associated consequences for each potential type of attack on the U.S. homeland. Table D-1 shows an example taken from one of the elicitations. As with the MCO challenge area, the risk scores were not used in the analysis for this paper.

Table D-1. Example IRAMM Homeland Defense Challenge Area Response

	Consequences	Total Probability	Risk
Biological	80	30%	24
Nuclear	90	30%	27
Radiological	35	30%	11
Chemical	80	30%	24
Other	20	30%	6
Cyber	70	40%	28
Total	NA	NA	**120**

Source: Thomason et al., IDA Document NSD-4883 *IDA Risk Assessment Integrated Risk Assessment and Management Model (IRAMM)*, May 2013.

IRAMM elicitations did not require a quantitative prediction of the likelihood of Irregular Warfare operations, nor did they ask about other relevant areas for the demand for military forces, including Humanitarian Relief, Defense Support to Civil Authorities, and Theater Engagement.

3. Integration of IRAMM Elicitations into SARA Demand Input

The IRAMM Major Combat Operation Challenge Area defines MCOs as "operations conducted against a state or non-state actor that possesses significant military capability."[204] As part of the elicitation, respondents gave their assessments and predictions of the likelihood of MCOs occurring in the next ten years, including the general case (i.e., what is the likelihood that an MCO would occur at all?) as well as specific cases of their choosing (e.g., Iran, Russia, China, etc.). The summaries of each IRAMM elicitation provided descriptions and probabilities of each type of MCO that the respondent addressed, and these responses formed the basis of the analysis to generate a new set of operation types that could be integrated into SARA's input model for military force demand.

Because SARA's original operation types were not nuanced enough to cover the full range of the IRAMM respondents' expectations, we expanded the list to include new operation types based on the experts' descriptions of their predicted conflict scenarios. This new set of operation types is rooted in how each respondent described the initiation and conduct of a particular MCO against some adversary, typically (though not always) named as a specific state or non-state actor. When possible, the context and scope of the conflict were considered to determine how the scenario fit into the original list of operation types for SARA's demand model. Because not all elicitations elaborated in great detail on how the MCOs would be fought or what they would entail, an operation type was selected based on judgment and interpretation.

Rather than name a new operation type for each individual scenario described in the elicitations, we searched for consensus between multiple elicitations that appeared to describe similar situations. For example, several respondents envisioned a scenario where Russian aggression pushes into the Baltic States, an action that would require a NATO reaction under the Article 5 treaty obligation, likely with American military forces playing a strong role. Similarly, other respondents described a case where North Korean troops cross the Demilitarized Zone into South Korea, an action which also would necessitate some response from the United States. Although these two scenarios are conceptually different and would occur under different circumstances, the demand for U.S. military forces to deploy and conduct combat operations is actually quite similar. In fact nearly every elicitation predicted a scenario in which the United States would respond to an attack

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[204] Thomason et al., IDA Document NSD-4883 *IDA Risk Assessment Integrated Risk Assessment and Management Model (IRAMM)*. Alexandria, VA: Institute for Defense Analyses, May 2013.

against one of its allies, usually in the form of ground troops. As a result, we added the operation type *Allied Response* to the original set from SARA's demand model. Similar analysis led to more new operation types, described in detail in Section E.

Often, the respondents' descriptions of their predicted MCOs contained enough information to categorize the scenario. For example, several respondents described conflicts with China in the South China Sea, but believed the combat operations would be limited to air and naval engagements. They used similar language regarding an air strike against potential Iranian nuclear facilities. Yet it is important to keep in mind that the respondents did not give their assessments in the language used in this paper, but rather under the context of a "major combat operation" challenge area for the United States. As a result, the final set of operation types described in this paper may differ substantially from the subject matter experts' original conceptions.

D. Full Set of Operation Types

Combining the original operation types in the SARA demand model with the updated scenarios derived from the IRAMM elicitations, we identify a list of operation types which would require the deployment of U.S. military forces. Operation types are not necessarily exhaustive of all possibilities which could confront the DOD, and there could be operation types not listed which could take on different characteristics than the scenarios described below.

1. Total Mobilization

Total mobilization refers to a conflict in which the majority of the United States' armed forces must be deployed and engaged across the globe. In practice, this refers to any potential "World War III"-type scenarios, such as two simultaneous major theater wars, or a single war fought along multiple fronts using air, land, and sea power.

2. Theater Air-Sea Battle Campaign

The most common scenario in the IRAMM elicitations that corresponds to the scope of a Theater Air-Sea Battle Campaign is a major air and naval battle with China. In this case, air and naval power form the primary strike force engaged in direct combat with conventional opposing forces.

3. Theater Land Combat Campaign

There are two types of Theater Land Combat Campaigns, each of which relies primarily on ground forces and land power in conventional combat roles.

a. Major Ground War

In a Major Ground War, ground forces form the majority effort in combined arms maneuver operations against a conventional adversary. Although these forces could be part of a multinational coalition, U.S. military forces comprise the overwhelming majority. Recent historical examples include the 1991 Persian Gulf War, as well as the initial invasion phase of Operation Iraqi Freedom in 2003.

b. Allied Response

In contrast to a Major Ground War, U.S. ground forces are augmenting a multinational or allied force in conventional combat, but are not the overwhelming majority. Hypothetical scenarios could include a Russian invasion of the Baltic States, a North Korean attack on South Korea, or opposing Iranian hegemony in the Middle East which threatens regional allies like Israel or Saudi Arabia

4. Tactical Nuclear Escalation

The Tactical Nuclear Escalation operation type differs from the other types because it is contingent on an existing conflict in order to occur. For example, an ongoing Major Ground War or Theater Air-Sea Battle Campaign could escalate to the tactical nuclear level (as opposed to the strategic nuclear level) if an adversary deploys tactical nuclear weapons against friendly or allied forces. Some of the examples identified in the IRAMM elicitations include a North Korean nuclear strike on South Korean and U.S. military forces in combat on the Korean peninsula, a Russian deployment of tactical nuclear weapons against NATO forces in Europe, or a Chinese nuclear strike against U.S. forces operating in the South China Sea.

5. Minor Contingency

Minor Contingencies constitute operations that fall short of sustained, high-intensity combat operations, but nonetheless require the operational deployment of combat power. In general, these operation types have a shorter duration and intensity than the operation types described above. Scenarios described in the IRAMM elicitations touched on four different types of minor contingencies: Air Centric, Naval Centric, Ground Centric, and an Air + Naval Mix.

a. Air Centric

An Air Centric minor contingency typically refers to the use of air power to achieve tactical and strategic objectives against limited targets. Hypothetical examples include an air strike on Iranian nuclear facilities, or limited air-to-air combat engagements between adversaries over the Baltic Sea.

b. Naval Centric

A Naval Centric minor contingency refers to a short skirmish between adversarial maritime vessels. A historical example could be the 1964 Gulf of Tonkin incident or the 1999 First Battle of Yeonpyeong between the North and South Korean navies.[205]

c. Ground Centric

A Ground Centric minor contingency refers to an operation relying mainly on ground forces and land power but not necessarily in a significant combat role. These operations are lesser both in force structure and intensity compared with the types of Theater Land Combat Campaigns described earlier. Examples could include the 2014-2015 U.S. advisor campaign in Iraq against the Islamic State of Iraq and Syria (ISIS), or the 1993 Operation Restore Hope in Mogadishu, Somalia.

d. Air + Naval Mix

The Air + Naval Mix operation type accommodates several common scenarios in the IRAMM elicitations which refer to the simultaneous use of tactical air and naval power but of lesser intensity and duration than the Theater Air-Sea Battle Campaign.

6. Counterinsurgency Campaign

a. Extended

An Extended Counterinsurgency Campaign involves large numbers of ground forces operating in a population-centric environment for several years. Canonical American examples include the war in Vietnam, Operation Enduring Freedom in Afghanistan, and Operation Iraqi Freedom.

b. Limited

A Limited Counterinsurgency Campaign would be a lesser magnitude than the Extended Campaign, likely in both footprint and duration. Although there does not appear to be a good comparative historical analogy, the notion of a limited campaign came up multiple times in the IRAMM elicitations as a counterpoint to the modern conflicts in Iraq and Afghanistan.

7. Humanitarian Assistance/Disaster Relief *(Not addressed in IRAMM)*

Humanitarian Assistance/Disaster Relief (HA/DR)[206] operations refer to the deployment of military forces to conduct activities "outside the US and its territories to

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[205] http://www.reuters.com/article/2010/11/29/us-korea-north-clashes-idUSTRE6AS1AL20101129.

[206] Doctrinally, these operations are referred to as "Foreign Humanitarian Assistance." See Joint Staff Publication JP 3-29, January 2014.

directly relieve or reduce human suffering, disease, hunger, or privation" and are "limited in scope and duration; designed to supplement or complement the efforts of the host nation (HN) that has the primary responsibility for providing that assistance; and may support other United States Government (USG) departments or agencies."[207]

8. Defense Support to Civil Authorities (DSCA) *(Not addressed in IRAMM)*

DSCA operations are conducted within the U.S. in response to natural disasters and other civil emergencies. These are synonymous with the term "domestic disaster relief."

9. Domestic Chemical, Biological, Radiological, or Nuclear (CBRN) Attack

A domestic Chemical, Biological, Radiological, or Nuclear (CBRN) Attack refers to any CBRN attack within the United States. Note that nuclear attack in this context is considered to be a strategic nuclear attack (i.e., without warning), which differs from the Tactical Nuclear Escalation operation type described earlier.

10. Other Domestic Attacks (non-CBRN)

a. Cyber

In this context, cyber refers to an attack in which an adversary uses cyber warfare to target critical infrastructure.

b. Other

A conventional terrorist attack on U.S. soil or other breakdown of law and order which is not the result of a natural disaster (e.g., riots, violent protests, and so on).

E. Deriving Probabilities of Occurrence for each Operation Type

1. Generating Total Probabilities from the IRAMM Responses

In the original SARA demand model, observations of historical analogues provided approximate expected monthly frequencies for how often each operation type would initiate. For example, if three counterinsurgency operations occurred over a period of thirty years (or 360 months), the expected frequency of occurrence per month would be 3/360 or 0.008333. These values were then used as the expected probabilities of occurrence inside the stochastic simulation of 10,000 possible futures.[208]

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[207] Joint Staff Publication JP 3-29, page I-1.

[208] For more details about how the SARA model simulates the demand for military forces, see Doyle et al., *The Stochastic Active-Reserve Assessment (SARA) Model: Force Planning under Uncertainty.* IDA Document NS D-5470, Alexandria, VA: Institute for Defense Analyses, 2015, 4-6.

Generating probabilities of occurrence for the full range of operation types from the IRAMM elicitations is slightly different. To do so, we can take advantage of IRAMM's interview format and use the total probability for each branch of the probability tree to serve as the demand input for a ten-year future.

a. Opinions and Branches

Each of the IRAMM major combat operation scenarios takes the form of a probability tree. To make this format compatible with how the SARA model takes demand inputs, we can call each of the individual IRAMM elicitations an *opinion* about the future consisting of *branches* which correspond to the number of each operation type that the respondent believes could occur in the coming decade. Each opinion then forms the basis for a separate vision about the future. An opinion in turn consists of a number of "branches"—the number of each operation type that occur in a decade—and a subjective probability that the coming decade will unfold along that branch. We built a revised version of the SARA demand simulator to accommodate this new form of data. Rather than generate individual operations according to their frequency, this version of SARA randomly draws full branches according to the branch probabilities, and randomly starts the operations associated with that branch.

b. Important Caveats

One important distinction between the baseline SARA model and the IRAMM-derived probabilities is that the IRAMM responses are based on the current global situation rather than a randomly drawn simulation that gives an initial condition. Since each of the probabilities were developed based on critical reasoning about a specific situation (e.g., the breakdown of civil authority in North Korea or the development of an Iranian nuclear weapons program), there may be some rigor lost in translating such events to the probability that a similar but general event may occur. In other words, the respondent may not have meant specifically that there is a 10 percent probability of a Major Ground War operation type in the next ten years, but rather that there is a 10 percent probability of such a conflict with North Korea.

Another caveat with using inputs from the IRAMM elicitations is not every respondent gave a probability for each operation type, nor were they aware of how their scenarios would be used to derive new operation types. Instead, they simply described what they believed to be the most likely conflict scenarios facing the U.S. in the next decade, which is conceptually different from listing every type of scenario which would demand the deployment of U.S military forces.

F. Incorporating Historical Data

1. Method

As a complement to the IRAMM respondents' expectations of what types of operations could occur in the next ten years, we can build a precedent for the demand for military forces by looking at how the United States has deployed its combat power in the decades since 1945. The Congressional Research Service (CRS) has published a report listing every instance of U.S. military force deployments abroad since 1798, including as a response to actual or potential conflicts as well as for humanitarian relief operations.[209] Combining the deployments listed in the report with background research of each operation, we can link many of these events with one of the new operation types for the SARA model. There is some judgment involved with this undertaking, of course; every effort was made not to double-count ongoing operations. Indeed, the CRS report summary notes that the list

> was compiled in part from various older lists and is intended primarily to provide a rough survey of past U.S. military ventures abroad, without reference to the magnitude of the given instance noted. The listing often contains references, especially from 1980 forward, to continuing military deployments, especially U.S. military participation in multinational operations associated with NATO or the United Nations. Most of these post-1980 instances are summaries based on presidential reports to Congress related to the War Powers Resolution.

With this caveat in mind, we only considered entries that resulted in the deployment of forces to a new contingency, or where additional troops were deployed to an existing operation. Because SARA's demand model is initially concerned with when a deployment begins (i.e., the first time military forces are required to respond to a contingency), operations that span more than one of the ten-year "buckets" are only counted in the decade in which they began. We can now treat each of these decades as if it were a "branch" in an IRAMM-style opinion tree. We will assume that each of these branches carries an equal probability weight.

2. Special Considerations for Noncombatant Evacuation Operations

Many of the military force deployments described in the CRS report are in support of noncombatant evacuation missions, which are conducted "to assist the Department of State (DOS) in evacuating US citizens, DOD civilian personnel, and designated host nation (HN) and third country nationals whose lives are in danger from locations in a foreign nation to

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[209] Torreon, Barbara S. *Instances of Use of United States Armed Forces Abroad, 1798-2015.* U.S. Congressional Research Service (R42738), January 15, 2015.

an appropriate safe haven."[210] Although these operations do require the deployment of military forces, they were excluded from this analysis as they are typically short in duration and result in the rapid redeployment of forces involved. There are examples where this is not the case, though, such as the 1996 Operation Assured Response in Liberia which lasted from 9 April to 18 June and involved a joint military force of troops, aircraft, transportation assets, and naval vessels. Nonetheless, these kinds of deployment are not currently included in our set of operation types, though they present a potential area of future research.

3. Interpreting Minor Contingency Operation Types

Ground-centric and air-centric minor contingencies occur frequently in the historical table, but the size and type of forces involved varies significantly for each case. For example, ground-centric contingencies refer to everything from sending a few hundred ground forces to protect an embassy to a more robust task force of several thousand similar to the ground component of Operation Inherent Resolve against the Islamic State in Iraq. The implications of this are more important for force sizing considerations, but the qualitative difference in each case is worth noting here as well. Similarly, air-centric minor contingencies can refer to aerial strike assets (fighter jets involved in air-to-air combat missions, bombing raids, etc.) or military logistics aircraft (transport and cargo planes).

4. Other Caveats

Each operation was counted during the decade in which it began. Some of these operations span multiple timeframes, but SARA is concerned with initiation and duration rather than with specific timelines. For the Counterinsurgency (COIN) campaigns, an extended COIN campaign begins in the 1995-2004 decade (the transition from OIF Phase I to Phase II) and another in the 2005-2014 decade, which represents the notion that OEF was actually more of a Minor Contingency (Ground) until around 2009, when it became an extended COIN campaign.

The CRS report does not list any Domestic CBRN/Cyber/Disaster Relief. It has a number of HA/DR contingencies listed, but they only started appearing in the Congressional Research Service reports in the early 90s, so we are unable to determine if the previous decades truly reflect a zero for humanitarian aid missions, or if they were just not captured as part of the CRS deployments of military forces.

Lastly, the Domestic "Other" attack number is also rather ambiguous, as this mostly represents terrorist attacks on US soil, which don't necessarily require a military response. We list only one, which represents 9/11. Other numbers could be easily justified.

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[210] Joint Staff Publication JP 3-68, *Noncombatant Evacuation Operations*, 22 January 2007.

G. Thinking about Future Demand

As described earlier, we use a new version of the SARA demand generator to simulate "sets" of 10,000 futures in a way that is compatible with the IRAMM elicitations. Each set of 10,000 futures is derived from an "opinion" about the future. An opinion consists of a number of "branches"—the number of each operation type that occur in a decade—and a subjective probability that the coming decade will unfold along that branch. IRAMM provides such "opinions" for 20 senior leader subject matter experts (the "Human SMEs"). We have also translated historical data into a form that is similar to the form of this SME data. We treat this set of branches as a virtual "opinion" and term it the "Historical SME," or just "History."

1. Using SARA to Help Think about Future Demand Using Human SMEs

The 20 opinions of the human SMEs allow us to get a sense of the future demands on the force as envisaged by the knowledgeable senior leader community. We simulate a set of 10,000 futures for each Human SME's opinion. For each of the 20 SMEs, the computer code randomly picks one of their branches (with the probability assigned to that branch), and plays out a future in which the operations in that branch arrive randomly over 10 years. This process is repeated 10,000 times.

We define a simple metric for the most stressful case of these 10,000: the most operations that are ongoing in any one month in any one of the 10,000 futures. This metric produces a single integer measure of maximum stress under a SME's opinion. By our simple measure, the most stressful case belongs to SME 3, which includes a case in which 6 operations are ongoing at once. It involves simultaneously fighting one major ground war, two allied response operations and one major counterinsurgency campaign, all while addressing the consequences of simultaneous biological and cyberattacks on the homeland. This sounds like a situation in which we may have to adopt an "all hands" approach; a situation in which non-deployable personnel could present a major impediment to force management in crisis.

2. Future Demand beyond the Perspective of Human SMEs

To address issues relating to the inevitable inaccuracy of predictions, this section relaxes some of the constraints imposed by the human SMEs in order to get a sense of what futures are possible that they may not have considered.

3. Future Demand Beyond the Perspective of Human SMEs 1: Semi-Wise SMEs

It is possible that the human SMEs have a good grasp of what futures are possible, but are not very good at assigning numerical probabilities to them. Certainly, it is easier to imagine what is possible than to quantify exact probabilities. To help us make decisions that are robust to this outcome, SARA generates "Restricted Pseudo-SMEs" (RPSMEs).

These are "opinions" generated randomly by the computer code by assigning probabilities to the set of all human SME "branches" (future combinations of operations) according to random draws from the uniform distribution. The subjective probabilities are now essentially "white noise" and contain no real information about the future. These partially artificial "opinions" can help us think about the consequences for our decisions if SMEs and senior leaders make errors in judging the likelihood of future events.

We simulated 20 RPSMEs in the same manner that we simulated the SME opinions. It is similar to the worst-case SME outcome (SME 3), and involves simultaneously fighting one major ground war, two allied response operations and one major counterinsurgency campaign; but in this case the nation is now subjected to four simultaneous attacks on the homeland rather than two. Notably, one of these attacks is now nuclear, which would likely raise the manpower required for domestic response significantly.

The "opinion" that reflects the historical experience of the seven decades 1945-2014 in the new SARA-IRAMM format is also useful for thinking beyond the perspective of the SMEs. We simulated 10,000 cases of the Historical SME. The resulting stress metric is 8 simultaneous operations. This overall metric is the same as for the RPSMEs; however, the details of the case are quite different. Six of the eight operations in this case are outside the contiguous United States (OCONUS) military engagements requiring the deployment of troops: one major ground war, one allied response operation, one major contingency, one ground forces minor contingency, and two naval forces minor contingencies. One operation is an OCONOS humanitarian response mission, which would also require the deployment of troops. Additional troops are required to respond to a terrorist attack in the homeland. This case, while quite different from the previous two considered, also raises the potential for serious stress on the force and the need for an "all hands" approach to deployment.

4. Future Demand beyond the Perspective of Human SMEs 2: Black Swans and Failures of Imagination

It is possible that the human SMEs do not have a good grasp of what futures are actually possible. To address this issue, SARA generates "Unrestricted Pseudo-SMEs" (UPSMEs). These are "opinions" generated by the computer by randomly generating "branches" (future combinations of operations), using random draws from a statistical distribution, and assigning probabilities to these "branches" according to random draws from the uniform distribution. These fully artificial "opinions" provide a lens through which to consider the potential for "Black Swan" futures that have not been imagined by human decision-makers. "Black Swan" events have actually figured prominently in our recent history, from the attack on Pearl Harbor to the 9/11 attacks to the financial crash of 2008 and ensuing Great Recession.

To ensure that the branches that are produced by the UPSME generator are at least "believable," we impose three artificial restrictions on the statistical distribution in practice.

First, no branch can include more than five of the same type of operation. Second, no branch can include more than one total mobilization operation. Third, no branch can include more than one existential thermonuclear attack. Figure D-2.shows that the resulting branch generator is actually quite conservative in its choices.

The worst case future from the 20 UPSMEs showed severe results, as listed in Figure D-2. It involves 25 simultaneous operations, including a thermonuclear war. It is clear that as soon as we relax the assumptions that SMEs have a good sense of what is possible, or that the future will look like the past, extraordinarily stressful scenarios become possible even with quite conservative assumptions. It is difficult to imagine a military that could accommodate non-deployable personnel in such a world.
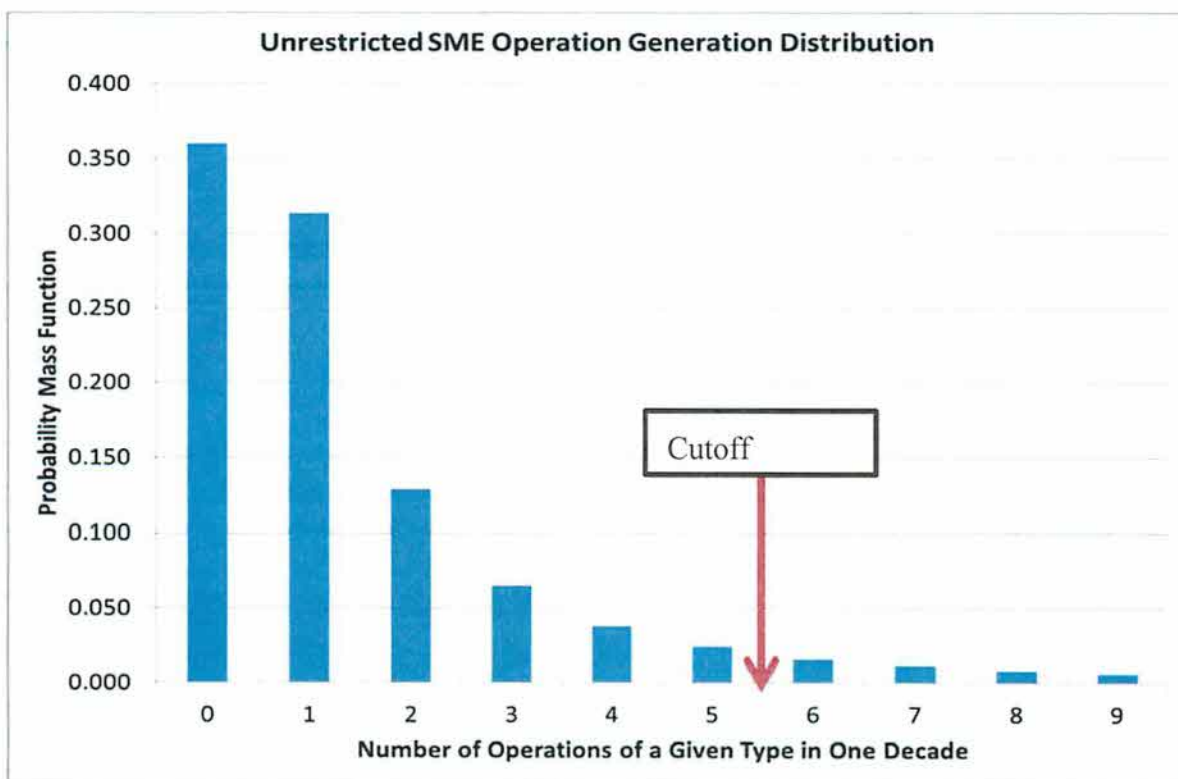
Figure D-2. The UPSME "Branch" Generator

H. Conclusions

Results from simulating senior leaders indicate that current policy makers implicitly anticipate the possibility of a severely challenging future (3 to 6 simultaneous operations). Results from simulating pseudo-SMEs based on the senior leaders indicate that the potential for human errors in estimating the numerical probability of possible futures leaves us with the more robust planning assumption that an even more challenging future (8 simultaneous operations) is possible. Results from simulations informed by history confirm this view. Results from simulating unrestricted pseudo-SMEs based on a fairly

conservative algorithm suggest that even this assumption may be over-optimistic and that extraordinarily stressful futures may be possible and should be considered in our decisions. Given these results, indications are that uniformed individuals in each of the military Services will be globally deployed during periods of challenging futures where the number of deployable personnel will dictate how constrained DOD is in its ability to meet these challenges.

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Appendix E
List of Research Participants

A. Individuals with Hearing Impairments

Mr. Joel Barish – Co-founder, DeafNation, Inc. and host, No Barriers

Ms. Marla Dougherty – Advocate at Northern Virginia Research Center

Ms. Rachel Dubin – IDA Research Assistant

Mr. Ethan Lusted – Graduate of the Citadel Military College

Mr. Keith Nolan – ROTC student

Ms. Bonnie O'Leary – Advocate at Northern Virginia Research Center

Dr. Christian Vogler – Associate Professor Communications, Gallaudet University

B. Accessibility Experts

Dr. Aaron Bangor – Lead accessibility architect at AT&T, vice-chair of Texas Governor's Committee on People with Disabilities

Ms. Dinah Cohen – Founding director, Pentagon Computer/Electronic Accommodations Program

Ms. Marla Doughetry – Northern Virginia Resource Center

Ms. Teresa Goddard – Job Accommodation Network

Ms. Deborah Jones – Northern Virginia Resource Center

Mr. Steven King – Computer/Electronic Accommodations Program (Pentagon Office)

Dr. Linda Kozma-Spytek – Gallaudet Technology Assistance Program

Ms. Bonnie O'Leary – Northern Virginia Resource Center

Mr. Lou Orslene – Job Accommodation Network

Dr. Christian Vogler – Gallaudet Technology Assistance Program

Mr. Mike Young – Computer/Electronic Accommodations Program (Pentagon Office)

C. Others

(b)(6) – Defense Health Agency

(b)(6) – USAF helicopter pilot and child of deaf parents

(b)(6) – Instructor to Ethan Lusted

(b)(6) – Director, Office of Carrier, Driver, and Vehicle, Safety Standards, U.S. Department of Transportation

(b)(6) – Department of Transportation

(b)(6) – Executive Director for the Hearing Center of Excellence

(b)(6) – Instructor to Keith Nolan

(b)(6) – Instructor to Keith Nolan

Appendix F
Survey

A. Informed Consent

Before responding to the attached survey, please read this informed consent statement and ask as many questions as you need to be sure that you understand the possible risks and benefits of participating.

Purpose: The purpose of the research for the Department of Defense (DOD), to better understand job accommodations and assistive technology for individuals who are Deaf and Hard of Hearing.

Description: The research will involve about approximately 30 participants who will complete a survey questionnaire of 8 items related to current job, hearing ability, communication preferences, and job accommodations for individuals who are Deaf or Hard of Hearing. After completing the survey, participants will email their responses to the researchers. It is expected that it will take approximately 10 minutes to complete the survey.

The research is being conducted by the Institute for Defense Analyses for the Office of the Under Secretary for Personnel and Readiness (OSD(P&R)). The overall objective of this project is to assess job accommodations and assistive technology to determine the extent that individuals who are Deaf or Hard of Hearing (D/HOH) might qualify for positions in the Armed Forces if regulations were modified.

Risk: All information on individuals will be held confidential, and we will protect the information you share to the best of our ability. Only grouped or anonymous data will be shared to minimize risk of personal information being shared.

Benefit: There may be no direct benefit to you for responding to the survey. The knowledge gained from the research will be shared with the DOD, so this may lead to new opportunities for individuals who are D/HOH within the DOD.

No compensation will be provided for completing this survey.

Contact for Questions: If you have any questions, concerns, or complaints about this research, please contact Dr. Joseph Adams (703) 845-2148, jadams@ida.org or Dr. James Belanich (703) 845-6606, jbelanic@ida.org.

If you have questions, concerns, or complaints that are not answered by the research team or you want to talk to someone other than the research team about your rights as a research subject, you may contact Liberty IRB at (386)740-9278. Liberty IRB (an Institutional Review Board) reviewed this study and is a group of people who review research studies to protect the rights and

welfare of research participants. Review and approval by Liberty IRB does not mean that the study is without risks.

Voluntary Participation: If you decide to take part in this study, it is completely of your own free will. There will not be any penalty or loss of benefits to you if you decide not to take part. Also, you may withdraw from the study at any time.

B. Survey Questions:

1. Briefly describe your job.

2. How would you describe your hearing (Deaf, hard of hearing, mild hearing loss)?

3. What methods of communication do you use with coworkers (please list all)?

4. What accommodations or assistive technology do you use on the job or at home?

5. Are there particular obstacles you had to overcome to be successful in this work position?

6. Are there particular issues that remain a challenge at work?

7. Can you provide some examples of how you regularly interact with coworkers and your supervisors?

8. If you are a supervisor, can you provide some examples of how you interact with those you supervise?

Appendix G
Illustrations

Figures

Tables

Appendix H
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Appendix I
Abbreviations

ABA	American Bar Association
AC	Active Component
AETC	Air Education and Training Command
AFCS	Air Force Civilian Service
AFSC	Air Force Specialty Codes
AMOPES	Army Mobilization Operations Planning and Execution
AMSARA	Accession Medical Standards Analysis and Research
AMSWG	Accession Medical Standards Working Group
AOR	Area of Responsibility
APHC	U.S. Army Public Health Command
ARNG	Army National Guard
ATC	Air Traffic Control
BCT	Brigade Combat Team
BDM	*Bund Deutscher Mädel* (League of German Girls)
BUMED	Navy Bureau of Medicine and Surgery
CAPE	Cost Assessment and Program Evaluation
CATMS	Correspondence and Task Management System
CBRN	Chemical, Biological, Radiological, or Nuclear
CCMD	Combatant Command
CENTCOM	United States Central Command
CEW	Civilian Expeditionary Workforce
CJCS	Chairman of the Joint Chiefs of Staff
CJTF	Combined Joint Task Force
CMATT	Coalition Military Advisory Training Teams
COIN	Counterinsurgency
CPA	Coalition Provisional Authority
CRS	Congressional Research Service
CY	Calendar year
dB	decibel
DCC	Direct Commissioned Course
DCPAS	Defense Civilian Personnel Advisory Service
DEP	Delayed Entry Program
DES	Disability Evaluation System
DGCPC	Direct Ground Combat Position Coding system

DHB	Defense Health Board
DMDC	Defense Manpower Data Center
DOD	Department of Defense
DODIG	DOD Inspector General
DODMERB	Department of Defense Medical Examination Review
DOS	Department of State
DSCA	Defense Support to Civil Authorities
E-E	Emergency-Essential
ENT	Ear, nose, and throat
EPTS	Existed prior to service
FORSCOM	Forces Command
FPEB	Formal Physical Evaluation Board
FQ	Fully qualified
FSA	Force Structure Allowance
FY	Fiscal Year
GAO	Government Accountability Office
GFM	Global Force Management
GME	Graduate Medical Education
GWOT	Global War on Terror
HA/DR	Humanitarian Assistance/Disaster Relief
HCE	Hearing Center of Excellence
HLSim	Hearing Loss Simulator
HN	Host Nation
HQ	Headquarters
IA	Individual Augmentee
ICD-9	International Classification of Disease, 9th Revision
IDA	Institute for Defense Analyses
IDF	Israeli Defense Forces
IET	Initial Entry Training
ILO	In lieu of
IMA	Individual Mobilization Augmentee
IPEB	Informal Physical Evaluation Board
IRAMM	Integrated Risk Assessment and Management Model
ISAF	International Security Assistance Force
ISC	Interservice Separation Code
ISIS	Islamic State of Iraq and the Levant
IwD	Individuals with Disabilities
J.D.	Juris Doctor

JAG	Judge Advocate General
JAOBC	Judge Advocate Officer Basic Course
JMD	Joint Manning Document
KIA	Killed in action
LCAC	Landing Craft Air Cushion
MCO	Major Combat Operations
MCRC	Marine Corps Recruiting Command
MCRD	Marine Corps Recruit Depot
MEB	Medical Evaluation Board
MED-PERS	Medical-Personnel Executive Steering Committee
MEPS	Military Entrance Processing Station
MOD	Ministry of Defence
MOD	Modification
MOS	Military Occupational Specialty
MPP	Military Personnel Policy
MTF	Military Treatment Faculty
MTOE	Modification Tables of Organization and Equipment
NATO	North Atlantic Treaty Organization
NCAR	National Center for Rehabilitative Auditory Research
NCO	Noncommissioned Officer
NCO	New Contract Objective
NIHL	Noise Induced Hearing Loss
NRC	National Research Council
NSDAP	*Nationalsozialistische Deutsche Arbeiterpartei* (National Socialist German Workers Party or NSDAP)
OCONUS	Outside the contiguous United States
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OMF	Objective Medical Finding
OND	Operation New Dawn
OSD	Office of the Secretary of Defense
PDA	Army Physical Disability Authority
PEB	Physical Evaluation Board
PERS	Personnel Command
PIHP	Personal Interfaced Hearing Protection
PTA	Pure tone average
PULHES	P, physical capacity or stamina; u, upper extremities; l, lower extremities; h, hearing and ears; e, eyes; and s, psychiatric

PULHHEEMS	Physique, upper limbs, lower limbs, hearing (left), hearing (right), eyesight left, eyesight right, mental function, and stability (emotional)
RC	Reserve Component
REGEDE	*Reichsverband der Gehörlosen Deutschlands* (Reich Association of the Deaf of Germany)
RFF	Request for Forces
ROTC	Reserve Officer Training Corps
SA	*Sturmabteilungen* (Storm Detachments)
SARA	Stochastic Active-Reserve Assessment
SECDEF	Secretary of Defense
SIGINT	Signal Intelligence
SME	Subject Matter Expert
SOF	Special Operations Forces
SPRINT	Speech Recognition In Noise Test
SRT	Speech Recognition Test
SSN	Social security number
STP	Student, Trainee, and Personnel Hold
STTH	Student, Trainee, Transients, or Holdees
TDA	Table of Distribution and Allowances
TDRL	Temporary Disability Retirement List
TJAGLCS	The Judge Advocate General's Legal Center and School
TTHS	Trainees, Transients, Holdees, and Students
TTS	Temporary threshold shift
U.S.	United States
UAS	Unmanned Aircraft Systems
UK	United Kingdom
UPSME	Unrestricted Pseudo–Subject Matter Expert
USAREC	U.S. Army Recruiting Command
USCENTCOM	U.S. Central Command
USD(P&R)	Under Secretary of Defense (Personnel and Readiness
USEUCOM	U.S. European Command
USG	United States Government
USMEDCOM	U.S. Medical Command
USMEPCOM	U.S. Military Entrance Processing Command
USSOCOM	U.S. Special Operations Command
VASRD	Veterans Affairs Schedule for Rating Disabilities
WIA	Wounded in action
WRAIR	Walter Reed Army Institute of Research

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This paper assesses the feasibility and advisability of permitting individuals with auditory impairment to access as members of the armed forces. This paper first examines the feasibility and advisability from the perspective of the individuals with auditory impairment, considering existing career and communication barriers, both current and developing assistive technologies and accommodations, and which military occupations may be potentially viable for such individuals. Second, this paper provides a data-driven context for understanding the impact on the force as it relates to the feasibility and advisability of permitting individuals with auditory impairment to access as members of the armed forces. To address the force impact, this paper draws on operational and personnel data from both the Defense Manpower Data Center and the Services, research on medical standards and fitness for duty, and forecasts regarding future demands on the force.

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