



INSTITUTE FOR DEFENSE ANALYSES

## **A Framework for Analyzing Tour Length Policy**

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# Executive Summary

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The Department of Defense (DoD) prescribes standard overseas tour lengths for Service members, as well as policies and procedures for permanent changes of station (PCS). Emerging Service requirements have generated requests for longer tours through Exceptions to Policies (ETPs), which can vary based on Service, location, specialty, and pay grade. In particular, the Navy has extended tours from 36 to 48 months for first term enlistees in Japan, Guam, and Spain. These tour extensions necessitated an analytic framework to assess the impacts of tour length on force readiness and retention. To achieve that objective, the DoD asked IDA to develop a methodology that can assess the implications of changing tour lengths on readiness, retention, and cost across all DoD Services.

## Background

PCS moves occur when military personnel move from one duty station to another. The DoD identifies six categories of travel to distinguish the reasons for a PCS move:

- Accession travel—occurs at the beginning of a military career and is associated with relocating personnel from their home to their first permanent duty station or training school
- Separation travel—occurs at the end of a military career and is the movement of personnel from their final permanent duty station to their home or point of entry into service
- Operational travel—includes moving personnel between duty stations within the continental United States (CONUS) or between overseas locations without transoceanic travel
- Rotational travel—occurs when personnel move to or from a CONUS location CONUS to a location Outside the Continental United States and involves transoceanic travel
- Training travel—includes the movement of personnel for long-term training
- Organized unit travel—occurs when units move to a different location such as when a base closes

We focused on operational and rotational PCS moves, which are the most likely to be affected by policy changes and account for approximately 29 percent of enlisted moves and 50 percent of officer moves in fiscal year 2020.<sup>1</sup>

## **Literature Review**

We began by reviewing and assessing the literature on tour length, retention, and readiness. In previous work on retention, several different definitions were used. Broadly, retention refers to the rate at which military personnel voluntarily stay in the military. How this rate is calculated and for whom differs across definitions; however, our definition of retention is the yearly continuation rate.

Readiness is a complex concept that is difficult to define and measure. Because of this, a variety of definitions and measures of readiness exist in the literature. We use the definition of readiness from the Department of Defense: “the capability of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it is organized or designed.”

Existing retention and readiness models rarely consider location and tour length. Instead, these models focus on family factors and demographics, as well as the relationships between deployment, operations tempo (OPTEMPO), and personnel tempo (PERSTEMPO). Readiness models also identify family as an important factor in individual readiness, which in turn impacts group readiness. Frequent moves reduce the readiness of both individuals and groups. Group cohesion is important as most activities carried out by Service members are team-based. However, the retention and readiness models do not consider the processes by which the factors affect retention and readiness.

Our literature review covered changes in tour lengths and factors affecting retention and readiness, and revealed the observations discussed in the following sections.

### **Tour Lengths and Completion**

- The percentage of incomplete tours is higher for first term tours than career tours.
- Longer sea tours lead to more incomplete sea tours—for example, increasing a tour from 3 years to 4 years increases actual tour length by approximately 2 months.

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<sup>1</sup> Department of the Navy Budget Materials, <https://www.secnav.navy.mil/fmc/fmb/Pages/Fiscal-Year-2020.aspx>, accessed October 26, 2020.

### **Retention**

- Family factors and demographics play a large role in retention.
- Longer tours and tours in desirable locations positively affect retention.
- A curvilinear relationship exists between deployment, OPTEMPO, and PERSTEMPO: retention increases at a decreasing rate and then decreases.

### **Readiness**

- Family plays a large role in Service Member (individual) readiness.
- Group cohesion has a positive impact on readiness because most activities are team-based.
- More frequent moves typically reduce readiness.
- Mental and physical readiness play a role in individual and unit readiness.

## **Conceptual Model**

Our review of the literature led us to include location desirability as well as the impact of moves on promotion ability in our conceptual model, which examines three outcomes of interest: retention, readiness, and cost. We include inputs such as demographic characteristics (gender, family status); military characteristics (years of service, rank, occupation); civilian economic variables (unemployment); and tour length and location. Our model posits that these inputs affect the outcomes by influencing a Service member's personal quality of life, work quality of life, and commitment to the military.

We also identified existing data that can be used to evaluate the model, as shown in the following table.

### Potential Data Sources

| Model Element                                           | Data Source                                                                                                                |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Personal characteristics                                | DMDC<br>DEERS<br>DHA                                                                                                       |
| Military characteristics                                | DMDC                                                                                                                       |
| Tour length policy                                      | Navy policy                                                                                                                |
| Tour length characteristics                             | Navy orders data                                                                                                           |
| Civilian economic conditions                            | Bureau of Labor Statistics<br>Current Population Survey                                                                    |
| Personal quality of life                                | AIP data/Dream Book data<br>Status of Forces Survey<br>Survey of Active Duty Spouses<br>Quadrennial Quality of Life Review |
| Work quality of life                                    | AIP data/Dream Book data<br>Status of Forces Survey<br>Survey of Active Duty Spouses<br>Quadrennial Quality of Life Review |
| Commitment to the military                              | Status of Forces Survey<br>Survey of Active Duty Spouses                                                                   |
| Retention intentions                                    | Status of Forces Survey<br>Survey of Active Duty Spouses                                                                   |
| Retention decision                                      | DMDC                                                                                                                       |
| Readiness                                               | DRRS                                                                                                                       |
| AIP – Assignment Incentive Pay                          |                                                                                                                            |
| DMDC – Defense Manpower Data Center                     |                                                                                                                            |
| DEERS – Defense Enrollment Eligibility Reporting System |                                                                                                                            |
| DHA – Defense Health Agency                             |                                                                                                                            |
| DRRS – Defense Readiness Reporting System               |                                                                                                                            |

Next, we developed a simulation model that considers three possible assignments: sea, shore, and training. The model outputs the number of PCS moves as well as the number of individuals who are required to remain longer or required to move early. The simulation model is based on individual, simulated agents that follow business rules and have characteristics, such as the probability of leaving. The business rules can be adjusted, allowing the model to be used for different Services or for different communities within a Service. In addition, the characteristics of the simulated individuals are intended to be adjusted based on the results of the empirical analysis.

## **Summary**

We produced a conceptual model that incorporates what we learned from the literature and extends it to include tour length. We then used structural equation modeling to evaluate the conceptual framework we developed. We additionally designed a simulation model that enables DoD to assess the impact of changing tour length. Increasing the realism of our tour-length simulation model will allow us to understand the impact of changes in tour-length policy on actual tour lengths, numbers of PCS moves, and costs in a wide variety of circumstances.

Overall, our review of the literature shows that longer tours are associated with higher training levels, and thus, readiness. The increased geographical stability of longer tours may lead to improved retention, but increased family separation due to longer sea tours may decrease retention. Both the literature review and our analysis of Navy data show that increasing the prescribed tour length by 1 year will likely increase actual tour length by only 3 to 4 months.



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# **1. Introduction**

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The Department of Defense (DoD) prescribes standard overseas tour lengths for Service members, as well as policies and procedures for permanent changes of station (PCS). Emerging Service requirements have generated requests for longer tours through Exceptions to Policies (ETPs), which can vary based on Service, location, specialty, and pay grade. The Navy, in particular, has extended tours from 36 to 48 months for first term enlistees in Japan, Guam, and Spain. These extensions have created a need for an analytic framework that can assess the impact of readiness and retention on tour length. As a result, the DoD asked IDA to develop a methodology to assess the implications of changing tour lengths on readiness and retention across all DoD Services.

In this paper, we review the literature to determine what is known about the impact of tour length on retention and readiness and identify gaps in current research. We then develop a conceptual model that unites retention and readiness to better assess the impact of changing tour lengths on both parameters as well as on costs. We also identify data to operationalize the model and develop a simulation model.



## 2. Permanent Change of Station Moves

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In this chapter, we briefly describe PCS moves and examine the current state of PCS moves in the Navy. The Navy has already implemented changes in Japan, Guam, and Spain, so we use them as examples throughout the paper. Using data for fiscal year (FY) 2000 through FY 2020 from annual budget justifications published by the Department of the Navy,<sup>1</sup> we examine the number and costs of PCS moves. All costs are reported in FY 2020 dollars using the deflators the DoD published in the National Defense Budget Estimates for FY 2020.<sup>2</sup>

PCS moves occur when military personnel go from one duty station to another. The DoD uses six different categories of PCS moves to distinguish the reasons for a PCS move. The first category is accession travel, which includes PCS moves associated with moving personnel from their home base to their first permanent duty station or training school. Separation travel, which occurs at the end of a military career, is the movement of personnel from their final permanent duty station to their home or point of entry into service. The movement of personnel between duty stations within the continental United States (CONUS) or between overseas locations not involving transoceanic travel is operational travel. Rotational travel occurs when personnel move to or from a location CONUS to a location Outside the Continental United States (OCONUS) that involves transoceanic travel. Training travel includes the movement of personnel for long-term training. The final type of PCS move, organized unit travel, occurs when units are moved to a different location such as when a base closes.

### A. PCS Moves for FY 2020

Figure 1 and Figure 2 display the number and percent of moves for each PCS category for Naval enlisted personnel and officers, respectively. For enlisted personnel, most PCS moves are due to accession and separation; for officers, most moves are rotational and operational. For both enlisted personnel and officers, unit travel accounts for a small percentage of total PCS moves.

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<sup>1</sup> Department of the Navy Budget Materials, <https://www.secnave.navy.mil/fmc/fmb/Pages/Fiscal-Year-2020.aspx>, accessed October 26, 2020.

<sup>2</sup> [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/FY20\\_Green\\_Book.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/FY20_Green_Book.pdf).

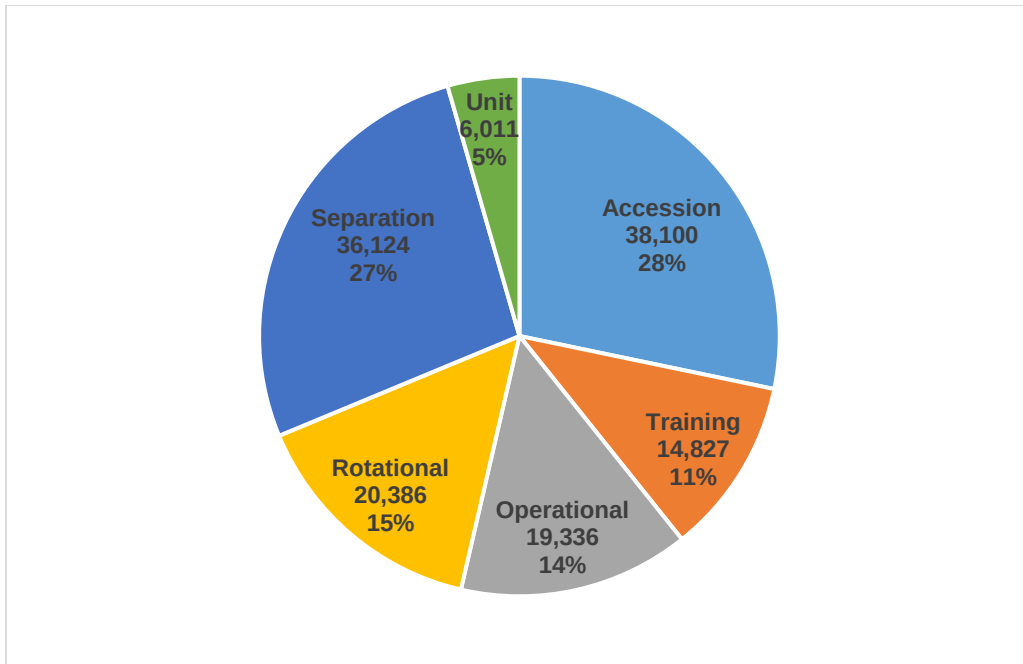


**Figure 1. FY 2020 PCS Moves for Enlisted Personnel**

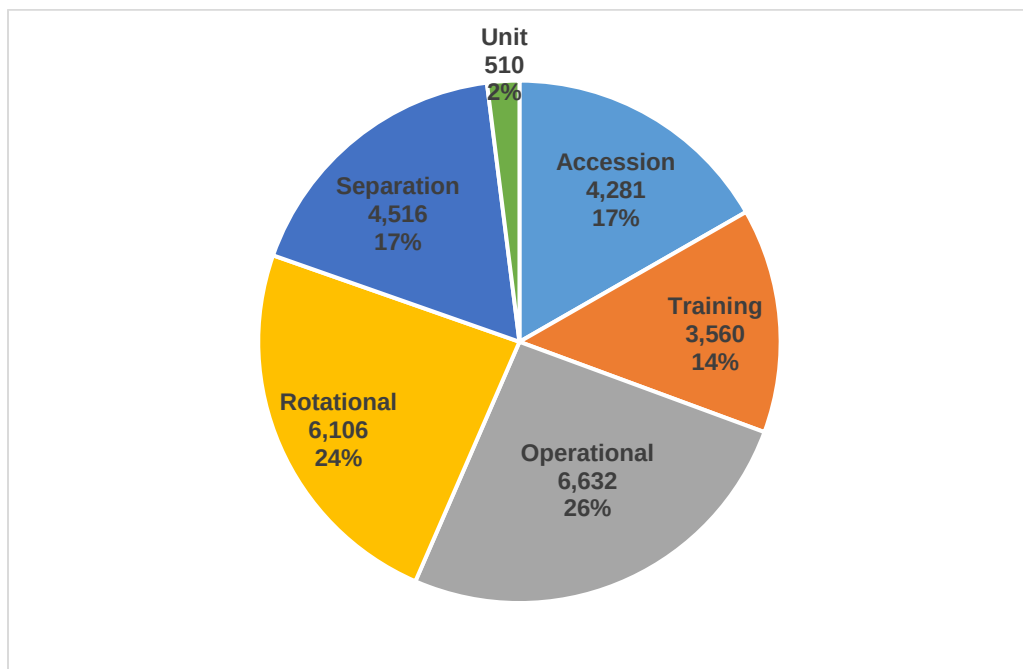


**Figure 2. FY 2020 PCS Moves for Officers**

The budget justification books also contain information on the total cost for each type of PCS move. Table 1 shows the average cost of a PCS move for each category and overall for enlisted personnel and officers. On average, PCS moves are costlier for officers than enlisted personnel for each type of move by a factor of at least two. For both enlisted personnel and officers, accession and separation moves are the least costly while

operational and rotational moves are the costliest. Because operational and rotational moves are the most affected by changes in policy, we will look at these types of moves in more detail.

**Table 1. Average Cost per PCS Move by Category for Enlisted Personnel and Officers**

| Type of Move | Enlisted Personnel | Officers |
|--------------|--------------------|----------|
| Accession    | \$1,507            | \$8,245  |
| Training     | \$4,004            | \$12,963 |
| Operational  | \$7,138            | \$14,156 |
| Rotational   | \$9,485            | \$16,211 |
| Separation   | \$2,436            | \$6,562  |
| Unit         | \$4,239            | \$10,008 |
| Overall      | \$4,167            | \$12,070 |

## B. Operational and Rotational PCS Moves for FY 2000 through FY 2020

Figure 3 provides the number of operational and rotational PCS moves for FY 2000 through FY 2020 for enlisted personnel and officers. For both types of personnel, a slight downward trend has emerged since 2017 that is more noticeable for enlisted personnel. Overall, the number of moves vary more for enlisted personnel, a trend that is likely due to the larger number of enlisted personnel than officers.

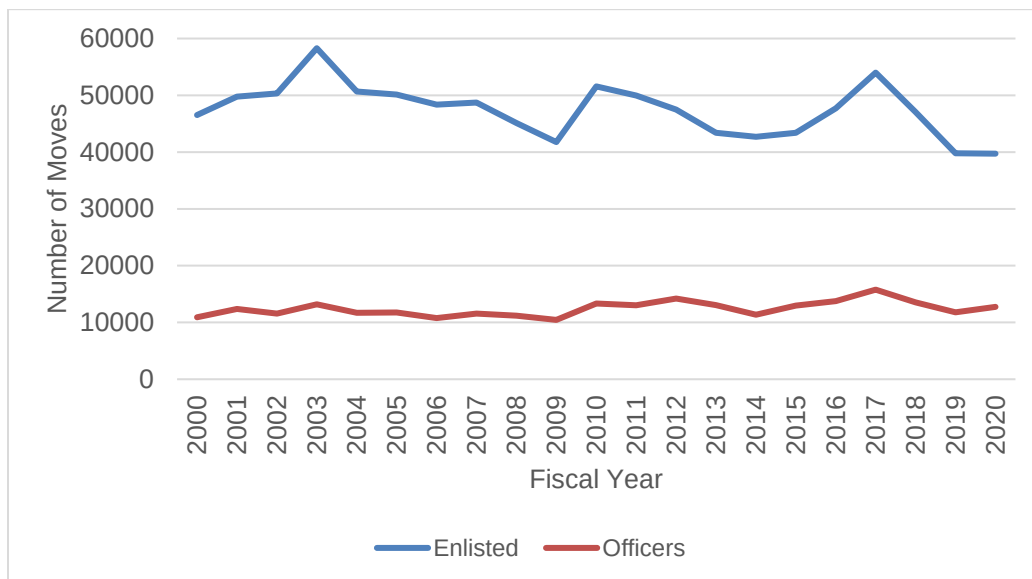


**Figure 3. Total Number of Operational and Rotational PCS Moves for Enlisted Personnel and Officers**

Figure 4 displays the total costs in millions of dollars associated with operational and rotation moves in FY 2020 dollars, while Figure 5 shows the average cost associated with these moves. The total costs associated with operational and rotational moves roughly follow the trends in number of moves, although costs have more variability.

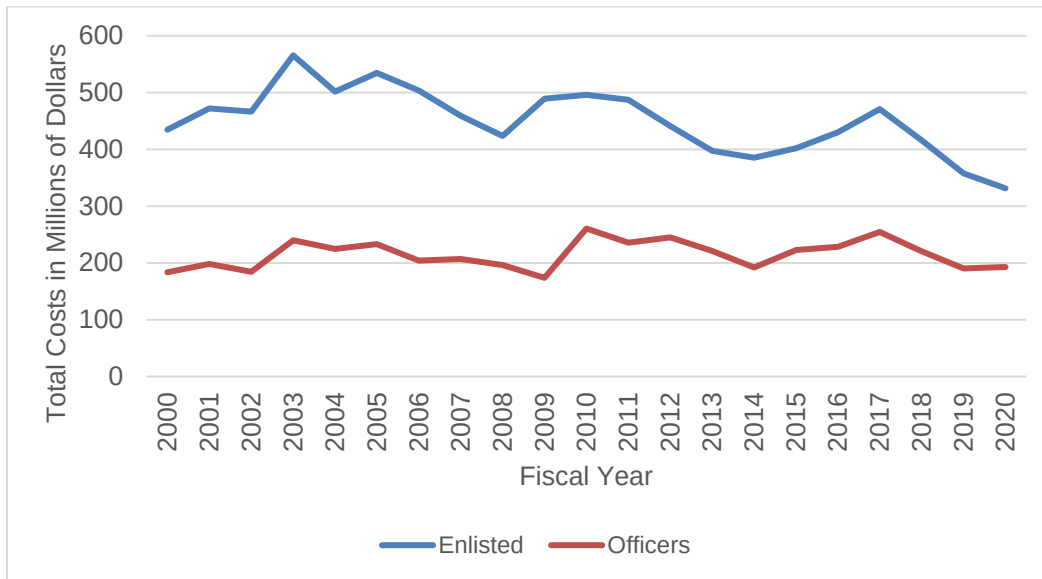


**Figure 4. Costs of Operational and Rotational PCS Moves for Enlisted Personnel and Officers**

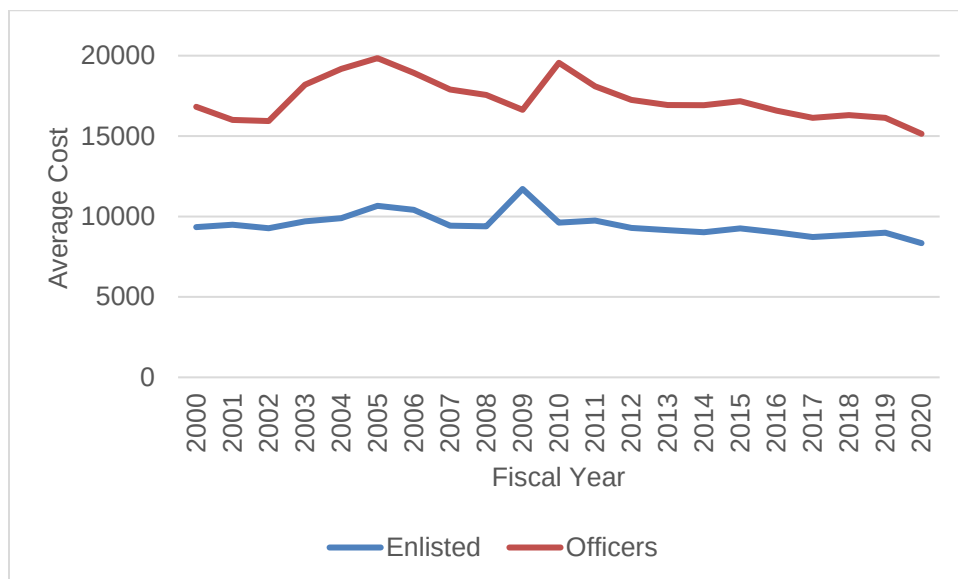


**Figure 5. Average Cost of Operational and Rotational PCS Moves for Enlisted Personnel and Officers**

### 3. Tour Lengths and Completion

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Before examining the impacts of changing tour lengths, it is important to examine the current policies for setting tour lengths, the factors that affect tour lengths and the completion rate of tours, and the current state of tour length and completion in the locations under consideration.

In this chapter, we provide an overview of current policies on tour lengths, such as how tour lengths are set and exceptions to these policies. We also examine previous literature on factors associated with tour lengths and whether a tour is completed. We then use data from the Defense Manpower Data Center (DMDC) Active Duty Masterfile and orders the Navy provided to: (1) examine the relationships among the previously identified factors, tour lengths, and completion rates and (2) compare prescribed, assigned, and actual tour lengths.

#### A. Policies and Processes for Setting Tour Lengths

To understand the impact of DoD’s military personnel assignments on retention, readiness, and overseas base sustainment, it is important to understand DoD assignment policies and associated data collection. DoD policy on PCS is set forth in DoD Instruction (DoDI) 1315.18.<sup>3</sup> This DoDI provides tour lengths for locations CONUS<sup>4</sup> and OCONUS<sup>5</sup> The tour length associated with a PCS is referred to as time on station (TOS).<sup>6</sup>

The DoD’s policy goal in disseminating DoDI 1315.18 is summarized as follows:

*Provides permanent change of station (PCS) policies and procedures to be used by the Military Services in maintaining an equitable assignment system for enhancing career attractiveness and professional development, sustaining an assignment base for overseas*

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<sup>3</sup> Department of Defense, DoDI 1315.18, “Procedures for Military Personnel Assignments,” October 28, 2015, incorporating change 3, effective June 24, 2019.

<sup>4</sup> Ibid. The contiguous 48 States and the District of Columbia; specially excluding Alaska and Hawaii.

<sup>5</sup> Ibid. Outside the contiguous 48 States and the District of Columbia. The states of Alaska and Hawaii, the Commonwealths of Puerto Rico and the Northern Mariana Islands, Guam, and the U.S. Virgin Islands, and U.S. territories and possessions (excluding the former Trust Territories of the Pacific Islands) are referred to as non-foreign, OCONUS.

<sup>6</sup> Ibid. The elapsed period a member has been permanently assigned to an installation, naval vessel, or other authorized assignment location.

*tours of duty, achieving stability for tour completions, developing tour lengths consistent with maintaining a high degree of combat capability and readiness, and achieving PCS stability.*<sup>7</sup>

While the focus of this study is on OCONUS in terms of longer TOS but fewer overseas tours, it is noteworthy to review policy on CONUS tours for context. For CONUS, the minimum TOS requirement for all assignments is 36 months.<sup>8</sup> This requirement may be waived by the secretary of a military department on a case-by-case basis with certain delegation authority permitted.<sup>9</sup> However, the 36-month minimum requirement has 24 authorized itemized exceptions,<sup>10</sup> which are shown in Appendix A.

A number of nuances regarding special groups and considerations are called out in the CONUS section of DoDI 1315.18, such as service retainability required to complete an assignment, limitation on number of first term service member moves, critical acquisition positions, military couples, single parents, and military mothers of newborns.<sup>11</sup> However, this paper focuses on the authorized exceptions and waivers.

TOS for OCONUS assignments are specified in DoDI 1315.18 by reference to the DoD's Joint Travel Regulations (JTR), which specifies OCONUS TOSs that range from 12 to 36 months. The standard tour length is 36 months accompanied and 24 months unaccompanied.<sup>12</sup> However, TOS for country and base varies depending upon location desirability, force protection, and anti-terrorism considerations.<sup>13</sup> Unlike minimum requirements for CONUS TOS, there are fewer listed exceptions for OCONUS TOS.

Exceptions to the tour lengths listed in the JTR's memorandum dated September 19, 2019, are provided in DoDI 1315.18. Exceptions, waivers, and clarifications are numerous and include: service members on government-to-government contracts, defense attaches, security cooperation officers, Marine Corps security guards assigned to service posts, medical officers, foreign area officers (FAOs) . In addition, variations of TOS for married

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<sup>7</sup> Ibid.

<sup>8</sup> Military Services may go above 36 months. For example, the USAF now has CONUS requirements of 48 months for all airmen and certain categories of officers. Air Force Instruction 36-2110, "Total Force Assignments," October 5, 2018.

<sup>9</sup> DoDI 1315.18, Enclosure 3, 3.a

<sup>10</sup> Ibid, 3.b(1)-(24). While not obviously articulated in DoDI 1315.18, it seems plausible many or all of the same 24 exceptions for CONUS could be applied to OCONUS assignments.

<sup>11</sup> Ibid, 18–22.

<sup>12</sup> Ibid, Enclosure 4, paragraph 1. Military Departments or Combatant Commanders may present evidence of hardships at specific overseas locations that require the tour lengths to be shorter. Enclosure 7.

<sup>13</sup> Memorandum W19012, "Tour Lengths and Tours of Duty Outside the Continental United States (OCONUS), Per Diem," Travel and Transportation Allowance Committee (PDTATAC), Defense Travel Management Offices, revised September 19, 2019.

military couples are included in specific detail. The same section provides voluntary extensions OCONUS, consecutive overseas tours (COTS), and in-place consecutive overseas tours (IPCOT). However, curtailment of OCONUS tours are discouraged.<sup>14</sup>

The policy focus in DoDI 1315.18 for assignments is to set minimum TOS for service members. In general, this instruction has a number of goals, including enhancing unit and service member family stability, improving morale and retention, and offsetting the costs associated with PCSs. The ETPs to DoDI 1315.18 that the Navy obtained seek to increase the maximum OCONUS TOSs—in specific geographic regions—for Service-related needs.<sup>15,16</sup> These Service ETPs increase the maximum TOS for assignments traditionally considered a hardship because service members far away from U.S.-based family and friends.<sup>17</sup>

In terms of data to track the number of DoDI 1315.18 exceptions and waivers for both CONUS and OCONUS TOS requirements, we understand that DoD does not consistently maintain such data. Further, the data available were not of a specific or granular nature to trace to a number of service members who serve less than required TOS due to exceptions or waivers.

We understand from discussions with the Office of the Secretary of Defense, Personnel & Readiness (OSD/P&R) personnel that the Services maintain different internal requirements to systematically capture and maintain such data. DoDI 1315.18 requires the secretaries of the military departments to maintain data on the number of approved policy exceptions for military personnel assignment. However, no specific data formats are required, and the level of specificity or granularity of data is not specified (e.g., specified exception to OCONUS TOS provided for transfer prior to completion of DoD minimum TOS).<sup>18</sup> In addition, the instruction does not require the collection of data for waivers.

We did receive data from OSD/P&R for 2001 through 2014 that we understand were used by the Government Accountability Office (GAO) for a study on costs and policies of

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<sup>14</sup> Ibid, Enclosure 4, 25–38.

<sup>15</sup> The Army obtained the ability, with conditions, to have Soldiers with dependents who decline a 36-month accompanied tour to serve a 36-month tour in an unaccompanied status (June 28, 2019, “Memorandum for Assistant Secretary of the Army for Manpower and Reserve Affairs from OSD/Personnel and Readiness.” The Navy wants certain categories of enlisted personnel assigned to the Forward Deployed Naval Forces (FDFN) Japan, Guam, and Spain to serve a maximum of 48 months.

<sup>16</sup> The Navy’s FDFN ETP seeks to improve training, experience, and overall readiness of the Seventh Fleet. We do not possess documentation on the Army’s justification.

<sup>17</sup> DoDI 1315.18, 35. Policy is to encourage COTS to reduce PCS turbulence (cost). However, the Services may direct involuntary COTs.

<sup>18</sup> DoDI 1315.18, Enclosure 2, paragraph 6, 11.

relocating military personnel (i.e., PCS).<sup>19</sup> As part of the study, the GAO examined Service-level data on TOS because it may be an indicator if PCS cost growth is fueled in part by military personnel serving less than required TOS. Similar to GAO, we found the data to be inadequate—primarily due to the lack of detail (e.g., which exceptions are invoked), and not all the Services provided data for OCONUS. In addition, data for CONUS and OCONUS were missing for several years in the time series.<sup>20</sup>

We did examine data the DMDC maintained to determine whether the desired exception and waiver information was included in personnel records. Unfortunately, we could not locate DMDC databases with the desired data fields. If specific TOS exception and waiver data are systematically included in all individual personnel files, it is highly recommended that the Services capture such data in their personnel databases; if such data are not captured, it is highly recommended that the Services do so.<sup>21</sup> These data would be invaluable in determining the effectiveness of OSD policy regarding military personnel assignments.

## **B. Factors Affecting Tour Lengths and Completion**

Several previous studies CNA conducted (Koopman and Gregory, 2007; McIntosh and Gregory, 2013) have analyzed factors related to tour completion and length. These studies examined completion rates of tours and tour lengths, the factors related to tour completion and length, the reasons for incomplete tours, what factors are related to tour length and completion, and the potential impact of policy changes on tour completion and lengths. The study by Koopman and Gregory (2007) uses data from tours that ended in FY 1994 through FY 2006, while McIntosh and Gregory (2013) extend the analysis to include tours ending in FY 2007 through FY 2011. Because of this overlap, McIntosh and Gregory (2013) compare results from FY 1994 through FY 2006 to those from FY 2007 through FY 2011 to identify similarities and differences. Both studies are similar in that they consider only sea tours of male enlisted personnel.

We also need to define completion. In these analyses, a tour is considered complete if the actual end date of the tour was within 12 months of the assigned end date of the tour with a 6-month window on each side of the assigned end date. For example, if the assigned end date is January 1, 2019, the tour would be considered complete if the actual end date was between July 1, 2018, and July 1, 2019. If the actual end date was before July 1, 2018,

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<sup>19</sup> Government Accountability Office (GAO), “Military Compensation: DoD Needs More Complete and Consistent Data to Assess the Costs and Policies of Relocating Personnel,” GAO-15-713, September 2015.

<sup>20</sup> We do note that any future studies of TOS data (if collected with sufficient granularity) need to account for officer training and development rotation, which will most likely result in TOS falling below requirements.

<sup>21</sup> The terms of the previously referenced ETPs do require the Navy and Army to collect data.

the tour is considered incomplete. If the actual end date was after July 1, 2019, the tour was considered to be an extended one (and hence would be considered complete in regards to the original orders).

### **1. Tour Lengths and Completion Results**

Both Koopman & Gregory (2007) and McIntosh and Gregory (2013) found:

- The majority of first term tours and approximately 40 percent of career sea tours are not completed.
- Increasing tours by 1 year increases time on tour by less than 1 year.

### **2. Factors Related to Tour Lengths and Completion Results**

Both Koopman and Gregory (2007) and McIntosh and Gregory (2013) found:

- Career tours are more likely to be completed or extended than first term sea tours.
- The percentage of incomplete tours increases as the prescribed sea tour lengths increase.

### **3. Reasons and Causes of Incomplete Tours Results**

Both papers were in accord as to the causes of incomplete tours as well, finding:

- Most incomplete first term sea tours are due to Navy losses.
- When excluding incomplete sea tours due to Navy losses, the most common reason for an incomplete sea tour was a reassignment to shore duty.

Overall, the results show that increasing mandatory sea duty is likely not an effective strategy.



## **4. Prior Research on Tour Lengths, Retention, and Readiness**

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Increasing tour lengths is expected to improve readiness by allowing longer unit training. However, increased tour lengths (and accompanying family separation) may possibly lead to lower retention, which could decrease readiness.

The purpose of this chapter is to determine what is currently known about how tour lengths affect retention and readiness. We then develop a simple framework for analyzing the impacts on retention and readiness. This framework is based on and modifies the framework developed by Warner and Horowitz (1991).<sup>22</sup> In this framework, we focus on rotational moves (because they are most affected by policy changes) and on enlisted personnel (because detailed information on enlisted career paths exist). Based on the tour paths prescribed by Naval Administrative messages, we assume that Sailors rotate between sea and shore tours throughout their careers.

### **A. Definition of Retention**

Previous work on retention defined the term in various ways. Broadly, retention refers to the rate at which military personnel voluntarily stay in the military. How this rate is calculated and for whom differs across definitions. A common option is to use the continuation rate broadly defined as the percent of Sailors who continue in the Navy after a certain time. The time used for calculating continuation rates can vary depending on the study. Our definition of retention is the yearly continuation rate. For example, the 2010 continuation rate is the percentage of personnel in the Navy in 2010 who are also in the Navy in 2011. We chose this definition because it can be used for both enlisted personnel and officers. In addition, this definition requires information that is not available in the DMDC, such as the projected rotation date.

### **B. Definition of Readiness**

Readiness is a complex concept with various aspects, making it difficult to define and measure. As a result, a variety of definitions and measures of readiness exist because the term can be used in different ways and at different levels in the military hierarchy (c.f., Rumbaugh, 2017). We generally use the definition of readiness from the Department of

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<sup>22</sup> John T. Warner and Stanley A. Horowitz, *Geographic Movement of Military Personnel: Issues and Policies*, IDA Paper P-2563 (Alexandria, VA: Institute for Defense Analyses, October 1991).

Defense: “the capability of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it is organized or designed” (Rumbaugh, 2017). This definition is broad and encompasses several types of readiness. To better understand what readiness is and how it is defined and measured, we examine specific types of readiness, how they are related, and the metrics used to measure them.

### C. Types of Readiness

Readiness is often thought of as an output measure that is the result of inputs such as personnel, training, and equipment. Consequently, one way to conceptualize readiness is as a hierarchy of readiness levels as done by Schank et al. (1997) and shown in Figure 6. At the top of the hierarchy is force readiness, which is the ability of the overall force (in this, the Navy) to successfully perform a given mission.

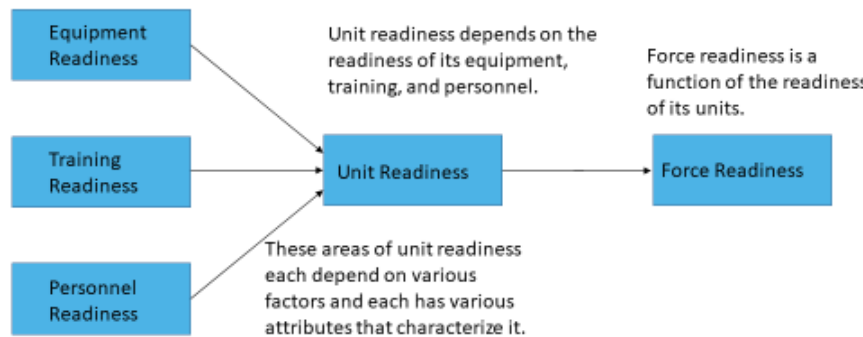


**Figure 6. Area Readiness and Force Readiness**

The Navy consists of separate units, and readiness at the force level requires the units to be ready. Because force readiness depends on unit readiness, unit readiness is an input for force readiness. Unit readiness, defined similarly to force readiness, is the ability of the unit to successfully perform its mission.

Unit readiness is a function of the readiness of personnel, training, and equipment. Personnel readiness refers to readiness of both the individuals in the unit and the collective capabilities of the individuals in a unit to perform a specific mission. Training readiness also concerns personnel as it looks at whether individuals in units have the collective training to successfully perform a given mission. Equipment readiness is defined as the ability of equipment (e.g., weapons systems, aircraft, and ship) to successfully perform a given mission.

## **D. Metrics Used to Evaluate Readiness**

When evaluating specific types of readiness, more than one metric is typically used because each readiness type may have multiple attributes. In the following sections, we identify some metrics used to assess readiness. One common source of these metrics is the classified Defense Readiness Reporting System (DRRS) in which data are collected for four categories of readiness: personnel, equipment on hand, supply maintenance, and training. We combine equipment on hand and supply maintenance into one category called equipment, and focus on personnel and training as they are more likely to be affected by changes in tour length.

### **1. Equipment Readiness**

Equipment readiness metrics evaluate whether units have the supplies and equipment to accomplish their assigned missions. These metrics can be categorized as either assessing the availability of equipment and supplies or the operability of equipment. While it is necessary for units to have equipment available, the equipment must also operate properly and be kept in operation. Operability metrics assess whether units have equipment that is operable and how long it can be kept in operation.

### **2. Training Readiness**

As with equipment readiness, metrics of training readiness are reported to DRRS. These metrics evaluate whether individuals and units have the skills and experiences necessary to accomplish their missions. Following Orlansky et al. (1997), we concentrate on two categories of metrics: accomplishment, which assesses the process phase of training—the extent to which training was completed—and performance, which evaluates the output portion of training—how well the required skills were demonstrated. Accomplishment metrics consist of OPTEMPO measures and whether specific training events have been completed. These metrics are typically objective as they consider whether an event took place and the length of time for training. Performance metrics can be objective (such as bomb miss distance) or subjective, such as quality of landings.

Table 2 provides examples of metrics of accomplishment and performance for training readiness.

**Table 2 Metrics Used for Training Readiness**

| <b>Category</b> | <b>Metric</b>                                                                  |
|-----------------|--------------------------------------------------------------------------------|
| Accomplishment  | Percent training accomplished by primary mission areas (Orlansky et al., 1997) |
|                 | Quarterly flying hours (recent, semi-recent, and career)                       |
|                 | Quarterly days underway                                                        |
| Performance     | Percent of units that are combat ready (Orlansky et al., 1997)                 |
|                 | Boarding rate on carrier                                                       |
|                 | Bombing accuracy on instrumented ranges                                        |
|                 | Operational readiness evaluation score                                         |
|                 | Torpedo attack scores                                                          |
|                 | Switchology errors                                                             |

### **3. Personnel Readiness**

According to Schank et al. (1997), the five attributes of personnel readiness are availability, qualified, experienced, stability, and motivation. Availability is concerned with the percentage of unit personnel available to deploy and thus primarily focuses on the quantity of personnel. In addition to quantity, it is necessary for personnel to possess the skills necessary to successfully perform their jobs. This is typically measured by examining the percentage of unit personnel qualified in their duty skill. To be successful in a mission, it is also necessary to have experienced personnel. The level of experience is the fill percentage of senior grades. The attributes of availability, qualified, and experienced are all related to manning. Unit manning documents specify the number of personnel needed in each rank and rating to perform the unit's wartime mission. In general, the closer actual manning levels are to the needed manning levels, the more likely a unit will be able to perform its mission.

In addition to manning levels, Schank et al. (1997) identify stability and motivation as attributes of personnel readiness. Stability is concerned with turbulence in that stable units have had the same people in the same position for a reasonable amount of time. This stability allows a unit to become more cohesive and work together more efficiently and effectively. Thus, stability is the most likely avenue for tour lengths to influence readiness. The Services also want motivated personnel with a high "taste" for military life and are committed to the military.

Metrics of the first four attributes—availability, qualified, experienced, and stability—are relatively easy to measure and obtain. Motivation, however, is difficult to measure, having no obvious or common metric as it involves measuring something intangible. However, factors that influence motivation have been identified and can be measured. They include physical and mental health, satisfaction with pay, and health care availability. Additionally, factors related to motivation, such as emotional well-being, can

be measured to some extent. In Table 3, we provide potential metrics for four of the five attributes of personnel readiness. These metrics are not exhaustive and are intended to provide an overview of possible metrics.

**Table 3. Metrics Used for Personnel Readiness**

| <b>Attribute</b> | <b>Metrics</b>                                                                                                                                                                                                                                                         |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Availability     | Percent of unit personnel available to deploy (Schank et al., 1997)<br>Average number of personnel on-hand (Morales, 2011)<br>Operating strength deviation (Schank et al., 1997)<br>Unit fill rate<br>Officer fill                                                     |
| Qualified        | Percent of unit personnel qualified in their duty skill (Schank et al., 1997)<br>Rate control number fit (Belcher et al., 2014)<br>Navy enlisted classifications fill (Belcher et al., 2014)<br>Navy enlisted classification fit (Belcher et al., 2014)<br>Officer fit |
| Experienced      | Unit fill rates of senior grades (Schank et al., 1997)<br>Navy enlisted classification fit (Belcher et al., 2014)<br>Officer fit                                                                                                                                       |
| Stability        | Percent of personnel overlap (Schank et al., 1997)                                                                                                                                                                                                                     |
| Motivation       | Difficult to measure; no common metric exists                                                                                                                                                                                                                          |

The metrics to measure availability are fill metrics in that they evaluate whether the inventory of personnel is sufficient given the number of authorized billets. Having an adequate inventory is necessary, but not sufficient, for personnel readiness. This leads to the use of fit metrics, such as those used to assess the attributes of qualified and experienced, which also consider whether inventory is adequate to fill authorized billets based on rank and rating. These metrics can also be calculated at various levels. For example, they could be calculated for the entire Navy or for each unit. These metrics can also be calculated at finer levels such as the fleet level or squadron level and, in the case of Navy enlisted classifications (NECs), only for critical NECs.

## **E. Factors Related to Retention**

A number of previous studies have examined factors related to retention. We categorize each factor into one of three types—personal, military, and economic. As noted in the previous section, stability is an important factor for readiness; thus, retention is likely to influence readiness as well. The purpose of this section is to summarize the literature as it relates to tour lengths.

## **1. Personal Factors**

### **a. Family Status**

Previous studies indicate that family status, such as marital and dependent status, affects retention though the processes through which family has an impact on the retention decision is complex. We find it more useful to consider different groups of Sailors based on their family status. The groups we consider are single Sailors with no dependents, married Sailors (with and without children), single Sailors with children, and dual-military couples.

The reason for differentiating among these groups is that they follow the family life cycle. The first stage of this life cycle is being a single adult, followed by being part of a newly married couple. Under this framework, the next stage is a family with young children and then a family with adolescent children. The final stages include children leaving the home and, finally, senior years. We condense the middle stages of newly married couple through a family with adolescent children because the literature for military retention does not differentiate among these stages but rather considers families in general. We do not consider the last two stages because Sailors in these stages are close to the end of their careers, leading to high retention rates due to retirement vesting. We include two additional stages—dual-military parents and single parents—because Sailors in these groups face unique challenges not adequately captured in the other two groups. The reason for choosing to create groups that follow the family life cycle is that factors affecting retention decisions depend on the stage of the family cycle.

#### **1) Single Sailors without Dependents**

According to a 2016 report from Military OneSource,<sup>23</sup> 43.9 percent of active duty Navy personnel were single and did not have children. Previous research found that unmarried military members had lower retention rates (e.g., Mackin, Hogan, and Mairs, 1993). One reason for this is that many single Sailors without dependents are young and have few years of service, and both factors are associated with lower retention rates. Orthner (1990) also explained that single military members were more sensitive to job and economic factors. Because of this, single military members may believe they are economically better off in the civilian sector and thus more likely to leave the military.

#### **2) Married Sailors with and without Children**

According to the same Military OneSource report, 48.9 percent of enlisted personnel and 66.4 percent of officers have spouses and/or dependents. Specifically, 14.5 percent of

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<sup>23</sup> <https://download.militaryonesource.mil/12038/MOS/Reports/2016-Demographics-Report.pdf>.

enlisted personnel and officers were married to civilians but had no children, while 31.4 percent were married to a civilian and had children.

It has been well documented that families have a major impact on retention, with married service members being more committed to the military, and that spousal support is a major factor in retention intentions.<sup>24,25</sup> Several previous studies on retention intentions noted that marital problems and spousal attitudes and support were the strongest predictors of intentions to stay or leave the military (NASEM, 2019). Not surprisingly, the more a spouse supports staying in the military, the more likely a service member is to stay (Etheridge, 1989). According to a study by the Office of People Analytics (Campbell et al., 2017), 93 percent of active duty personnel whose spouses strongly favor staying in the military do remain, while only 44 percent stay if their spouse strongly favors leaving.

For both active duty service members and their spouses, time spent away from family is the top family concern (Blue Ribbon Families (BRF), 2019). Time spent away from family includes deployments, training, days underway, and other instances where the service member is away from home. Of particular concern is the impact of deployment on children. For those military families recently experiencing a deployment, the majority noted their child(ren) had experienced difficulties such as anxiety, sleep problems, and behavioral issues.

Financial issues and stress are also major concerns and stressors for military families. Though the military provides steady pay and benefits, some families still struggle financially. According to BRF (2019), financial issues and stress are the top military stressors for military families. This study found a majority of respondents (70 percent) report that having two incomes is necessary for their family's well-being, and that military families report higher rates of difficulty in making ends meet compared to civilian families (13 percent compared to 7 percent).

Military families also cite frequent relocations as a source of stress. Socially, relocating involves leaving the current support network of friends and family and having to reestablish a support network in a new location. This, along with stresses that arise from adjusting to a new location, places strain on families and can lead to feelings of isolation, especially for spouses. Families may also face financial stress from moving. Though the military does cover the cost of PCS moves, families may have costs that are not reimbursed. According to BRF, 31 percent of military families had \$1,000 or more in unreimbursed expenses associated with their last move. Further, military spouses cite frequent relocations

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<sup>24</sup> National Academies of Sciences, Engineering, and Medicine, "Strengthening the Military Family Readiness System for a Changing American Society," *National Academies Press*, 2019.

<sup>25</sup> Office of People Analytics (OPA), Defense Research, Surveys, and Statistics Center, "Spousal Support to Stay as a Predictor of Actual Retention Behavior: A Logistic Regression Analysis," Survey Note 9, 2017.

as the cause of spousal under- and unemployment. Research also indicates that several PCS moves are associated with higher rates of under- and unemployment.

The aforementioned concerns and stressors are not exhaustive, though they do represent those most frequently cited by active duty service members and their spouses. Other potential concerns are the availability and affordability of housing, ability to obtain timely medical appointments, availability and affordability of on-installation child care, and quality of children's education.

### **3) Single Parents**

According to military policy, single custodial parents, in general, are not eligible to enlist in the Armed Forces without a custody transfer of children, though policies differ among the Services. The reason for this policy is that it is too difficult to balance full-time parental duties as a single parent and commit fully to the military due to the long and non-standard work hours, deployments, and the possibility of unaccompanied tours. However, there are exceptions to this policy. For example, starting in 2018, the Navy instituted a program allowing single parents to apply for a dependency waiver with the policy set to expire on October 1, 2020. To be eligible, applicants for the program must score 50 or higher on the AFQT, qualify for critical ratings or programs, and complete a Family Care Plan.<sup>26</sup> More common is that Sailors become single parents while in the military due to various reasons such as divorce, death, or adoption. In these situations, military members are allowed to remain in the military if they have an approved Family Care Plan.

Given this policy, it is not surprising that the number of single parents in the military is relatively small. According to the Military OneSource report cited earlier, in 2016 4.3 percent of all active duty personnel were single parents with the same percentage of active duty Navy personnel being single parents. In contrast to their civilian counterparts, where most single parents are women, the majority of single military parents are men due to the large number of men in the military. However, a larger percentage of women in the military are single parents compared to the percentage of men in the military.

Though the stresses faced by single parents would suggest lower retention rates for this group, Schumm et al. (1986)<sup>27</sup> did not find evidence to support this. Using data from an Army Family Research Program survey, the authors found single parents had an 80 percent or greater chance of reenlisting. This rate is similar to enlisted personnel with preschool or older children, and officers with no children, preschool age children, and older

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<sup>26</sup> <https://www.navycs.com/blogs/2018/10/02/enlisting-unmarried-applicants-w-custody-to-active-duty>.

<sup>27</sup> Walter R. Schumm, Rose E. Rice, D. Bruce Bell, and Michelle MV Perez, "Trends in Single Parenting in the U.S. Army," *Psychological Reports* 78, no. 3 (1996): 1311–1328.

children. The only noticeable difference is that enlisted personnel with no children were less likely to have favorable retention intentions.

#### **4) Dual-Military Career Couples**

According to the Military One Source report cited above,<sup>28</sup> in 2016 approximately 5.9 percent of active duty Navy members were in dual-military marriages with the percentage of females in a dual-military marriage (16.6 percent) higher than the percentage of males (3.6 percent). Previous research (Long, 2010)<sup>29</sup> shows that dual-military career couples are retained at lower rates than either single personnel or those married to a civilian, with retention rates being lower for women in dual-military marriages than for men. Though dual-military career couples face many of the same stressors as other couples, such as parenting and separation stressors, these stressors may affect dual-military parents differently.

The top stressor for dual-military career couples is parenting issues, especially child care. While the presence of children is a motivator for remaining in the military for those married to a civilian, this is less of a motivator for dual-military parents and may stem from childcare issues. A 2006 RAND study<sup>30</sup> found childcare issues have the most negative impact on dual-military parents.

Dual-military parents face additional stresses from separation due to deployments. According to Long (2010), in 1995 military members spent about 15 to 20 percent of their time away from their families, while dual-military couples spent about 33 percent of their time apart. Since this time, PERSTEMPO has increased so that these values may be even higher. Though the number and duration of deployments tend to be positively related to military satisfaction, dual-military parents find the amount of time apart unacceptable, thereby hurting retention.

PCS moves can be especially stressful for dual-military couples as they may increase the amount of time couples are apart. Though the services attempt to collocate spouses, this is not always possible. This leads to more time apart compared to military members with a civilian spouse, thus reducing satisfaction and hurting retention. Alternatively, spouses may be collocated at an undesirable location, which negatively affects retention.

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<sup>28</sup> <https://download.militaryonesource.mil/12038/MOS/Reports/2016-Demographics-Report.pdf>.

<sup>29</sup> Valarie A. Long, "Retention and the Dual-Military Couple: Implications for Military Readiness," *Attitudes Aren't Free* (2010): 349.

<sup>30</sup> Joy S. Moini, Gail Zellman, and Susan M. Gates, *Providing Child Care to Military Families: The Role of the Demand Formula in Defining Need and Informing Policy*, Vol. 387, Rand Corporation, 2006.

### **b. Taste for Service**

A common feature in several retention models is an unobserved taste for service. These models assume that when making retention decisions, the preferences of personnel matter in addition to other factors such as pay and working conditions. Underlying this factor is the belief that individuals compare their preferences for civilian life to military life, and thus the taste factor is interpreted as the net preference for civilian life. Geographic stability may play a role in taste factors; thus, tour length policy may influence this factor. A negative taste factor indicates a stronger preference for the military compared to the civilian sector, while a positive value indicates the opposite. The inclusion of this factor is intended to explain how two individuals with the same characteristics can make different retention decisions. What differentiates them is considered to be their tastes and preferences for the military and civilian sectors. Because of this, those with stronger preferences or tastes for the military are expected to stay in the military longer than those with a relative distaste for military service, as those individuals are expected to leave early. Consequently, as years of service increase, we expect stronger tastes for military service and higher retention rates. Despite the importance of a taste factor in the retention process, this factor is difficult to measure and is included as an unobserved random variable in retention models.

### **c. Other Factors**

Previous studies have found gender, education level, race, and ethnicity to affect retention. Retention rates are lower for women than for men (MLDC, 2010; Dichter and True, 2014<sup>31</sup>), and women have shorter service periods than men (Dichter and True, 2014). Previous research indicates the reenlistment rates of high-quality personnel tend to be higher than those of lower quality personnel. A 2007 RAND report<sup>32</sup> provides two potential reasons. The first is that high-quality recruits tend to move more quickly through the initial listed ranks, a trend associated with higher reenlistment rates. Second, the reenlistment process favors those of higher quality. However, our search of the literature did not yield differential results connected to tour lengths.

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<sup>31</sup> M. E. Dichter and G. True, "This Is the Story of Why My Military Career Ended Before It Should Have: Premature Separation from Military Service among U.S. Women Veterans," *Affilia: Journal of Women and Social Work*, 30(2): 187–199.

<sup>32</sup> [https://www.rand.org/content/dam/rand/pubs/research\\_briefs/2007/RB2002.pdf](https://www.rand.org/content/dam/rand/pubs/research_briefs/2007/RB2002.pdf).

## **2. Military Factors**

### **a. Rank (Enlisted Personnel versus Officers)**

In previous studies, either separate analyses were conducted for enlisted personnel and officers or the study was restricted to one of the two groups. This is because retention rates differ between the two groups. Additionally, the effects of certain factors on retention may differ between groups leading to separate analyses. As a whole, retention rates are higher for officers than enlisted personnel, though this occurs largely to the comparatively low retention level of junior enlisted personnel. It is somewhat difficult to examine how the impact of certain factors on retention differs between the groups due to differences in methodological approaches in previous studies.

### **b. Rate and Years of Service**

Previous studies typically include rate or years of service in their analyses due to the effect they have on retention. We consider these together as they are closely related. A number of previous studies have noted that retention rates are greater in higher rates and for more years of service (Navy Times, 2020<sup>33</sup>). For enlisted personnel, the retention rate for Zone A Sailors in FY 2019 was 64 percent, while the reenlistment rates for Sailors in Zones B and C were 72 percent and 85 percent, respectively.

### **c. Occupation/Rating**

Retention rates vary by occupation or rating, and occupational group is often included in retention models. However, caution should be used when comparing studies as the occupational groupings differ among studies, although they do have some similarities. In general, previous studies show those in health care and aviation maintenance are more likely to reenlist while those in administration are less likely (Hansen and Wegner, 2005; Lien et al., 2006). An article from *Navy Times* also notes a greater difficulty in retaining personnel among special warfare operators, nuclear operators, and those specializing in cryptologic computer networks due to the excellent civilian job market in these areas.

Previous research also indicates that the impact of certain factors, such as incentive pay, varies by occupational group (e.g., Goldberg and Warner, 1982). These effects are greatest for those in administration/logistics, combat, combat support, and service occupational clusters and least for those in the technical and aviation occupational clusters.

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<sup>33</sup> <https://www.navytimes.com/news/your-navy/2020/01/21/here-are-the-latest-navy-retention-numbers/>.

#### **d. Tour Length and Time on Station**

Annually, approximately one-third of military personnel have a permanent change of station (PCS) move, which may involve moving household goods and dependents. Several previous studies have looked at how increasing tour lengths would create potential savings (e.g., GAO, 2015<sup>34</sup>; Grayson and Mireles, 2016<sup>35</sup>), while several others have examined the impact on an individual's retention and readiness (GAO, 2001; Morales, 2011<sup>36</sup>; Warner and Horowitz, 1991<sup>37</sup>).

The 2001 GAO study found a relationship between the length of PCS tours and outcomes related to satisfaction and retention. In this study, which used data from the 1999 Survey of Active Duty Personnel, participants were asked to respond to a number of questions regarding their satisfaction, retention intentions, and military history, such as number of PCS moves. Using information provided, the average tour lengths were calculated by dividing the length of service by the number of PCS moves.

Military members with shorter tours reported lower satisfaction with the frequency of PCS moves, with a noticeable difference between military members with average tours of less than 1 year or between 1 and 2 years between moves having less satisfaction with the frequency of PCS moves.

In the 2001 GAO study, the spouses and significant others of those with average tour lengths of less than 1 year and between 1 and 2 years are more likely to favor the military member leaving compared to those with longer tours. The percent of those with shorter tours that indicate they are likely or very likely to stay in the military is lower than for those with longer average tours.

Morales (2011) conducted a survey of 105 active duty Marines to estimate the impact of PCS moves on several outcomes, including number of promotions. The study found that longer time on station is moderately correlated with PCS-related stress ( $r=0.19$ ).

When examining the impact of time between PCS moves, it is difficult to disentangle the effect of time between PCS moves and other factors. For example, a GAO report (2001)<sup>38</sup> found that unmarried personnel without dependents, lower ranking personnel, and enlisted personnel in combat occupations have the shortest times between PCS moves. Because of this, it is difficult to determine whether it is the shorter tour lengths or other

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<sup>34</sup> <https://www.gao.gov/products/GAO-15-713>.

<sup>35</sup> <https://pdfs.semanticscholar.org/7746/0a088810f95d297d4d4f488e8f281fe6f4dd.pdf>.

<sup>36</sup> Freddy A. Morales, *Analyzing Benefits of Extending the PCS Tempo in the Marine Corps*, (Monterey CA: Naval Postgraduate School, 2011).

<sup>37</sup> John T. Warner and Stanley A. Horowitz, *Geographic Movement of Military Personnel: Issues and Policies*, IDA Paper P-2563 (Alexandria, VA: Institute for Defense Analyses, October 1991).

<sup>38</sup> <https://www.gao.gov/new.items/d01841.pdf>.

factors that are associated with lower satisfaction and retention. For example, it is known that career stage is associated with retention and tour length. Because of this, the lower retention rates observed for shorter tour lengths may be a function of those in lower ranks having shorter tours.

#### **e. Location**

A tour's location can influence the stay/leave decision because longer tours in less desirable locations or in arduous billets have detrimental effects on retention due to decreased morale. Further, location can be a major factor in the satisfaction of a service member's family and is known to affect retention (NASEM, 2019). Previous studies have typically not looked at specific locations but instead have compared broad categories such as CONUS versus OCONUS, an approach that does not provide information on location desirability.

In a study of hard-to-fill billets in the Navy, Christensen et al. (2002) and Golding et al. (2002)<sup>39</sup> used data from the Job Advertisement and Selection System to identify hard-to-fill CONUS shore duty billets that do not have incentives. The authors note that one reason a billet may be hard to fill is its location, which may affect retention. The study uses several measures of location desirability. The first is the number of applications per job as a measure of location desirability, which indicates that the impact of location on continuation rates is negligible for first-term Sailors. For careerists, location has a positive effect so that being placed in a desirable location is related to higher retention rates. In the second analysis, the authors look at whether a Sailor received a preferred billet and found that those who did had higher continuation rates, with a lesser effect for careerists. They note that location is not the only factor that makes a billet hard to fill; other factors include whether the billet is career enhancing.

As with other factors, caution needs to be used when examining the impact of location on retention. One potential issue is that certain locations may be designated as unaccompanied in that dependents are not with the service member. Unaccompanied tours are typically short, and all designated unaccompanied tours are overseas. Both of these factors are also associated with retention such that lower retention rates for those serving in certain locations may be due to the tour being unaccompanied. Further, it may not be the location itself that is undesirable but rather the features of that location such as availability of child care, proximity to family and friends, and opportunities for spousal employment.

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<sup>39</sup> These are technically two separate studies but overlap in that they both look at location desirability on continuation rates as one of their objectives. The same analysis was used for this objective in both papers, making the results the same.

#### **f. Sea Duty**

Within the Navy, Sailors are generally assumed to prefer shore duty over sea duty, as is evident in Navy policies that provide pay for sea duty (e.g., sea pay) to reduce turnover stemming from long sea duty. Several previous studies examined the impact of sea duty on retention and tended to focus on first-term reenlistment. In general, increased sea duty is associated with reduced retention.

Warner and Goldberg (1984)<sup>40</sup> examined the impact of sea duty on first term reenlistment rates and found that as the fraction of time spent in sea duty increased, reenlistment rates decreased. The authors estimated that when the fraction of time (measured from 0 to 1) spent in sea duty increased by 0.1, the reenlistment rate decreased by 0.016. In other words, if the amount of sea duty increased by 10 percentage points, the retention rate would decrease by 1.6 percentage points.

In a similar study on the impact of sea duty on first term reenlistment, Lien et al. (2006) found a positive relationship between the amount of sea duty during the first term and first term reenlistment. The authors explained that this finding likely reflects the expectation that if Sailors had relatively frequent sea duty in the first-term, they anticipate experiencing less sea duty in the second term. This reflects a view among Sailors that first term sea duty is a proxy for second term expectations. In a second analysis using Sailors' expected time spent on sea duty during the second term, the authors find that sea duty negatively impacts reenlistment with the effect being larger for those with shorter initial terms of service.

This study notes that though sea duty has a negative effect on reenlistment, this outcome is easily remedied through bonuses and incentives. Based on the authors' results, if the time spent on sea duty increases by 10 percent, a 2 percent increase in pay is needed to compensate for the negative effects of increased sea duty.

#### **g. Deployments, OPTEMPO, and PERSTEMPO**

Several previous studies have investigated the impact of the number and length of deployments on retention, OPTEMPO (the pace of operations measured at the unit level), and PERSTEMPO (the amount of time an individual spends away from the home station). Though the three are separate concepts, we consider them together as they all relate to the tempo of operations. In general, it is assumed that high levels of OPTEMPO and PERSTEMPO and frequent deployments are associated with decreased retention rates.

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<sup>40</sup> John T. Warner and Matthew S. Goldberg, "The Influence of Non-pecuniary Factors on Labor Supply: The Case of Navy Enlisted Personnel," *The Review of Economics and Statistics*, MIT Press 66(1) (1984): 26–35.

Due to decreasing force size, the number and length of deployments is increasing. Though it is often hypothesized that more frequent deployments negatively affects retention, previous studies (e.g., Hosek and Totten, 1998; RAND, 2003<sup>41</sup>) have generally found a positive relationship between deployment or OPTEMPO and retention. A 2003 RAND study found that for enlisted personnel in their first term, the retention rate increases as the number of non-hostile deployments increase, and that retention rates barely differ as the number of hostile deployments increase. For those in their second term, retention rates are higher for those who had at least one deployment compared to those who had not been deployed. Similar results were found for officers in that deployments positively affect retention. Differences were observed in the effects of hostile deployments on retention. For junior officers, hostile deployments had a positive impact on retention, while for midgrade officers the effect was less. One reason is that deployments may create a greater sense of integration into the Navy, a factor that positively influences retention decisions (NASEM, 2019).

The 2003 RAND study also examined the impact of deployment length on retention for first term enlisted personnel and found the impact of length varied across services. For the Army, longer deployments were associated with higher retention rates; for the other three services, longer deployments were associated with decreased retention.

A study by Huffman et al. (2009)<sup>42</sup> considered the relationship between OPTEMPO (which included PERSTEMPO) and found that previous studies produced inconsistent results regarding the relationship between OPTEMPO and retention. These differences largely stem from differences in definitions of OPTEMPO and how OPTEMPO is measured and did not control for key variables. The Huffman study also found a curvilinear relationship between TDY and turnover and between work hours and turnover such that as the number of TDY assignments or work hours increases retention rates at a decreasing rate. This study found no relationship between days in training exercises and retention and between the number of deployments and retention.

For several reasons, a positive relationship may exist between deployments or OPTEMPO and retention. One reason is that deployments and OPTEMPO may be beneficial to career progression. During deployments, training, and schooling, Sailors are able to enhance their skills, allowing for quicker career progression, which is associated with higher retention. Another reason is that Sailors may enjoy the fast pace of operations or deploying for training, which could be due to a taste for service.

Caution should be taken when generalizing a positive relationship between deployments or OPTEMPO and retention as this does not hold for all groups or for all

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<sup>41</sup> [https://www.rand.org/pubs/research\\_briefs/RB7557/index1.html](https://www.rand.org/pubs/research_briefs/RB7557/index1.html).

<sup>42</sup> [https://www.tandfonline.com/doi/full/10.1207/s15327876mp1703\\_4](https://www.tandfonline.com/doi/full/10.1207/s15327876mp1703_4).

studies. High OPTEMPO is often cited as a reason for intending to leave the military as high OPTEMPO leads to excessive time away from families. Ultimately, the impact of high OPTEMPO depends on other factors.

#### **h. Pay and Incentives**

Military pay, including base pay, Basic Allowance for Subsistence, and Basic Allowance for Housing, is positively related to retention. To examine the impact of military pay on retention, elasticities are typically calculated that measure the sensitivity of retention rates to changes in military pay. Typically, pay elasticities are the ratio of the percentage change in the retention rate to the percent change in pay. A value of 1.5 indicates that a 1 percent increase in military pay is associated with an increase in retention of 1.5 percent. Goldberg (2001) summarized results of previous studies that calculate pay elasticities and found the range of estimated elasticities to be fairly wide, from 0.2 to 3.8. The reasons for such a wide range were that different outcomes were used (for example, reenlistment or total retention), pay was calculated in different ways, and studies looked at different groups such as those in their first term or enlisted personnel. When examining studies that look at elasticity estimates with regard to military pay only, elasticities estimates typically ranged from 1.2 to 2.2, indicating military members are responsive to changes in pay.

Incentives are a frequently used retention tool in the military. One set of incentives frequently used for retention are Selective Reenlistment Bonuses (SRBs). These are cash incentives given to enlisted personnel with critical skills to reenlist or stay in the military. The amount of an SRB varies based on the needs of the Navy and the difficulty in filling a position. In general, those in nuclear ratings are eligible for the highest SRBs. Previous research (e.g., Goldberg and Warner, 1982; Hosek and Peterson) indicates that SRBs are associated with higher reenlistment rates. These findings suggest that military members are slightly more responsive to incentive pay than military pay, perhaps because SRBs are more targeted to those likely to be influenced.

Several other special and incentive payments are part of military compensation, many of which are for retention. Aside from the SRB, special pay for retention is for specific occupations or critical skills. More common special payments not intended for retention are hardship duty pay (paid to those in OCONUS locations in hardship locations), assignment incentive pay (used to compensate military members for unusual or extended assignments), and hazardous duty pay and imminent danger pay (given to those performing hazardous duties or serving in combat zones). In addition, this pay is subject to the Combat Zone Tax Exclusion, and recipients do not owe federal income tax on military pay received while in the combat zone. Previous research acknowledges this incentive pay but, with the exception of SRBs, it has not been thoroughly researched regarding its impact on retention.

### **i. Readiness**

Readiness, which will be discussed in more detail in the following section, affects retention decisions of personnel. Activities such as training exercises, flying hours, and ship-steaming days not only produce readiness, they also serve as a retention tool. Low or reduced readiness levels have negative effects on morale and job satisfaction, which in turn hinders retention. An example of this is fighter pilots in the Air Force. The Air Force currently faces a shortage of fighter pilots, possibly due to issues with readiness (Panetta et al., 2017). Due to reductions in flying hours, fighter pilots are opting to leave the Service. Low levels of readiness also affect retention by reducing unit cohesion. When service members cannot develop or further develop critical skills, their confidence in successfully completing missions decreases, negatively affecting unit cohesion (Panetta et al., 2017).

## **3. Economic Factors**

### **a. Civilian Unemployment Rate**

The state of the civilian economy is assumed to influence retention decisions and has been included as a predictor in several previous studies and retention models (c.f., Mackin, Hogan, and Mairs, 1993; Warner and Goldberg, 1984). Consistent with economic theory, previous studies typically find that if the conditions in the civilian economy are poor or perceived to be poor, a Sailor is more likely to choose to stay in the military, while a strong civilian economy is associated with lower retention rates.

The unemployment rate is frequently used to measure civilian economic conditions. When civilian unemployment rates are high, job prospects in the civilian sector are lower, leading to the payoff for staying in the military being higher than the payoff for leaving. The converse holds true when civilian unemployment rates are low. Using data from FY 1990 through FY 2005, a study by Simon et al. (2010)<sup>43</sup> found that a 1 percentage point increase in the civilian unemployment rate is associated with increases in Army first term retention of 0.5 percentage points, Navy retention of 0.8 percentage points, Air Force retention of 0.9 percentage points, and Marine Corps retention of 0.7 percentage points. These estimates are fairly modest and may be due to other factors considered in the analysis; specifically fiscal year, which likely captures some of the effects of unemployment.

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<sup>43</sup> Curtis J. Simon, Sebastian Negrusa, and John T. Warner, "Educational Benefits and Military Service: an Analysis of Enlistment, Reenlistment, and Veterans' Benefit Usage 1991–2005," *Economic Inquiry* 48, no. 4 (2010): 1008–1031.

### **b. Civilian Wages**

Civilian wages are also an important aspect of the civilian economy that influence retention decisions and are included in the most common models of retention (c.f., Gotz and McCall, 1984; Warner, 1979). Under these models, military members making the stay-leave decision are assumed to compare civilian wages to military compensation. These models posit that as civilian wages increase relative to military compensation, retention rates decrease, while lower civilian wages compared to military compensation increase retention. Results from previous studies (e.g., Enns, Nelson, and Warner, 1984; Goldberg and Warner, 1984) are consistent with this hypothesis. In these previous studies, retention models were typically used to examine the impact of changing military compensations, such as increasing SRBs or a change to the retirement system. Results are expressed as pay elasticities.

## **F. Factors Related to Readiness**

In comparison to the literature on retention, far fewer studies have been conducted on the factors related to readiness. Potential reasons for this are that readiness can be defined in various ways, and appropriate data on measures of readiness are less available and are often classified or treated as sensitive.

The metrics used in previous studies vary. In the studies that examine the relationship between military factors and readiness, the metrics are measured at the individual or group level where groups could be crews, ships, or units. Metrics used in these studies include both input and output measures such as team effectiveness and trust, time free of serious failures, maintenance backlogs, and crew stability.

### **1. Personal Factors**

#### **a. Family Status**

In comparison to the literature on the relationship between family and retention, the literature on the relationship between family and readiness is rather sparse. Despite the lack of research in this area, the military has long acknowledged that families affect readiness as Sailors have attrited, gone AWOL, or performed poorly due to concerns about their families. When examining how family affects readiness, we consider that a service member's family situation will likely affect his/her behavior and commitment and, thus, individual performance and group or unit readiness (Vernez and Zellman, 1987).

Previous research has found that families and their dynamics contribute to readiness in several ways. Kirkland and Katz (1989) indicate three aspects of readiness through family dynamics: presence or availability for duty, commitment to outstanding duty performance, and ability to focus on mission requirements without distraction due to family

worries. Family problems and concerns are frequently a source of stress, which in turn can have negative impacts on readiness. When broadly considering stress, Schumm et al. (2001) found that higher levels of stress in service members' family and personal lives is associated with lower self-reported levels of readiness. Potential stressors include those faced by both military and civilian families such as health of family members, relationships between family members, and stressors unique to the military. Military stressors include long and unpredictable work hours, frequent separations from family, frequent relocations, and relocations to international and to undesirable locations. Drummet et al. (2003) provide a thorough discussion of how separation and relocation affect families. Overall, these stresses can have negative impacts on readiness by hindering a Sailor's ability to participate in training exercises or perform in combat (Schneider and Martin, 1994), both of which reduce readiness.

Children are often a source of stress for service members and their spouses. These stresses may be similar to the ones civilian families face such as the availability of child care or stresses related to being in a military family. These may include concerns about how relocation affects children's academic achievement, the effects of frequent separations and deployments on children's emotional and physical health, and finding child care on short notice. In a comprehensive review of family factors and their relationships to retention and readiness, Vernez and Zellman (1987) found that only one family factor was found in the readiness literature. This factor was a negative relationship between the number of children and readiness. A study of Army personnel by Burnam et al. (1992) provides a potential reason for this relationship. Married Soldiers with accompanying children take more time off duty, have greater frequency of being late or missing an alert, and leave a deployment early more often compared to married personnel with unaccompanying children or without children. Single parents with accompanying children have even higher absence rates, which may be due to childcare issues.

Stress can also stem from a service member's relationship with his/her spouse or significant other. Stresses may arise from relocation, including the loss of spousal employment or disruption of career development, relationship maintenance during separations and deployments, and challenges that arise upon the return of a service member after separation or deployment (Drummet et al., 2003). Burman et al. (1992) found that marriage has a complex relationship with readiness such that married Soldiers have lower availability for duty and are more likely to take days off duty due to personal or family reasons. On the other hand, married Soldiers have fewer job-related problems and exhibit a higher level of commitment to the military.

Though family problems and concerns can be a major source of stress that impedes readiness, families can also enhance readiness by providing support to service members and by mitigating the effects of stressful events such as deployment. This support may be in the form of emotional support, support of the military, and care for wounded, injured, or

ill service members. A major source of support is military spouses. Several previous studies have focused on the relationship between spouses and have found that higher levels of marital satisfaction, a measure of spousal support, are associated with increased readiness. Burman et al. (1992) found that higher levels of marital satisfaction are associated with fewer job-related problems. A study of deployed Army Soldiers by Carter et al. (2015) found that marital satisfaction is inversely correlated with negative spillover (a measure of how much spousal conflict interferes with work functioning) such that higher levels of marital satisfaction were associated with lower levels of negative spillover.

While single parents and dual-military couples face many of the same stressors as other military families, these stressors may be more troublesome for these families who also face unique stressors affecting readiness. Burman et al. (1992) found that dual-military couples have a higher rate of job-related problems and are more likely to miss an alert, while single parents are more likely to be late for alerts or deployments. One reason may be the availability of child care. Finding child care is a frequent source of stress for these families, especially during deployments. Stress due to finances is more common among single-parent families.

#### **b. Physical and Mental Health**

Mental and physical health are both considered a central part of the military and an important component of the well-being and readiness of service members and their families. The physical and mental health of service members have been found to have an impact on readiness. We first examine the relationship between mental health and readiness and then between physical health and readiness as they impact readiness differently.

The mental health of service members is of concern to the military due to the negative effects that poor mental health may have on readiness. Previous studies have found that poor mental health is related to outcomes that decrease readiness. Burman et al. (1992) found that emotional well-being and the absence of depression are associated with fewer job-related problems, absences from alerts or deployments, and greater commitment to the military. Those with depression have more time off duty. Hourani et al. (2006) found that military personnel with mental health problems were more likely to experience lower job productivity including being late for work, leaving work early, being hurt in an accident on the job, working below normal levels of performance, and being absent from work. Despite many factors that may affect mental health, stress frequently has been identified as having a major and negative effect on mental health. Stress can come from multiple sources, and due to the demanding nature of both the military and the family, occupational and family stress are commonly faced by service members. A study by Hourani et al. (2006) found that military personnel with higher levels of stress have higher rates of mental health problems. In addition, this study found that service members reported higher levels of stress

at work than in their families, suggesting work stress has a greater impact on mental health than family stress.

Physical health is an essential component of readiness, as successful military operations require high levels of physical fitness (Knapik et al., 2009). Poor physical fitness reduces personal readiness by inhibiting the ability of service members to perform their duties and possibly rendering them ineligible for deployment. In addition, financial repercussions include healthcare and disability costs. Conversely, good physical fitness not only allows service members to perform their duties, it also reduces the risk of injury and illness while enhancing resilience to the operational stressors service members face in combat (Szivak and Kraemer, 2015).

### **c. Individual Characteristics**

Unlike research on retention, little research exists on how many of the demographic characteristics we previously considered, such as race and gender, are related to readiness. The study by Burman et al. (1992) examined the relationship between readiness and several individual characteristics such as age, race, gender, educational level, and income level. In general, most of these individual characteristics were not related to readiness, although there were several exceptions. Gender is related to readiness though the results are mixed. Compared to females, males have more job-related problems but less time off duty. Education is also related to readiness as those with higher educational levels are less likely to have time off duty.

## **2. Military Factors**

### **a. Tour Lengths/Time on Station**

Economic theory of human capital suggests that as experience in doing a job or task increases, productivity increases at a decreasing rate. When changing jobs, productivity may decrease due to a learning period to acquire new skills. In contrast, if skills are fully transferable, productivity is not affected. Warner and Horowitz (1991) consider each assignment or billet as a different job and contend that the extent to which skills are assignment-specific or are transferable will determine the impact on productivity. When skills are assignment-specific, individual performance diminishes with frequent moves that ultimately decrease overall military effectiveness. Compounding this are accountability incentives—more frequent moves diminish the accountability of current actions and decisions. Warner and Horowitz (1991) note exceptions where longer assignments may not improve productivity. In addition, long assignments in arduous duty jobs or at undesirable locations can decrease productivity due to the nature of these assignments.

Warner and Horowitz (1991) also contend that frequent moves diminish readiness as the military is team-oriented. Frequent moves lead to diminished teamwork and require

more time to orient and supervise new unit members. Warner and Horowitz (1991) summarized several previous studies and found a negative relationship between personnel turnover and readiness. Other studies have also found evidence that time on station (TOS) is related to readiness. In a study on the readiness of Navy destroyers, the authors (Quester, Beland, and Mulligan, 1989) found that a 1 percent decrease in the new crew rate in the quarter prior to a deployment increased the probability the ship was ready at deployment by 0.02. In addition, turnover in higher grades (E-5 and above) had a larger impact on readiness than the turnover of lower grades. A second study on Army tank crews by Scribner, Smith, and Baldwin (1984) found that doubling the time the tank crew commander and gunner had been with the crew increased the tank's test score on a standardized test range by 4 percent. A third study by Morales (2011) found that time spent at an assignment was positively related to team effectiveness and team trust in that longer time on assignment was related to increased effectiveness and trust.

Warner and Horowitz (1991) raise the possibility of a trade-off in readiness in the short term to increase readiness in the long term under certain circumstances. Many services frequently rotate officers in the belief that doing so improves long-run effectiveness, though it detracts from individual and unit performance in the short term. Specifically, frequent rotations provide more information to promotion boards allowing them to make better promotion decisions. Additionally, frequent rotations provide a larger pool of officers trained for command, which may enhance wartime capabilities.

#### **b. Deployments, OPTEMPO, and PERSTEMPO**

As was done when considering retention, we combine deployments, OPTEMPO, and PERSTEMPO into one category referred to as tempo. The relationship between tempo and readiness is thought to be quadratic (Panetta et al., 2017). As tempo initially increases, individual and unit readiness increases as this allows Sailors to use and further develop their skills. Readiness then is expected to increase at a decreasing rate as tempo increases until it reaches a maximum. After this point, increasing tempo—by increasing crew overwork—decreases readiness by decreasing morale, opportunities for training, and ship maintenance.

Over the past 2 decades, the U.S. military has been engaged in a high tempo rate due to the war on terror, disaster relief missions, operations in several African nations, and the Ebola epidemic, to name a few. During this same time, the size of the Navy's surface fleet has decreased by 11 percent, leading to ships being unavailable for maintenance and crews not receiving training (CSIS, 2018). Without proper maintenance and training, readiness suffers. A 2018 GAO study found evidence of this when examining ships homeported overseas. This study found that due to high OPTEMPO, the Navy assigned more ships to homeport overseas with the number of ships homeported overseas doubling from 2006 to

2018. Ships homeported overseas have higher OPTEMPO, which limits training and maintenance, making it difficult for crews to be fully trained and ships to be maintained.

### **c. Manning**

Manning is directly related to readiness levels and affects readiness in several ways. In general, undermanning is associated with decreased levels of readiness. One reason for this is that ships that are undermanned are not fully mission capable. Because of this, ships may be unable to complete their missions, which is necessary for readiness (Beland and Quester, 1991). Undermanning also affects the training of personnel. Without an adequate personnel inventory, sailors may not receive needed training or be able to participate in exercises that enhance readiness. Further, undermanning leads to overwork, which decreases readiness and increases safety risks. Due to having fewer sailors maintaining and operating ships, sailors must compensate by working more hours. Overwork diminishes a crew's capabilities to perform tasks and ship maintenance, leading to decreased material ship condition. Safety issues arise as crews may reduce sleep time due to their workload, resulting in safety risks. (GAO, 2018).

Studies by Beland and Quester (1991) and Quester et al. (1989) using data from frigates and destroyers over a 5-year period found that manning is related to readiness. Increasing the ratio of a ship's enlisted manning level to its manning requirements increases the time a ship is free of serious failures.

A 2017 GAO study investigated outcomes during a Navy initiative from 2004 through 2012 to decrease crew sizes to reduce costs. During this initiative, the material condition of ships eroded while maintenance costs increased, and these were not offset by reduced personnel costs. Reduced manning also led to other negative outcomes such as increased maintenance backlogs and casualty reports. The workload increased from 67 to 70 hours of productive work per week. The 2017 GAO study found the increased workload caused by reduced manning may have reduced readiness and created safety risks.

### **d. Cohesion**

Unit cohesion, defined as "as a sense of group integration and personal bonding among military service members" (Martin et al., 2000),<sup>44</sup> has been identified as an important factor in readiness in terms of both combat effectiveness and performance (Griffith, 2002). Research suggests cohesion directly affects individual and group readiness. For individuals, cohesion leads to a sense of belonging and social support, which enhance individual well-being. At the group level, cohesion positively affects group

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<sup>44</sup> Lee Martin, Leora N. Rosen, Doris B. Durand, Kathryn H. Knudson, and Robert H. Stretch, "Psychological and Physical Health Effects of Sexual Assaults and Nonsexual Traumas among Male and Female United States Army Soldiers," *Behavioral Medicine* 26, no. 1 (2000): 23–33.

processes such as communication, decision making, and performance. Greater cohesion can also moderate the negative effects of stress on individual well-being and performance by reducing the impacts of stress on these outcomes.

According to Siebold (2007), the standard model of military group cohesion has four components based on four relationship types: (1) peer relationships regarding bonding between members on the same level of military hierarchy such as squadron members; (2) leader relationships between those at different levels of the military hierarchy such as between platoon members and platoon leaders; (3) organizational relationships between personnel and the next higher organizations such as companies; and (4) the institutional relationship between personnel and their military branch. Each type of bonding has two aspects: affective, which is the emotional part of bonding; and instrumental, or the action part of bonding. Primary group cohesion is concerned with the first two components and assesses the trust among group members and the ability to work together as a team. This type of cohesion is generally associated with performance such as combat readiness. Secondary group cohesion exists with strong trust in the organization or institution and is associated with outcomes such as retention, behavior, and attitudes toward military service.

Multiple measures of cohesion exist due to its different components. These measures may be subjective or objective. Subjective measures are typically obtained from survey data from individuals by rating items on a Likert scale. Previous studies have linked subjective cohesion measures to positive readiness outcomes. For example, a study by Griffith (2002) found higher levels of cohesion are associated with higher perceived levels of individual and group combat readiness. Further, a meta-analysis by Oliver et al. (1999) of 39 studies found a moderate effect size of about 0.3 for cohesion on readiness.

Objective measures of cohesion tend to focus on crew stability. The reasoning for this is that the longer members of a unit (or a subgroup such as a squadron) are together, they share more common experiences and opportunities for developing trust. Crew stability can be measured in several ways such as the percent of a crew new to a ship during a given time frame, the percent of a unit's personnel who continue from one time period to the next, and crew retention. Regardless of the measure, cohesion is associated with positive outcomes. For example, a study by Beland and Quester (1991) found that a 1 standard deviation increase (equal to 34 percent) in the percent of enlisted crew new to a ship during the current quarter is associated with a reduction in the percentage of time a ship has no serious failures by approximately 4 percentage points.

## **G. Summary**

This literature review covered changes in tour lengths and factors affecting retention and readiness. We found:

- Tour Lengths and Completion

- The percentage of incomplete tours is higher for first term tours than career tours.
- Longer sea tours lead to more incomplete sea tours – for example, increasing a tour from 3 years to 4 years increases actual tour length by approximately 2 months.
- Retention
  - Family factors and demographics play a large role in retention.
  - Longer tours and tours in desirable locations positively affect retention.
  - A curvilinear relationship exists between deployment, OPTEMPO, and PERSTEMPO: i.e., retention increases at a decreasing rate and then decreases.
- Readiness
  - Family plays a large role in Service Member individual) readiness.
  - Group cohesion has a positive impact on readiness as most activities are team-based.
  - More frequent moves typically reduce readiness.
  - Mental and physical readiness play a role in individual and unit readiness.



## 5. Model

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In this chapter, we develop the conceptual model that incorporates what we learned from the literature and extends it to include tour length. We model the rotation of sailors from sea to shore, and allow for changing tour lengths to evaluate the impact on manning levels. This model provides the theoretical foundation for our planned empirical evaluation of the impact of changing tour lengths on retention and readiness.

### A. Notation

Suppose that  $N_{sea}$  sea billets and  $N_{shore}$  shore billets are to be filled. Let  $F_{sea}$  be the number of sailors moving from sea to shore duty and  $F_{shore}$  the number of sailors moving from shore to sea duty. The lengths of the sea and shore tours are denoted by  $t_{sea}$  and  $t_{shore}$ , respectively. If all billets are filled,

$$F_{sea} = N_{sea}/t_{sea} \text{ and } F_{shore} = N_{shore}/t_{shore}$$

indicating the number of billets is inversely related to tour lengths.

### B. Simple Framework

In equilibrium, the number of Sailors moving to and from sea tours are equal such that  $F_{sea} = F_{shore}$  or, equivalently,  $\frac{N_{sea}}{t_{sea}} = \frac{N_{shore}}{t_{shore}}$ . By rearranging,  $N_{sea} = \frac{t_{sea}}{t_{shore}} N_{shore}$ . Using this formula, the number of sea billets clearly is directly related to sea duty tour lengths and inversely related to shore duty tour lengths. This result implies that if sea and shore duty tours are of equal length, the number of sea billets is equal to the number of shore billets.<sup>45</sup>

In general, sea tours are longer than shore tours; under this simple framework, it is easy to see this requires more sea billets than shore billets. Further, priority is typically given to manning sea billets, necessitating longer sea tours. Limitations on the maximum length of sea tours and the minimum length of shore tours can exacerbate manning issues. For instance, shore tours are typically 36 months, which is the minimum requirement for shore tours. Suppose that a given rating has 2,000 sea billets and 1,000 shore billets. To achieve equilibrium under this scenario, sea tours would need to be 72 months in length;

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<sup>45</sup> If the number of sea and shore billets are not equal, it may be necessary for sailors to move from shore to shore billet (or sea to sea billet).

however, policy mandates a maximum sea tour length of 60 months. Under this scenario, due to policy restrictions, undermanning of sea billets will necessarily occur.<sup>46</sup>

### C. Applying the Framework to the Navy's Sea Shore Flow Model

To examine any potential issues with manning, note that under equilibrium  $\frac{t_{sea}}{t_{shore}} = \frac{N_{sea}}{N_{shore}}$ . The ratio on the right-hand side is called the sea to shore ratio (SSR) and is used in the setting of tour length. This indicates we can compare these two ratios to determine potential manning issues. If  $\frac{t_{sea}}{t_{shore}} > \frac{N_{sea}}{N_{shore}}$  this implies the number of shore billets is greater than it should be under equilibrium, while when  $\frac{t_{sea}}{t_{shore}} < \frac{N_{sea}}{N_{shore}}$  the number of shore billets is too low to be in equilibrium.

In the Sea Shore Flow Model that the Navy used to determine tour lengths, the prescribed tour lengths for each rating are provided. Also given are the number of sea and shore billets for each rating and the SSR. We focus on the first two tours, which are prescribed to be a sea tour followed by a shore tour. The ratio of the first sea tour to the first shore tour,  $\frac{t_{sea}}{t_{shore}}$ , is calculated and compared to the ratio of total sea billets to total shore billets,  $\frac{N_{sea}}{N_{shore}}$ .

Table 4 presents the ratings for which  $\frac{t_{sea}}{t_{shore}} > \frac{N_{sea}}{N_{shore}}$ ; for brevity, only ratings are presented for which  $\frac{t_{sea}}{t_{shore}} > \frac{N_{sea}}{N_{shore}}$  by 0.5 or more. For most ratings where  $\frac{t_{sea}}{t_{shore}} > \frac{N_{sea}}{N_{shore}}$  the discrepancy is minimal. Of those ratings having a noticeable discrepancy, all are ratings for aircrewmembers (AWR, AWO, AWV, and AWF). These and most of the ratings where  $\frac{t_{sea}}{t_{shore}} > \frac{N_{sea}}{N_{shore}}$  are all considered to be shore-centric ratings. It is not surprising that these ratings are overrepresented. Because these ratings require a large amount of time on shore and hence a comparatively large number of shore billets, it is likely more shore billets will be present than would be required based on tour lengths. In order to have equilibrium for these ratings, either the length of the first sea tour must be decreased or the number of shore billets increased.<sup>47</sup>

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<sup>46</sup> It is also possible to relax the shore tour minimum duration.

<sup>47</sup> Or the length of shore tours could be increased.

**Table 4. Sea to Shore Time Ratio Greater than Billets Ratio**

| <b>Rating</b> | <b>Tour Lengths</b>   |                         |                             | <b>Billets</b>     |                      |                             |
|---------------|-----------------------|-------------------------|-----------------------------|--------------------|----------------------|-----------------------------|
|               | <b>First Sea Tour</b> | <b>First Shore Tour</b> | $\frac{t_{sea}}{t_{shore}}$ | <b>Sea Billets</b> | <b>Shore Billets</b> | $\frac{N_{sea}}{N_{shore}}$ |
| AWR<br>(A505) | 60                    | 36                      | 1.67                        | 389                | 421                  | 0.92                        |
| AWO<br>(A520) | 74                    | 36                      | 2.06                        | 785                | 700                  | 1.12                        |
| AWF<br>(A530) | 64                    | 36                      | 1.78                        | 245                | 332                  | 0.74                        |
| AWV<br>(A550) | 69                    | 36                      | 1.92                        | 161                | 231                  | 0.70                        |

Table 5 presents the ratings where  $\frac{t_{sea}}{t_{shore}} < \frac{N_{sea}}{N_{shore}}$  and the discrepancy is 0.5 or more. The ratings with the greatest imbalances are for electrician mates, nuclear power (EMN(SS) and EMN(SW)); electronics technicians, nuclear (ETN(SS) and ETN(SW)); and machine mates, nuclear (MMN(SW), MMNELT(SS), MMNELT(SW)). Common to these ratings is that they all are from the nuclear field and are shore-centric. The discrepancy exists for both submarine qualified (SS) and surface qualified (SW) ratings. These ratings all have relatively short first sea tours of 48 months. For these ratings, to reach equilibrium the first sea tour would need to be longer or more shore billets would be needed. It may be possible to increase the number of shore billets as these are shore-centric ratings.

**Table 5. Sea to Shore Time Ratio Less than Billets Ratio**

| Rating               | Tour Lengths   |                  |                             | Billets     |               |                             |
|----------------------|----------------|------------------|-----------------------------|-------------|---------------|-----------------------------|
|                      | First Sea Tour | First Shore Tour | $\frac{t_{sea}}{t_{shore}}$ | Sea Billets | Shore Billets | $\frac{N_{sea}}{N_{shore}}$ |
| ABE (A101)           | 69             | 36               | 1.92                        | 2,013       | 780           | 2.58                        |
| ABF (A102)           | 89             | 36               | 2.47                        | 1,782       | 597           | 2.98                        |
| AO (A420)            | 55             | 36               | 1.53                        | 6,208       | 2706          | 2.29                        |
| EMN(SS)<br>(D100)    | 48             | 36               | 1.33                        | 1,264       | 545           | 2.32                        |
| EMN(SW)<br>(D101)    | 48             | 36               | 1.33                        | 982         | 332           | 2.96                        |
| ETN(SS) (D110)       | 48             | 36               | 1.33                        | 1,149       | 446           | 2.58                        |
| ETN(SW)<br>(D111)    | 48             | 36               | 1.33                        | 825         | 302           | 2.73                        |
| MMN(SW)<br>(D131)    | 48             | 36               | 1.33                        | 1,768       | 521           | 3.39                        |
| MMNELT(SS)<br>(D133) | 48             | 36               | 1.33                        | 588         | 257           | 2.29                        |
| MMNELT(SW)<br>(D134) | 48             | 36               | 1.33                        | 312         | 143           | 2.18                        |

The other three ratings with a noticeable imbalance include two ratings for aviation boatswain's mate (ABE and ABF) and aviation ordnance man (AO), which are all sea-intensive ratings. These ratings all have relatively long prescribed first sea tours ranging from 55 months (AO) to 89 months (ABF). To reach equilibrium, these ratings would need longer first sea tour lengths or shorter first shore tours. However, neither options is feasible as the length of first sea tours are already long (and for two of the three ratings are longer than Naval policy of 60-month maximum sea tours), and the length of shore tours are at their minimum. The only other alternative is to increase the number of shore billets, which is also likely not feasible as these are sea-intensive ratings requiring a large number of sea billets.

## 6. Evaluation Plan

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To evaluate and estimate the conceptual framework shown in Figure 7, we use structural equation modeling (SEM), which is a multivariate statistical method (Bollen, 1989).<sup>48</sup> SEM is well-suited for estimating our conceptual framework for several reasons. First, compared to common statistical methods such as regression, SEM allows for the simultaneous estimation of multiple equations as in our conceptual framework. Estimating the hypothesized relationships simultaneously provides accurate estimates by avoiding issues with simultaneity bias. Second, SEM allows for the use of latent variables that cannot be directly observed or measured. Our conceptual framework has several latent variables such as spousal support and commitment to the military.

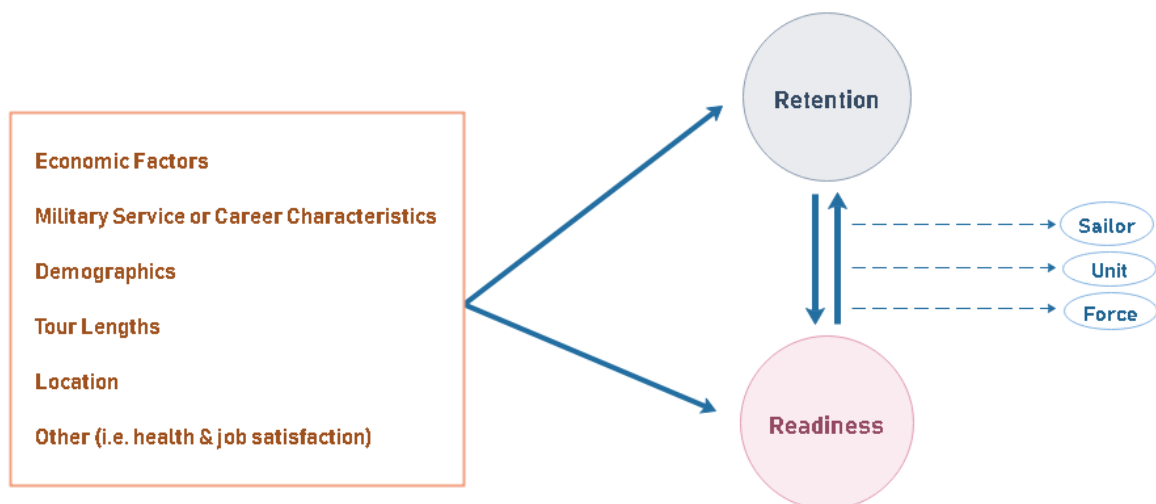


**Figure 7. Conceptual Framework**

Data are needed from multiple sources to estimate the model represented by the conceptual framework in Figure 7. In Table 6, we provide potential data sources for each element of the model.

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<sup>48</sup> Kenneth A. Bollen, “Structural Equations with Latent Variables, Wiley, New York, 1989.

**Table 6. Potential Data Sources**

| <b>Model Element</b>                                    | <b>Data Source(s)</b>                                                                                                      |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Personal characteristics                                | DMDC<br>DEERS<br>DHA                                                                                                       |
| Military characteristics                                | DMDC                                                                                                                       |
| Tour length policy                                      | Navy policy                                                                                                                |
| Tour length characteristics                             | Navy orders data                                                                                                           |
| Civilian economic conditions                            | Bureau of Labor Statistics<br>Current Population Survey                                                                    |
| Personal quality of life                                | AIP data/Dream book data<br>Status of Forces Survey<br>Survey of Active Duty Spouses<br>Quadrennial Quality of Life Review |
| Work quality of life                                    | AIP data/Dream book data<br>Status of Forces Survey<br>Survey of Active Duty Spouses<br>Quadrennial Quality of Life Review |
| Commitment to the military                              | Status of Forces Survey<br>Survey of Active Duty Spouses                                                                   |
| Retention intentions                                    | Status of Forces Survey<br>Survey of Active Duty Spouses                                                                   |
| Retention decision                                      | DMDC                                                                                                                       |
| Readiness                                               | DRRS                                                                                                                       |
| AIP – Assignment Incentive Pay                          |                                                                                                                            |
| DMDC – Defense Manpower Data Center                     |                                                                                                                            |
| DEERS – Defense Enrollment Eligibility Reporting System |                                                                                                                            |
| DHA – Defense Health Agency                             |                                                                                                                            |
| DRRS – Defense Readiness Reporting System               |                                                                                                                            |

One major complication from using multiple data sources is that sources are measured at different times and on different levels (e.g., measured at the Service member level versus the unit level). A further issue may be that identifying information may not be available from all data sources, making matching across studies impossible. We will overcome these issues by using individual and group-level covariates in our models. The selection of groups depends on careful evaluation of the data, most of which we do not possess. Further refinement of our model may also be necessary based on the data to which we have access and how it is measured.

## 7. Assessing and Exploring the Available Data

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### A. Examining Factors Related to Tour Lengths and Completion

#### 1. Defense Manpower Data Center Active Duty Master File

The Defense Manpower Data Center (DMDC) Active Duty Master File is a database containing information on active duty personnel in the U.S. military. This database is used to calculate tour lengths and completion rates and to examine the relationship between actual and prescribed tour lengths. This database also contains demographic information, including education level, marital status, age, occupation, and other information recorded at the Sailor level. Additionally, this database includes information specific to the military such as where each Sailor is stationed, the dates arrived on station and departed the station, and numerous other fields.

In our analysis, we consider only active duty Navy personnel for FY 2001 through FY 2018. Data are collected monthly. For this analysis, we use the data file from September of each fiscal year.

Using this database, the length of each tour is calculated as the duration of time a Sailor spends at a single unit. This is done by subtracting the arrival date from the departure date as recorded in months. We refer to this tour length as the *actual tour length* as it reflects the actual amount of TOS for a Sailor. Tours that are still in progress (such as most of those starting in FY 2018) are excluded.

##### a. Orders

The Navy provided data on the assignments of Sailors.<sup>49</sup> We were given information on the assigned dates of arrival and departure for permanent changes of station (PCSs). By subtracting the assigned arrival date from the assigned departure date, the *assigned tour length* is calculated. We compare the actual and assigned tour lengths for finished tours to examine differences between what the Navy sets for tour lengths (assigned tour lengths), what actually happens (actual tour lengths), and what Navy policy mandates (prescribed tour lengths).

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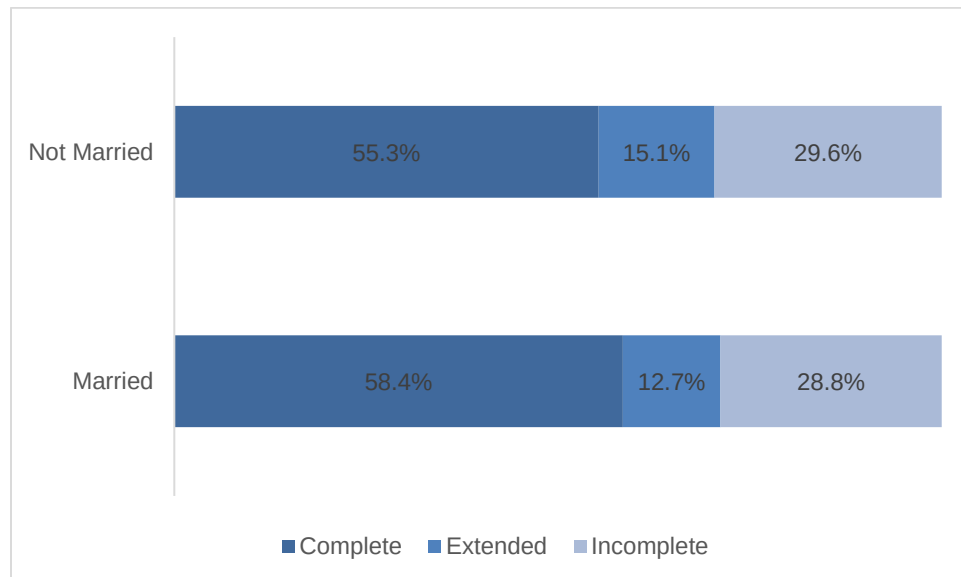
<sup>49</sup> We were not given the name of the database.

## 2. Factors Related to Tour Completion

We define a completed tour as one completed in the 12-month window with 6 months on either side of the tour completion date. We examine the factors that may be related to whether a tour was completed. For tours that were not completed, we examine whether they were incomplete (meaning that the sailor left before completion) or extended (meaning that the sailor remained more than 6 months after the end date).

### a. Marital Status

Figure 8 shows the rates of completed, incomplete, and extended tours by marital status. This figure indicates slight differences between personnel who are married and not married. The completion rate for married personnel (58.4 percent) is slightly higher than for non-married personnel (55.3 percent). This difference may be due to unmarried personnel having a higher rate of extended tours (15.1 percent for unmarried personnel versus 12.7 percent for married personnel). The percentage of tours that are incomplete are similar for married (28.8 percent) and unmarried (29.6 percent) personnel.



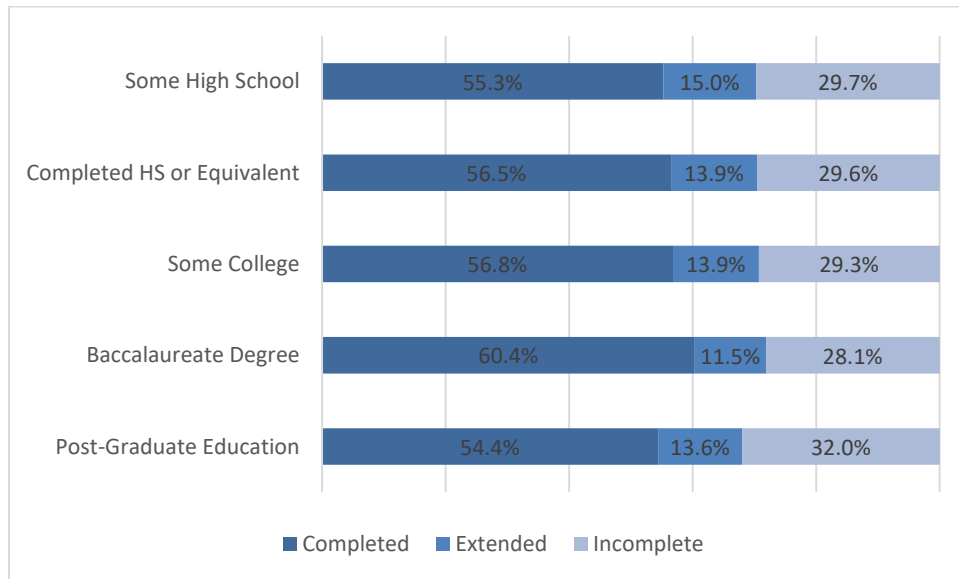
Note: Personnel with an unknown marital status are excluded.

**Figure 8. Tour Completion Rates by Marital Status**

### b. Educational Level

Figure 9 shows slight differences in completion rates by educational level. Those with a baccalaureate degree have the highest percentage of completed tours (60.4 percent) while those with a post-graduate education have the lowest (54.4 percent). These differences are also reflected in the percentage of tours that are extended as the educational levels with the lowest rate of completed tours have higher rates of extending their tours. The percentage

of tours that are incomplete is similar across educational levels with the exception of those with a post-graduate education. The percent of incomplete tours for those with a post-graduate education is around 3 to 4 percentage points higher than for the other educational levels.

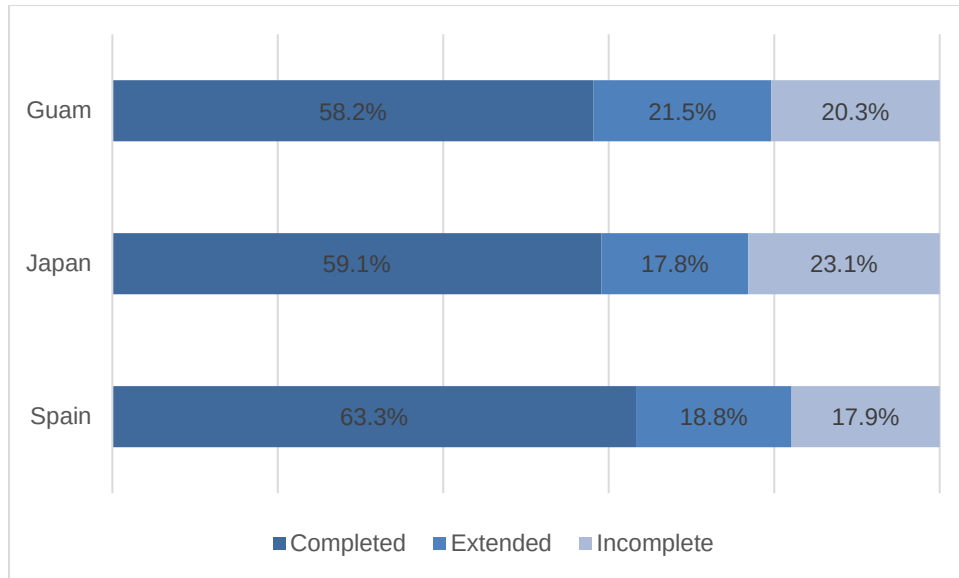


Note: Personnel with an unknown educational level are excluded.

**Figure 9. Tour Completion Rates by Educational Level**

### c. Location

Figure 10 shows noticeable differences among the three locations under consideration. Most noticeable is that the percentage of completed tours is higher in Spain by over 3 percentage points than the other two locations, which have relatively similar completion rates. The percentage of incomplete tours is highest in Japan and is nearly 3 percentage points higher than Guam and 5 percentage points higher than Spain. The percentage of tours that are extended is similar in Japan and Spain and about 3 percentage points lower than the tour extension rate for Guam.

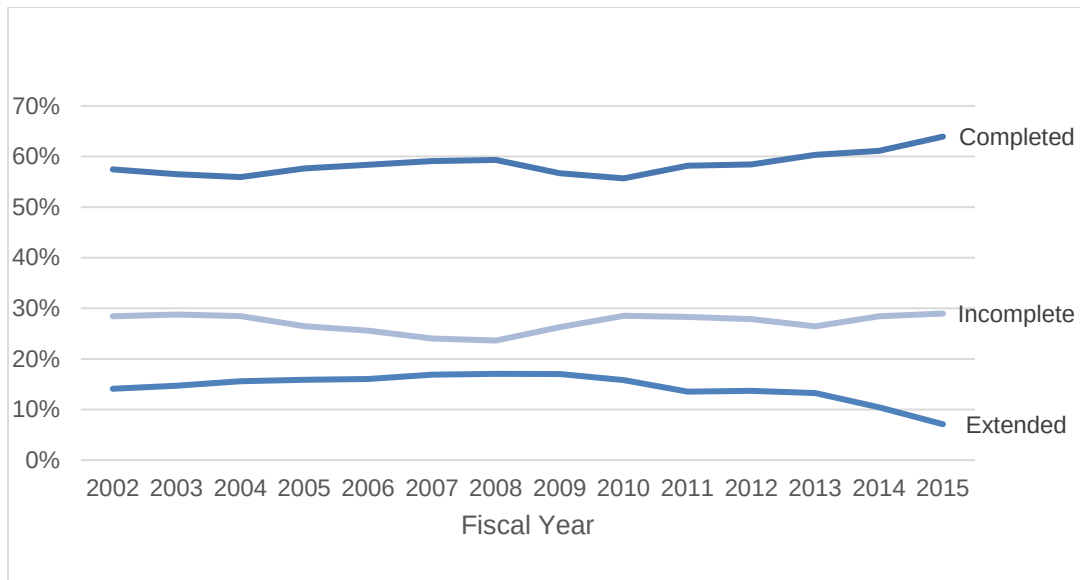


*Note:* Rates are calculated by using a weighted average over UICs within a location. UICs with 9 or fewer personnel are excluded.

**Figure 10. Tour Completion Rates by Location**

#### **d. Year**

Figure 11 shows the rates of annual completion, incompleteness, and extension for tours that began in fiscal years 2001 through 2015. Though data are available for 2016 through 2018, many of these tours are still in progress so these rates would be misleading. This figure indicates the percentage of tours that are incomplete is fairly constant with a slight decrease from 2005 through 2009. The percentage of complete tours increased during this time while the percent of extended tours decreased, with a marked decrease since 2013.



Note: Most recent years excluded as most tours are still in progress.

**Figure 11. Tour Completion Rates over Time**

#### **e. Rank**

Figure 12 and Figure 13 display completion, incompleteness, and extension rates by rank for enlisted personnel and officers, respectively. For enlisted personnel, completion rates are noticeably lower and incompleteness rates noticeably higher for E1 through E3 personnel. This is not surprising due to the high rate of attrition for personnel in these ranks. Completion rates are also relatively low for personnel with a rank of E8 or E9. This is also not surprising as personnel in these ranks often have skills in high demand and are consequently pulled more frequently. Completion rates increase as rank increases until a rank of E5, at which point the rates decrease. Incompletion rates follow the opposite pattern by decreasing through rank E5; then from rank E6, incompletion rates increase. The percentage of extended tours steadily decreases for ranks E1 through E3 through rank E9.

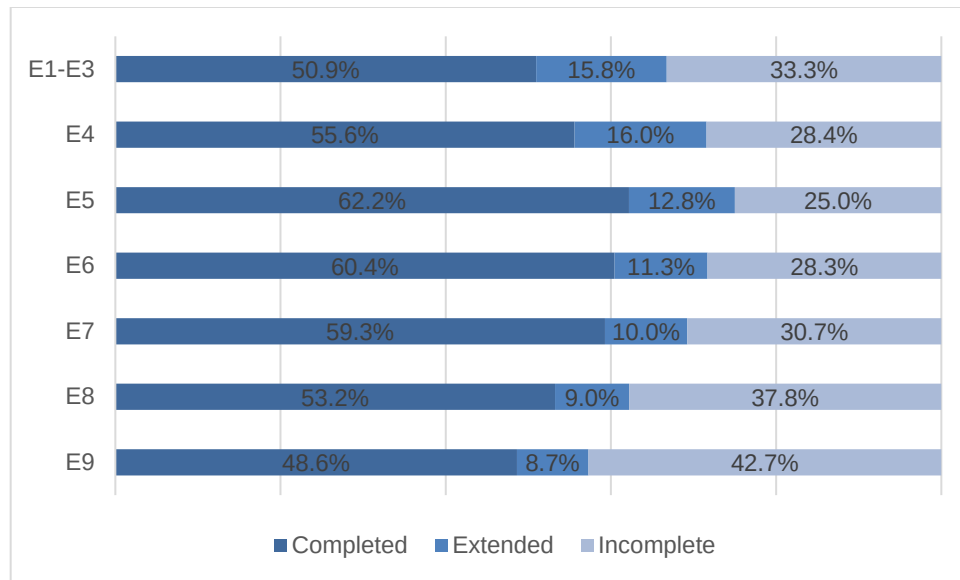
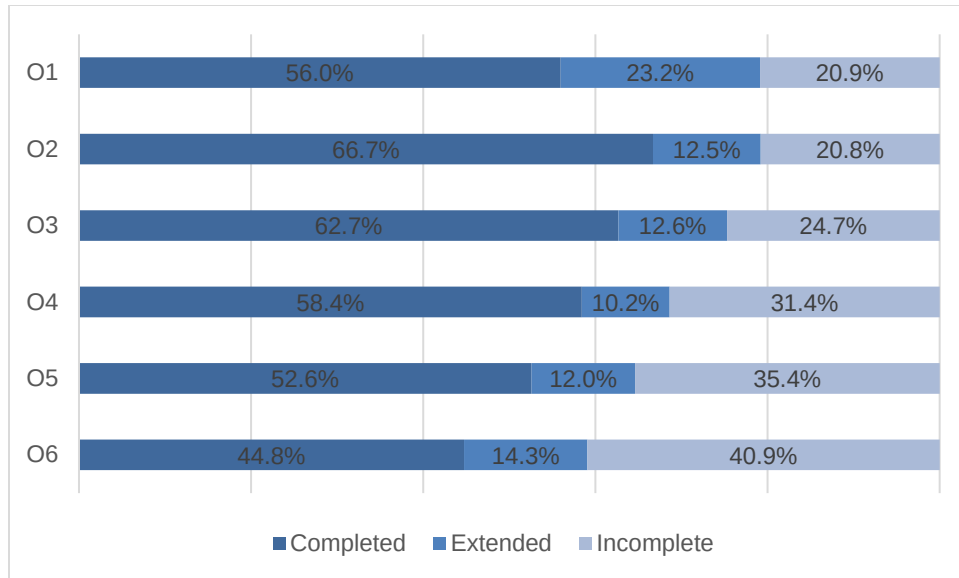


**Figure 12. Tour Completion Rates for Enlisted Personnel by Rank**

When looking at officers, the completion rate increases between rank O1 and O2 and then decreases as rank increases. The incompletion rate shows nearly the opposite pattern as this rate is roughly the same for rank O1 and O2 and then increases through rank O6. Officers of rank O1 have an extension rate nearly twice that of the other ranks. When comparing enlisted personnel and officers, rates are somewhat similar and we observe similar patterns. With the exception of ranks E9 and O6, completion rates are above 50 percent. For both officers and enlisted personnel, completion rates initially increase and then decrease so that senior personnel have the highest incompletion rates. In general, as rank increases so does the incompletion rate, with the exception of ranks E1 through E3. For both enlisted personnel and officers, the extension rate decreases as rank increases.



Note: Due to small sample sizes, officers of rank O7-O9 are excluded.

**Figure 13. Tour Completion Rates for Officers by Rank**

#### **f. Occupation**

Figure 14 examines completion, incompleteness, and extension rates by occupational group for enlisted personnel. Two groups are present in terms of completion rates, with one group (health care specialists, functional support/administration, and communications/intelligence personnel) having a completion rate of greater than 60 percent. The second group (all other occupational groups) has a completion rate of less than 56 percent. When examining the percentage of tours that are incomplete or extended, we do not observe similar patterns. For gun crews/seamanship specialists, electronic equipment repairers, electrical/mechanical equipment repairers, and craftworkers, about one-third of tours are incomplete; for the remaining occupational groups, about one-fourth of tours are incomplete. The percentage of tours that are extended is similar for most occupational groups with the exception of other technical/allied specialists, which have a noticeably higher extension rate.

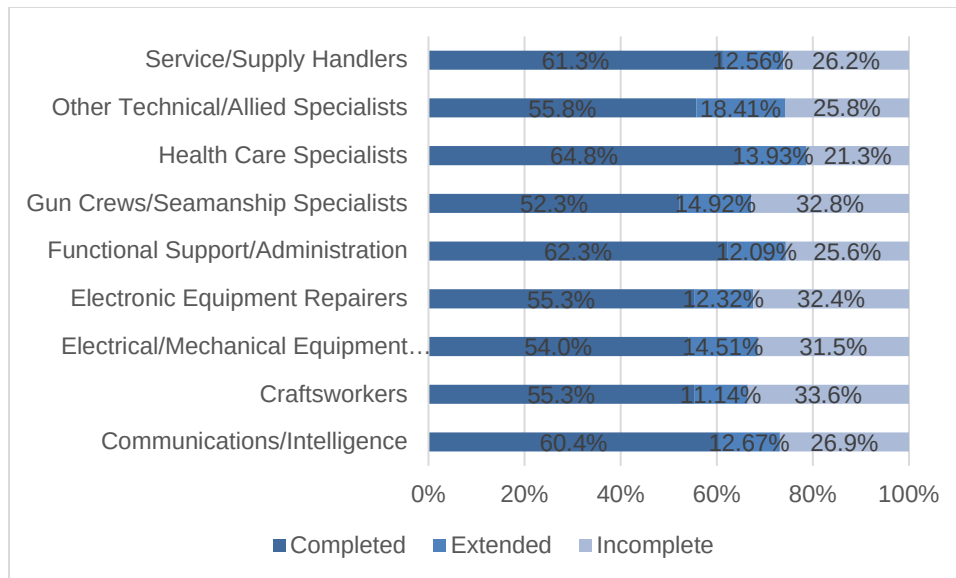
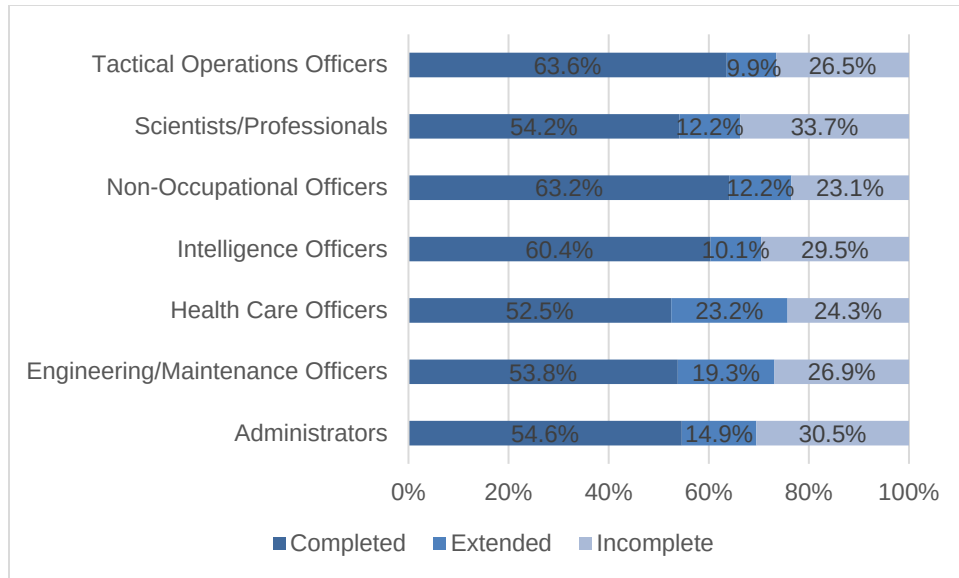


**Figure 14. Tour Completion Rates by Occupational Group for Enlisted Personnel**

Figure 15 compares completion, incompleteness, and extension rates for officers. Similar to enlisted personnel, two groups exist in terms of completion rates. The first group (tactical operations officers, non-occupational officers, and intelligence officers) has a completion rate above 60 percent, while the second group (the other four occupational groups) has a rate under 55 percent. Scientists/professionals, intelligence officers, and administrators have a noticeably higher percentage of incomplete tours of around 30 percent or higher, while for the other four occupational groups the rate is closer to 25 percent. In terms of extended tours, health care officers and engineering maintenance officers have extension rates nearly twice those of the other occupational groups.

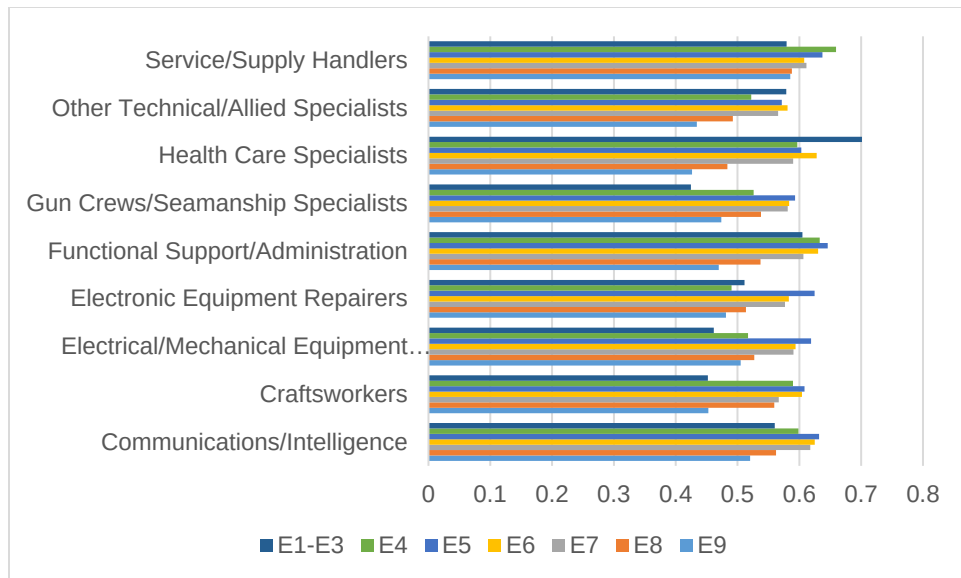


Note: General officers/executives (all with rank O7-O9) are not included.

**Figure 15. Tour Completion Rates by Occupational Group for Officers**

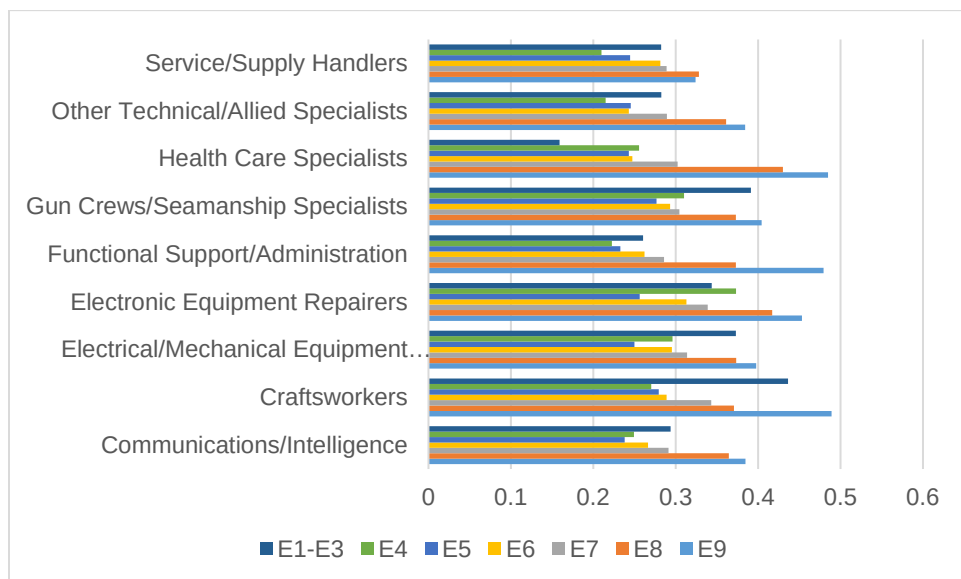
#### **g. Rank and Occupation**

Figure 16 through Figure 18 show the completion, incompletion, and extension rates, respectively, by occupational group and rank. With the exception of health care specialists, completion rates are lowest for those in ranks E1 through E3, and for all occupational groups completion rates are lowest for those of rank E9. As seen when looking at rank, completion rates tend to increase for junior and mid-career ranks and then decrease. Incompletion rates tend to be highest for those in ranks E1 through E3 and E8 through E9, and for the occupational groups of craftworkers, electronic equipment repairers, and electrical/mechanical equipment repairers. Extension rates tend to peak for those in the mid-career ranks of E4 and E5 and are highest for other technical/allied specialists and electrical/mechanical equipment repairers.



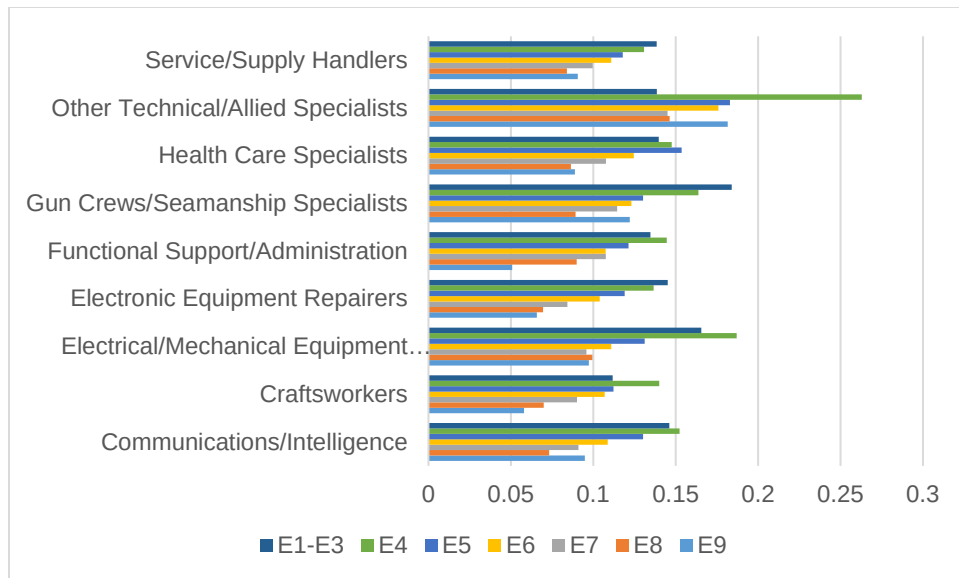
Note: Personnel with unknown rank are excluded.

**Figure 16. Tour Completion Rates by Rank and Occupational Group for Enlisted Personnel**



Note: Personnel with unknown rank are excluded.

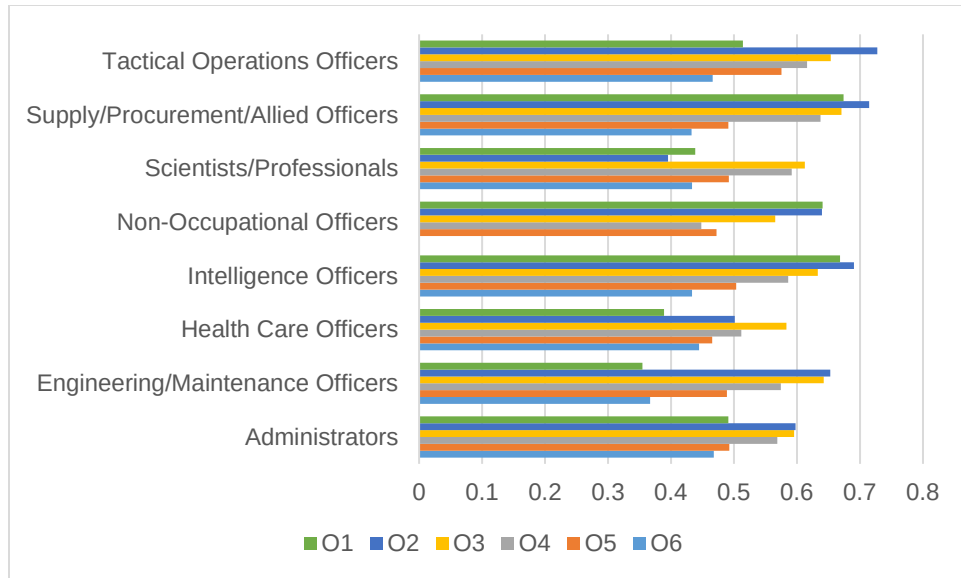
**Figure 17. Tour Incompletion Rates by Rank and Occupational Group for Enlisted Personnel**



Note: Personnel with unknown rank are excluded.

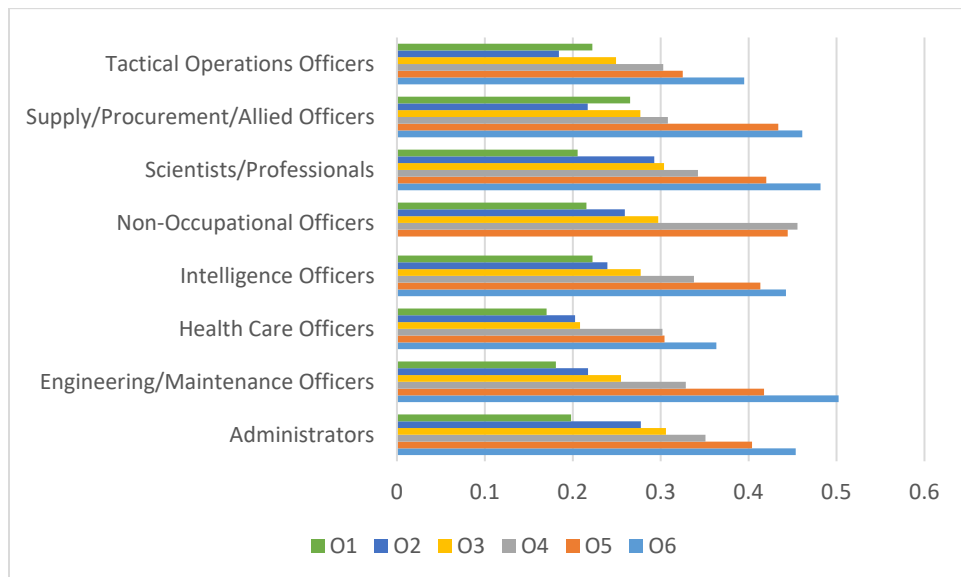
**Figure 18. Tour Extension Rates by Rank and Occupational Group for Enlisted Personnel**

Figure 19 through Figure 21 display the completion, incompleteness, and extension rates, respectively, for officers by occupational group and rank. Completion rates for most occupational groups tend to peak for ranks O2-O4 with rates being lower for scientists/professionals and health care officers. With the exception of tactical operations officers and supply/procurement/allied officers, incompleteness rates increase as rank increases. For tactical operations officers, health care officers, engineering/maintenance officers, and administrators, the extension rate is noticeably higher for officers in rank O1. For example, for engineering/maintenance officers, the extension rate of O1 officers is around three times higher than the next highest extension rate.



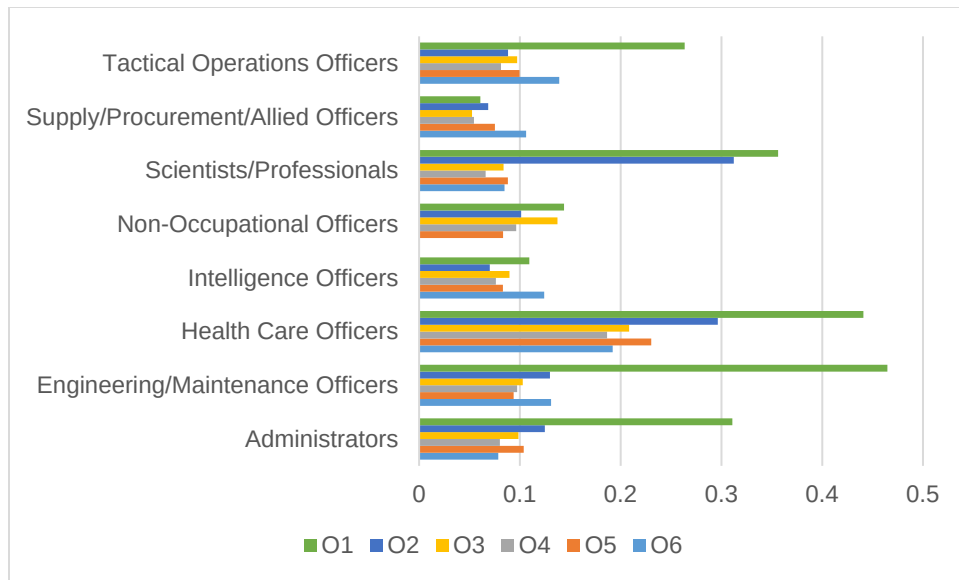
Note: General officers are excluded. No non-occupational officers have rank O6.

**Figure 19. Tour Completion Rates by Rank and Occupational Group for Officers**



Note: General officers are excluded. No non-occupational officers have rank O6.

**Figure 20. Tour Incompletion Rates by Rank and Occupational Group for Officers**



Note: General officers are excluded. No non-occupational officers have rank O6.

**Figure 21. Tour Extension Rates by Rank and Occupational Group for Officers**

## B. Comparing Prescribed, Assigned, and Actual Tour Lengths

The previous analysis is useful for identifying factors related to an unrelated to tour length and completion. Completion rates by themselves are an imperfect metric given the variability in the tour lengths. Further, it is of interest to understand where issues may arise. For example, do the assigned tour lengths differ from policy? Or do the actual tour lengths differ from the assigned lengths? Answering these questions provides useful insight on areas where policy should be focused.

In this analysis, we classify each tour as either a first term tour or a career tour. First term tours are the first tours that personnel serve while being considered first term personnel. Career tours are those that are not first term tours. First term personnel are defined in accordance with the Navy's definition. For enlisted personnel, first term personnel are those under their first enlistment contract; for officers, first term personnel are those in ranks O1 and O2.<sup>50</sup>

We use the same definitions as previously for defining a tour as incomplete, complete, or extended.

Figure 22 looks at the completion, incompleteness, and extension rates for first term and career enlisted personnel and officers that had 12-, 24-, 36-, 48-, and 60-month prescribed tours. Completion rates are lowest for first term enlisted personnel, who also have the highest incompleteness rate. In contrast, first term officers have the highest completion rate

<sup>50</sup> <https://www.public.navy.mil/bupers-npc/support/distribution/Pages/FirstTermPersonnel.aspx>.

and the lowest incompleteness rate. Enlisted personnel differ from officers in that completion rates are lower for first term tours than for career tours, while the opposite is true for officers. We also observe a similar trend for incompleteness rates. These rates are higher for first term enlisted tours than enlisted career tours; for officers, career tours have a lower incompleteness rate than first term tours. For both enlisted personnel and officers, the percentage of extended tours is higher for first term tours than career tours.

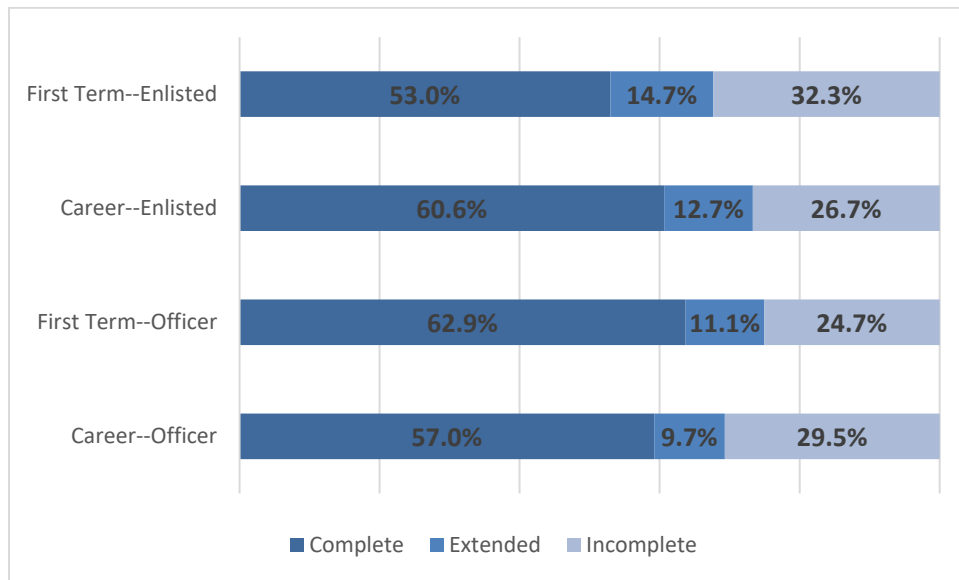


**Figure 22. Tour Completion Rates by Type of Tour**

Because completion rates may differ based on prescribed tour lengths, we next examine completion, incompleteness, and extension rates by tour type and prescribed tour length for both enlisted personnel and officers. For this analysis, we consider 24-, 36-, 48-, and 60-month tours for enlisted personnel and 24-, 36-, and 48-month tours for officers (because the number of 60-month tours for officers is relatively small).

When looking at these rates for enlisted personnel, as shown in Figure 23, we notice that for both first term and career tours, completion rates and extension rates decrease as tour lengths increase, while incompleteness rates increase as tour length increases. Figure 24 shows a different pattern for officers, with 24-month tours having the highest completion rates followed by 48-month and then 36-month tours. Not surprisingly, we see the opposite pattern for incompleteness rates with 36-month tours having the highest incompleteness rates followed by 48-month tours and then 24-month tours. Extension rates are fairly similar across tour lengths but are slightly lower for 36-month tours.

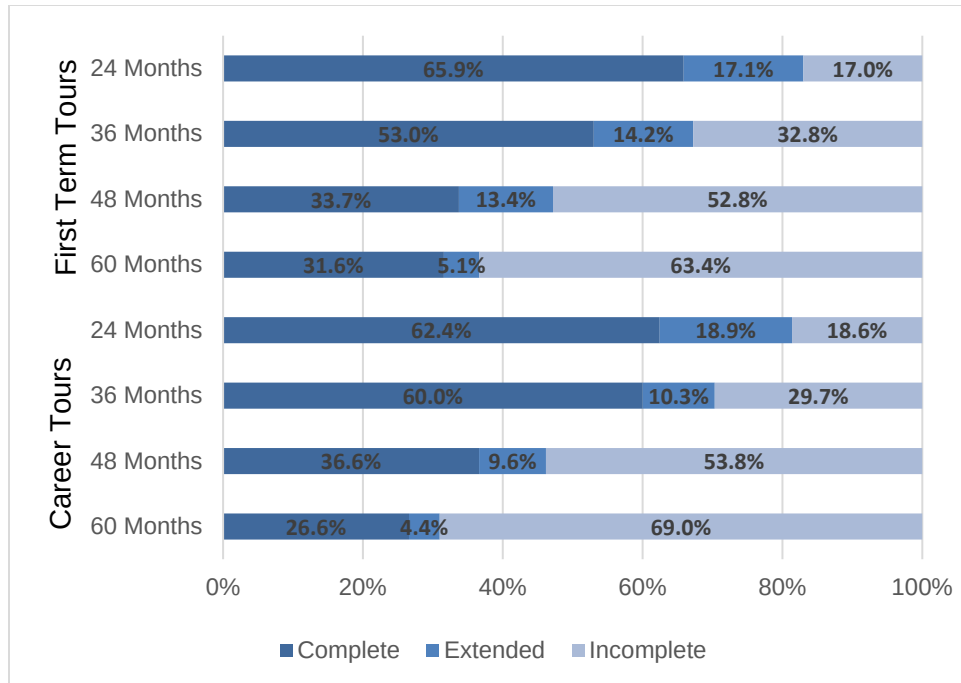


**Figure 23. Tour Completion Rates by Type of Tour and Length for Enlisted Personnel**

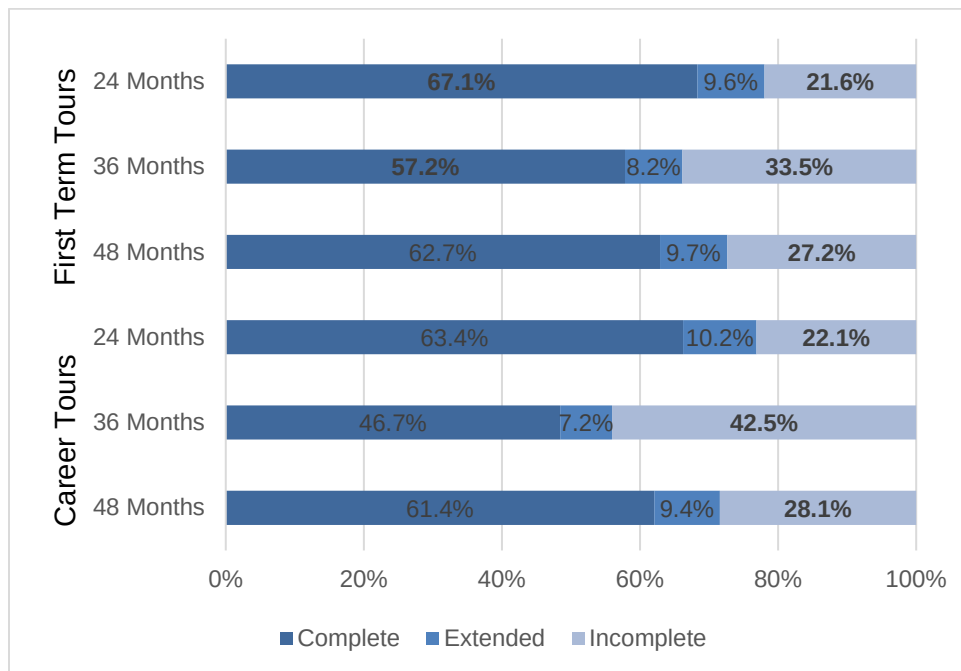


**Figure 24. Tour Completion Rates by Type of Tour and Length for Officers**

We also consider time period due to changes in Navy policy and economic conditions. We chose three time periods: 2001 through 2007, 2008 through 2012, and 2013 through 2018. We chose these time periods because in 2008, policy changed regarding how tour lengths were assigned. Prior to 2008, first term enlisted sailors had a tour length based on

policy regardless of the amount of time remaining on their contract. For example, suppose a sailor signed a 4-year contract and their initial training was 8 months. They would then have 3 years and 4 months left on their contract. Despite this, the sailor could be assigned a 4-year tour, which would be considered incomplete if the sailor left the Navy as the time on station would be 8 months less than prescribed. Starting in October 2008, the assignment of tour lengths was changed to make the prescribed tour length equal to the time remaining on the contract.

Figure 25 displays the completion rates for enlisted personnel by prescribed tour length, type of tour, and time period. As seen previously, as the tour length increases, completion rates decrease. When looking at differences by time period, we notice that for 24-month tours, completion rates are similar over the 3 time periods for both first term and career tours. Completion rates are also similar for 36-month career tours, while for first term tours of the same length, tours during 2008 through 2012 have lower completion rates. For 48-month and 60-month tours, completion rates are similar for 2001 through 2007 and 2008 through 2012, and the rates for 2013 through 2018 are considerably lower.

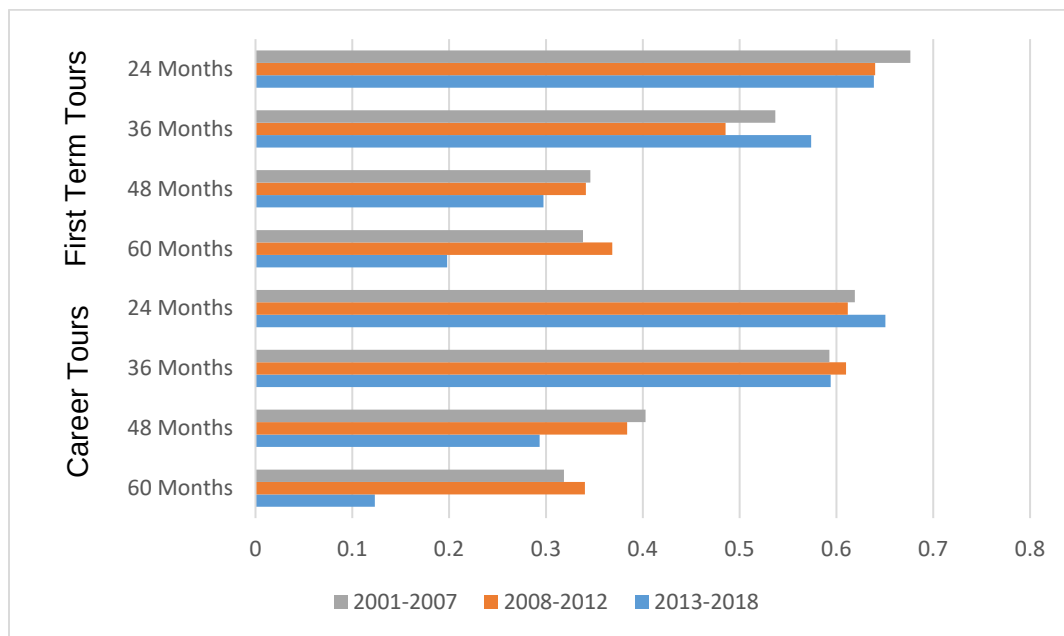


**Figure 25. Tour Completion Rates by Type of Tour, Tour Length, and Time Period for Enlisted Personnel**

Figure 26 displays completion rates by prescribed tour length, type of tour, and time period for officers. As observed previously, completion rates decrease as tour lengths increase, though this decrease is not as pronounced as for enlisted personnel. For 24-month tours, completion rates are fairly similar for each time period. Differences are found among time periods for 36-month and 48-month tours. For 36-month tours, completion rates are

highest during 2008 through 2012 while for 48-month tours, completion rates have decreased over time.

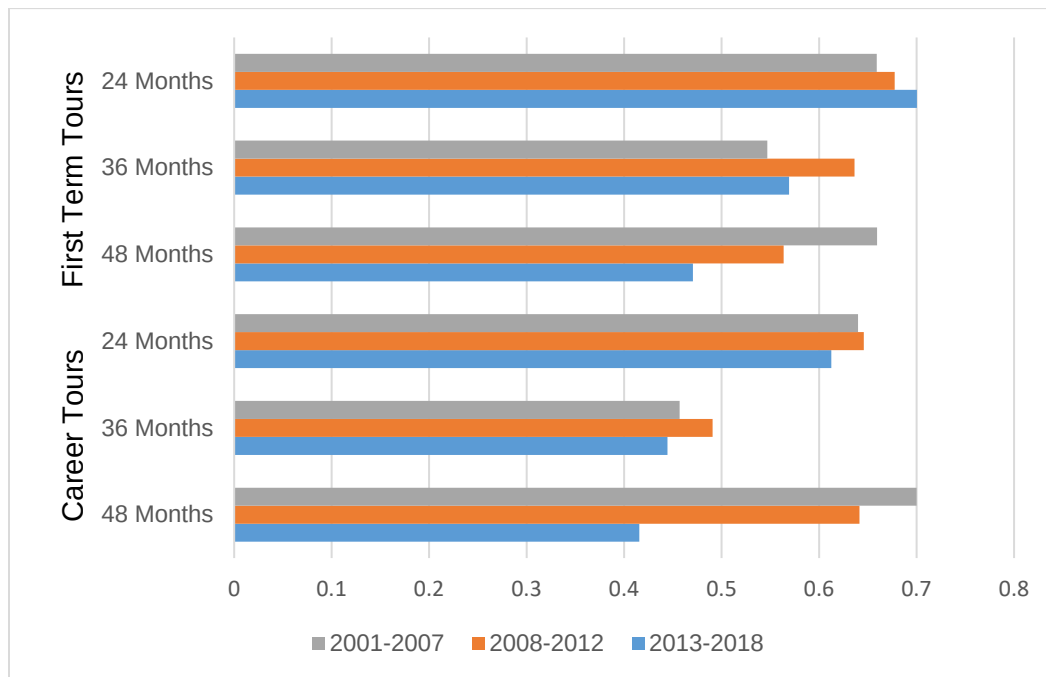


**Figure 26. Tour Completion Rates by Type of Tour, Tour Length, and Time Period for Officers**

In addition to completion rates, it is also of interest to examine the average length of tours compared to the prescribed tour lengths. This comparison provides additional information on whether the prescribed tour length has an appreciable effect on the actual length of the tour. In Table 7 and Table 8, we provide the average months served on tours of varying prescribed lengths for first term and career tours for enlisted personnel and officers, respectively.

For enlisted personnel, the discrepancy between the prescribed tour length and the actual tour length increases as prescribed tour lengths increase, with similar differences for first term and career tours. The average actual tour length for 24-month tours is greater than 24 months for both first term and career tours. For the other tour lengths, the average actual tour length is less than the prescribed tour length, and results indicate that increasing tour lengths has a minor impact on the actual tour length. For example, for enlisted personnel, average tour lengths for 36-month tours is 33.4 months while for 48-month tours, the average actual length is 36.8 months. Despite a 12-month difference in the prescribed tour lengths, only a 3.4-month difference exists in the actual length of the tours. We observe similar pattern for career tours where the average actual tour length for 48-month tours is only 4.3 months greater than for 36-month tours. The difference in average

actual tour lengths for 48-month and 60-month tours is similar with a difference of 3.6 months for first term tours and 3.3 months for career tours.

**Table 7. Average Actual Tours Lengths Compared to Prescribed Tour Lengths for Enlisted Personnel**

|                         |           | <b>Average<br/>Months per<br/>Tours</b> | <b>Months under/over<br/>Prescribed Length</b> | <b>Months Served as Percent<br/>of Prescribed Length</b> |
|-------------------------|-----------|-----------------------------------------|------------------------------------------------|----------------------------------------------------------|
| <b>First Term Tours</b> | 24 Months | 25.4                                    | 1.4                                            | 105.8%                                                   |
|                         | 36 Months | 33.4                                    | -2.6                                           | 92.8%                                                    |
|                         | 48 Months | 36.8                                    | -11.2                                          | 76.7%                                                    |
|                         | 60 Months | 40.4                                    | -19.6                                          | 67.3%                                                    |
| <b>Career Tours</b>     | 24 Months | 25.4                                    | 1.4                                            | 105.8%                                                   |
|                         | 36 Months | 32.4                                    | -3.6                                           | 90.0%                                                    |
|                         | 48 Months | 36.7                                    | -11.3                                          | 76.5%                                                    |
|                         | 60 Months | 40.0                                    | -20.0                                          | 66.7%                                                    |

For officers, average actual tour lengths are less than the prescribed length for each tour length considered. While for enlisted personnel the increase in actual tour lengths was minimal when increasing prescribed tour lengths, the increase in actual lengths for officers is greater. For example, when comparing 36-month and 48-month tours, the average tour length increases by 7.8 months for first term tours and 13.2 months for career tours. These results suggest that for officers, increasing prescribed tour lengths has a greater impact on actual tour lengths than for enlisted personnel.

**Table 8. Average Actual Tours Lengths Compared to Prescribed Tour Lengths for Officers**

|                         |           | <b>Average<br/>Months per<br/>Tours</b> | <b>Months under/over<br/>Prescribed Length</b> | <b>Months Served as Percent<br/>of Prescribed Length</b> |
|-------------------------|-----------|-----------------------------------------|------------------------------------------------|----------------------------------------------------------|
| <b>First Term Tours</b> | 24 Months | 23.7                                    | -0.3                                           | 98.8%                                                    |
|                         | 36 Months | 30.8                                    | -5.2                                           | 85.6%                                                    |
|                         | 48 Months | 38.6                                    | -9.4                                           | 80.4%                                                    |
| <b>Career Tours</b>     | 24 Months | 23.0                                    | -1.0                                           | 95.8%                                                    |
|                         | 36 Months | 29.2                                    | -6.8                                           | 81.1%                                                    |
|                         | 48 Months | 42.4                                    | -5.6                                           | 88.3%                                                    |

## C. Overlap in the Navy

### 1. Cohesion

The metric we use to measure cohesion is personnel overlap at the Unit Identification Code (UIC) level. We chose this metric for several reasons. The first is that it has been identified in the literature as a measure of personnel stability and indirectly measures cohesion. Previous studies have linked personnel turnover, either through those leaving the military or relocating to a different unit, to decreased readiness. This suggests that overlap, the percentage of personnel present in a unit from one time period to the next, would increase readiness. The second reason for assessing overlap is that it is readily accessible from the DMDC data. Most other metrics require access to the classified DRRS system or rely on Soldier surveys. Though we have access to DRRS, because it is a classified system, it is difficult to share information retrieved from it.

We consider 1-year overlap rates measured at the unit level. This rate is the percentage of personnel in a given unit during the year that are in the given unit in year  $t-1$ . For example, the 1-year overlap rate for 2012 is the percentage of unit personnel in the unit in 2012 and 2011.

#### a. Overlap Rates for Enlisted Personnel and Officers

Figure 27 shows the 1-year overlap rates for enlisted personnel and officers. The overlap rate is higher for enlisted personnel than officers by about 2 to 3 percentage points. For both groups, a slight increase occurred in overlap rates from 2002 to 2018 even with noticeable increases and decreases. Overall, the trends for both groups are similar. For example, overlap rates for both groups peak in 2008, 2012, and 2017.



Figure 27. 1-Year Overlap Rates for Enlisted Personnel and Officers

### b. Overlap Rates by Rank

Figure 28 and Figure 29 display 1-year overlap rates by rank for enlisted personnel and officers, respectively. For enlisted personnel, overlap rates tend to decrease as rank increases; for officers, overlap increases as rank increases. In general, the trends for overlap rates are similar across ranks for enlisted personnel and for officers, with increases and decreases in overlap rates occurring during the same years across ranks. When comparing enlisted personnel and officers, overlap rates have more variability among ranks for officers than for enlisted personnel.

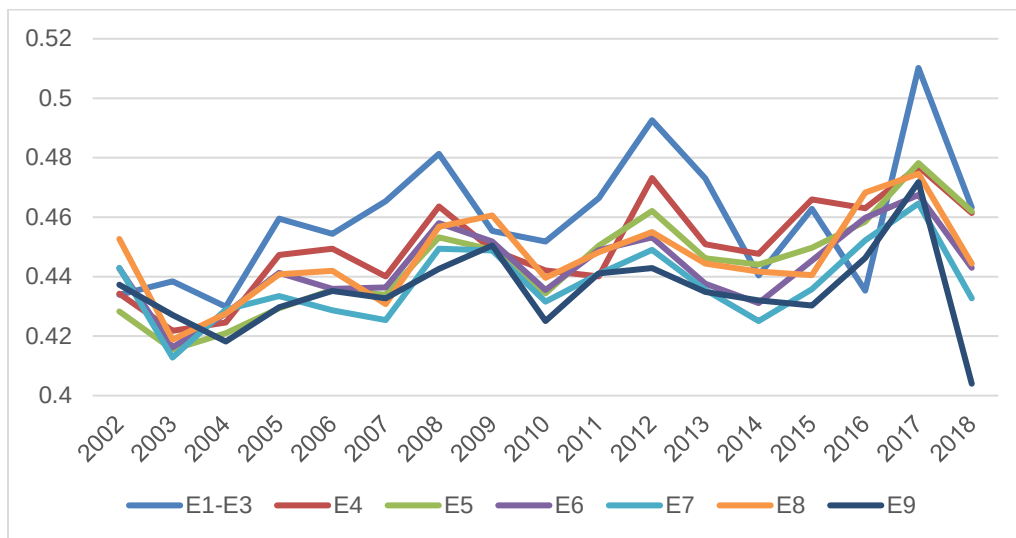
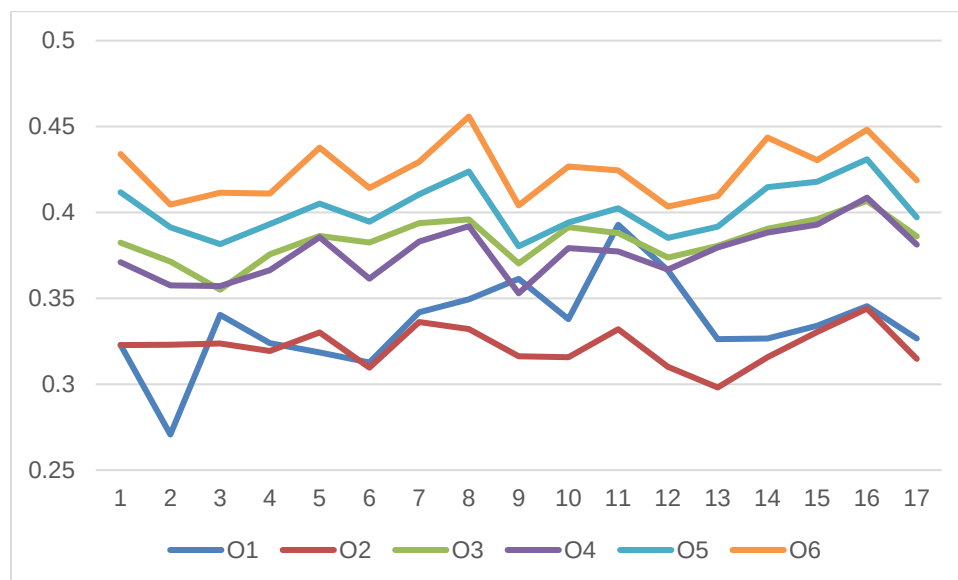


**Figure 28. 1-Year Overlap Rates for Enlisted Personnel by Rank**



Note: Due to small sample sizes, officers of rank O7-O9 are excluded.

**Figure 29. 1-Year Overlap Rates for Officers by Rank**

### c. Overlap Rates by Occupational Group

Figure 30 and Figure 31 display the 1-year overlap rates for enlisted personnel and officers, respectively. When looking at enlisted personnel, the overlap rate for non-occupational personnel is considerably higher than the other occupational groups by around 15 percentage points. The overlap rates for the other occupational groups tend to be fairly similar, though gun crews/seamanship specialists, other technical/allied specialists, and electrical/mechanical equipment repairers have slightly higher overlap rates, while service/supply handlers and health care specialists have slightly lower overlap rates.

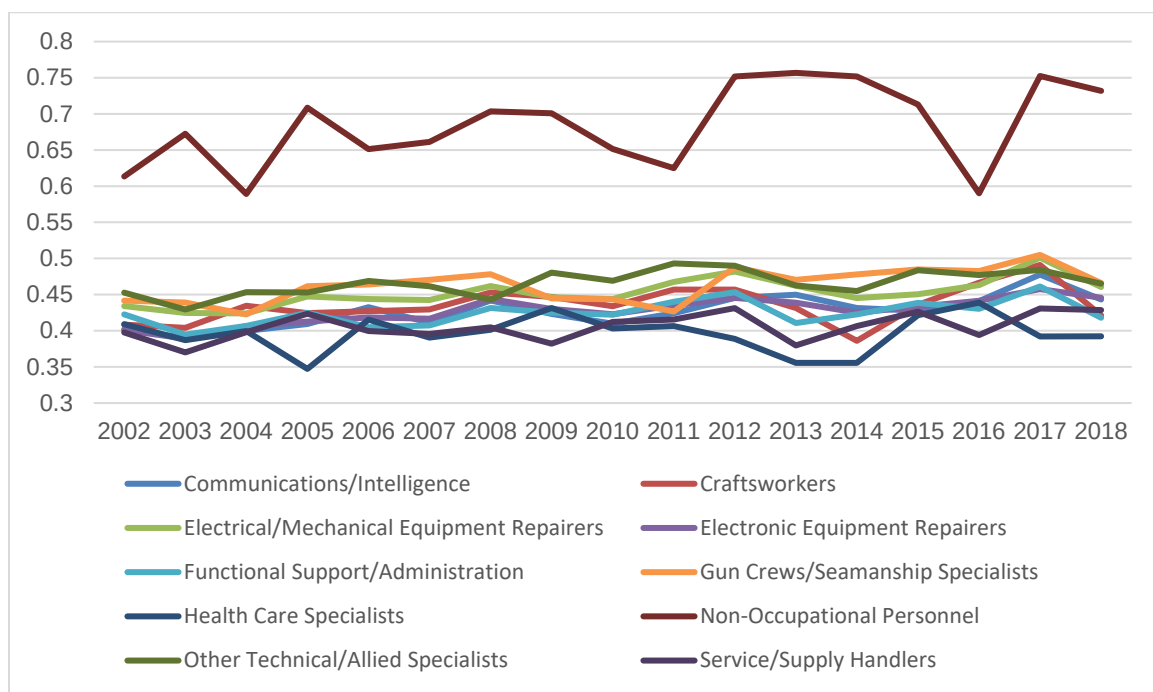
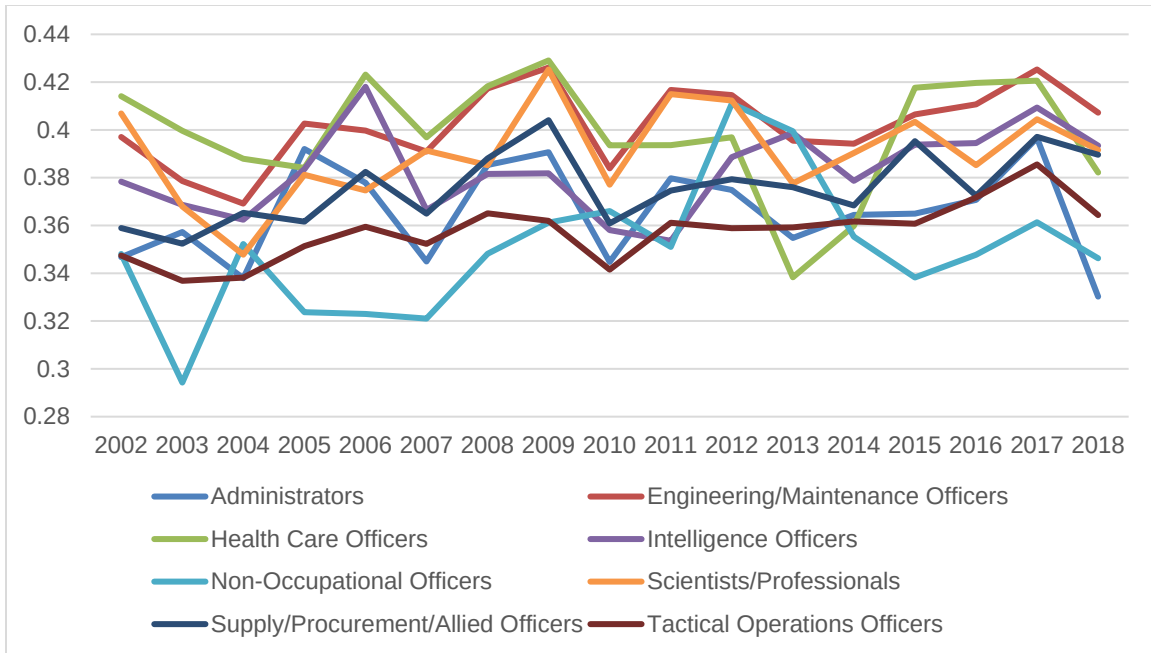


**Figure 30. 1-Year Overlap Rates for Enlisted Personnel by Occupational Group**

When looking at overlap rates by occupational group for officers, no group has noticeably higher or lower overlap rates than the others. However, there are differences across groups. Health care officers, scientists/professionals, and engineering/maintenance officers have higher overlap rates, while non-occupational officers and tactical operations officers have lower rates.



Note: Due to small sample sizes, general officers are excluded.

**Figure 31. 1-Year Overlap Rates for Officers by Occupational Group**

#### d. Overlap Rates by Location

Figure 32 displays overlap rates for the three locations of interest. In general overlap, rates are higher in Guam than in Japan and Spain. These results follow what is expected when looking at tour lengths—when tour lengths are longer, overlap rates are higher. This figure also shows that trends in overlap rates are not similar across locations. For example, in 2009, overlap rates spiked in Guam and Japan, while in Spain results showed a slight decrease.

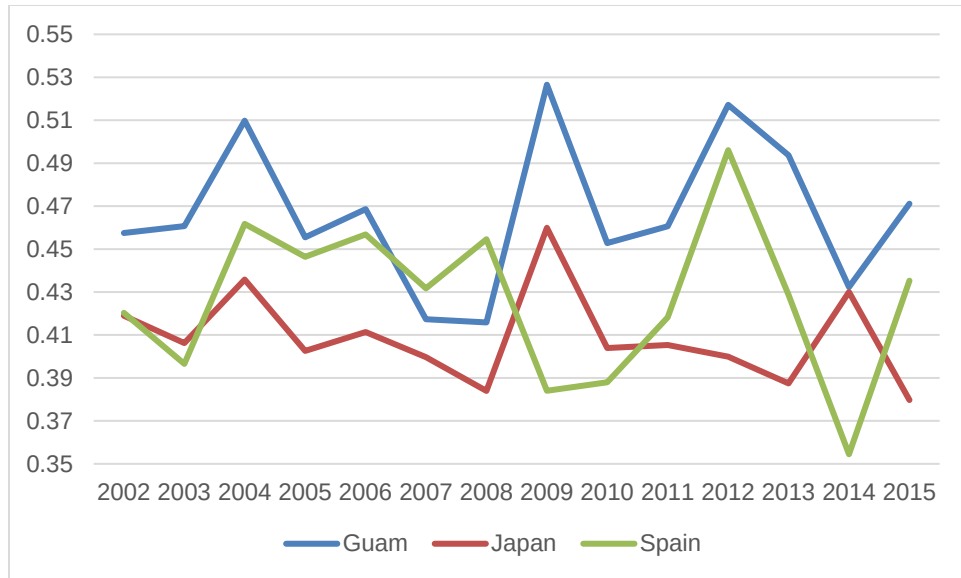


**Figure 32. 1-Year Overlap Rates by Location**



## 8. Agent-Based Tour Length Model

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### A. Overview

The Agent-Based Tour Length Model (AB-TLM) is a methodology for describing the behavior and analysis of an agent-based simulation used for modeling units, personnel, and tours. It provides a framework for specifying and developing simulations to explore the impact of policies on a small model set of units and personnel. The goal is to understand larger problems by looking at the impact of input parameters and decisions on a small set of people and units. Using AB-TLM, we developed a prototype simulation called Tour Length Simulation 1 (TL-SIM1), which we describe in Appendix C. We use the simulation to understand how changes in tour lengths for critical units affect manning levels, overlap rates, and the number of PCS moves required.

### B. Agent-Based Simulation

An agent-based simulation is one in which a collection of entities, each with its own characteristics, is tracked through a progressive set of phases, transforming its attributes and interacting with the environment along the way. It is a type of discrete event simulation (DES) in that the new state is calculated one step at a time, and there is no evaluation of attributes or statistics outside those discrete steps.

In AB-TLM, the entities represent military personnel, and the step time is 1 year. One record exists with some number of attributes (for example, age, rank, years in service, etc.) for each person, for each year of the simulation. In addition, each person belongs to one military unit for that year. As each subsequent year is simulated, the attributes are modified according to defined rules, and the new group membership is determined using these variables as well as system-wide attributes (such as percent fill of a critical unit).

### C. Entities and Attributes in AB-TLM

#### 1. Attribute Types

The AB-TLM system includes three types of attributes. The first two, Inherent and Historic, belong to each individual. The third, Environmental variables, relate to the overall environment of the simulation year by year.

1. **Inherent.** These attributes are the simple properties of a given individual, which are examined and possibly modified each year of the simulation. Examples of

inherent attributes are a service member's age and the number of years spent on the current tour.

2. **Historic.** Historic variables are calculated by looking back over an individual's "career" in the simulation. Historic variables can track values such as what percentage of a member's career has been served in a critical unit, or whether a member has received enough years of training.
3. **Environmental.** Environmental attributes belong not to each member but to each year of the simulation. Environmental attributes track system-wide characteristics, such as what percent of the billets in a critical unit are filled. These attributes can change during the process of assigning personnel to units.

## 2. Units

Every year, each service member is assigned to one of three units:

1. **Critical.** This type of unit has a specified, minimum fill rate and will be filled first from all available members. This represents a real-world unit such as a sea unit or a deployed unit.
2. **Support.** A support unit is the backup unit and will be the next unit filled after the critical unit meets its fill rate goal (if it does).
3. **Training.** A training "unit" is generally a small pool of people who are removed from the two main types of units for some period of time.

## 3. Next Action

Each year, the simulation determines each service member's next action. The following actions are supported:

1. **STAY.** The member stays in the current unit.
2. **PCS.** The member moves to another unit or to training.
3. **HOLD.** If a service member has finished their tour in the critical unit, but leaving would take the unit below its minimal fill, the service member can be held for 1 extra year.
4. **PULL.** If a service member is about to start the last year of a tour in the support unit, but the critical unit still needs more people to reach its minimal fill rate, the member may be pulled to the critical unit before finishing that tour.
5. **EXIT.** A service member leaves the military. This can happen at any point during a tour.

6. **NEW.** This is the next action assigned whenever a new service member is added to the simulation.

#### 4. **Updating Attributes**

Two overall methods are used for updating attributes in the simulation: deterministic and stochastic. A deterministic function always returns the same value for the same inputs. For example, if a person is 23 years old in 1 year of the simulation, they will always be 24 in the following year.

A stochastic function returns a value based on probability, and therefore has the possibility of returning different values given the same inputs. An example of a stochastic function would be to calculate whether a given service member exits the service in this year of the simulation, given their age, years in service, and percent of time spent in a critical unit. These functions can be modeled by using statistics gathered from real-world data.

#### 5. **Availability Pools**

Each annual iteration of AB-TLM determines the subsequent unit assignment for every service member in the simulation. The assignment is completed in several phases, with the first set of phases attempting to fill the critical unit.

Availability pools group service members according to what next actions are allowed, depending upon the rules of the system. For example, a service member with 1 year remaining in the support unit may belong to the availability pools to stay in the current unit, and to be pulled to the critical unit.

Membership in any given pool does not necessarily mean the service member will take that next action. Because service members may participate in several pools, only one will ultimately be selected.

#### 6. **Annual and Overall Statistics**

The system is designed to support a large number of measures that illustrate the simulated results of the user inputs. Some of these statistics are useful annually, and some are useful when reviewing the entire lifespan of the simulation.

Some of the statistics calculated include:

- **Average Tour Length.** For each unit, a measure of the average amount of time service members stay in that unit.
- **Percent Overlap.** For a given unit, over a given time period, what percent of the people at the beginning of the unit are still in the unit at the end of the time period. This gives a sense of unit cohesion in the simulation.

- **Number Held.** The average number of people held an extra year in the critical unit.
- **Number Pulled.** The average number of people pulled a year early from the support unit.
- **Number Exits.** The average number of people leaving the service annually.
- **Fill Rate.** The average fill rate; that is, the number of people in the unit divided by the number of billets.

In addition, annual and average counts are aggregated of how many people are in their first, second, third, and fourth year of tour for each unit.

## D. Simulation Process

The steps of the simulation are as follows:

1. Read in scenario parameters
2. Generate the initial population
3. For each year:
  - a. Create a new record for continuing members
  - b. Determine which members leave the service
  - c. Fill the critical unit to minimal fill (if possible)
  - d. Determine who receives training
  - e. Place any remaining service members into the correct unit
4. Calculate statistics for that year

A detailed description of these steps is given in Appendix C, which describes a prototype implementation of AB-TLM.

## E. Verification and Validation of the Simulation Model

To ensure our simulation model is useful, we verified and validated the model. Next, we outline the process of model verification and validation.

### 1. Model Verification

Model verification consists of assessing whether the conceptual model is correctly implemented. Our conceptual model of how the personnel inventory is simulated and the rotation of personnel across billets, as well as the assumptions underlying this model, is outlined earlier in section D. Note that the purpose of verification is to ensure our

conceptual model is correctly implemented, not that the conceptual model is correct, which is part of model validation.

To verify the model, two individuals with extensive R programming experience and were not involved in the coding of the simulation reviewed the R code used in the simulation model. Both individuals agreed the code used implements the conceptual model correctly and matches the conceptual model. In addition they found no issues or errors in the code. Based on this, we consider the simulation model to be sufficiently verified.

## **2. Model Validation**

The purpose of model validation is to assess the accuracy of the simulation model in representing real-world phenomena. We follow the three-step approach of Naylor and Finger (1967) to validate the model.

The first step of model validation is to assess its face validity. The purpose of this step is to evaluate whether the simulation model is a reasonable approximation of how service members rotate through billets. To assess face validity, three former service members and IDA colleagues with knowledge of the detailing process were consulted multiple times. These former service members served in the Army, Navy, and Air Force. Based on the feedback of these individuals, the simulation model was modified so the model more closely reflects reality. According to those consulted, though our model is necessarily simplified, it does reasonably reflect actual rotational policies in the armed services.

The second step of model validation is confirming the assumptions of the model. These assumptions fall into one of two categories: structural and data. Structural assumptions are the assumptions made about how the system operates, which in our study is how personnel rotate among the billets, when personnel leave the military, and so on. Data assumptions are made about how data are created and used in the model. In our study, these assumptions include how our original inventory was simulated, how we simulated whether an individual left, and so on.

To validate the structural assumptions, we need to compare our assumptions in the conceptual model to the actual behavior observed. In our model, we must make the following assumptions:

1. We assume that after an individual reaches 20 years of service (YOS), that person retires from the military. For enlisted personnel this is a reasonable assumption. Based on DMDC data for FY 2000 through FY 2018, around 5 percent of enlisted personnel have 20 or more YOS. In addition, the continuation rate for those reaching 20 percent decreases markedly to around 50 percent, suggesting that sailors typically serve less than 20 years and that most careerists leave after 20 YOS. Note that this assumption can be relaxed and updated to reflect actual probabilities.

2. We assume each person who leaves the military, either through turnover or retirement, is replaced with a new recruit so that the number of individuals entering and leaving the military is equal. For the Navy, this is also fairly reasonable to assume. Navy end strength has fluctuated with a high of just over 380,000 in FY 2002 and a low of just under 330,000 in FY 2012.<sup>51</sup> These numbers largely reflect changes in legislated end strength, such as due to budget sequestration, as opposed to an inability to meet recruitment goals. As a result, it is reasonable to assume that for the Navy, a new recruit enters for each sailor who leaves.
3. Our model assumes that sea manning (critical billets) is prioritized over shore manning and training (support and training billets). This is a reasonable assumption as the Navy is a sea-centric institution and priority is typically given to manning sea billets.
4. As a baseline, our model assumes that tour lengths for critical and support units are 3 years, and tour lengths for training units are 2 years. Based on the Navy Sea Shore Flow Model (SSFM), the assumption of equal critical and support unit tour lengths (sea and shore tours, respectively) is not used in practice for many enlisted ratings because sea tours are typically longer. Nonetheless, we use this as a baseline assumption because the Navy uses these tour lengths to represent “typical” tour lengths.<sup>52</sup> Further, based on the SSFM, training typically does not last for 2 continuous years. We make this assumption because it simplifies our simulation model.
5. Our model assumes that, with a shortage of critical unit personnel, this shortage is corrected by first holding those eligible to PCS from the critical unit and then, if a shortage still exists, by pulling support unit personnel who have completed 2 years of their tours. In practice, this process is not always used but is a reasonable simplification. In terms of cost, to hold personnel rather than pull them is generally cheaper, so it is reasonable to assume that in order to minimize costs, personnel are first held and then pulled.
6. Our model assumes personnel are randomly selected to be held, pulled, or sent to training. Random selection makes the additional assumption that personnel are substitutable. Though considerations may be made about where to send personnel, such as YOS and personal factors, within a given rank and rating the Navy does implicitly assume that personnel are substitutable. In the detailing process, the Navy’s primary concern is to satisfy its needs, and from that

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<sup>51</sup> <https://www.csis.org/analysis/us-military-forces-fy-2020-navy>.

<sup>52</sup> <https://www.thebalancecareers.com/frequently-asked-questions-about-navy-assignments-4054270>.

perspective individuals can be substituted for one another if they are of the same rank and rating.

We also must validate the assumptions we made about our data. These assumptions include the following:

1. To simulate the initial inventory, we used the actual personnel YOS distribution. Using the DMDC data, we calculated the percentage of personnel for each YOS up to 20 YOS. This information was used to simulate the number of personnel for each YOS. Assuming the distribution of personnel by YOS stays relatively constant, this is a reasonable assumption.
2. When calculating the number of years remaining on a tour for the initial inventory, we assumed that each possibility (1, 2, or 3 years) is equally likely. This assumption is not entirely reasonable due to incomplete tours and would lead to an unequal distribution of number of years remaining, with the most individuals having 3 years left and the fewest individuals with 1 year remaining. We acknowledge that our assumption is a simplification. However, when looking at the distribution of years remaining on a tour at the end of our simulation, we do not observe a uniform distribution and instead observe a distribution more in line with what we expect. This is due to the holds and pulls that occur and, to a smaller extent, training.
3. To randomly select individuals who leave the military, we use continuation rates by YOS calculated using DMDC data. For each individual, a random number between 0 and 1 is chosen from the uniform (0,1) distribution. If the randomly chosen number is greater than the historical continuation rate, we assume the individual leaves. We acknowledge that the choice to leave the military is not random and is influenced by other factors. However, this approach allows us to incorporate the decision to leave and is an area that could be revisited by incorporating a more complicated retention model.

The third and final step of model validation is validating input-output transformations. Essentially, this entails comparing results from the simulation model to actual data, allowing us to assess whether the results we obtain are reasonable. For the simulation model we considered five outcomes: 1-, 2-, and 3-year overlap rates; average number of pulls for tour lengths; number of holds; and number of PCS moves. We first explain how the different measures are calculated and then compare the results calculated from actual data to the results obtained from the simulation model.

Overlap rates were calculated by “looking backwards” at the UIC level. That is, the 1-year overlap rate is the percentage of personnel in a given unit in year  $t$  who were also in that unit in year  $t-1$ . For example, the 2012 1-year overlap rate is the percentage of personnel at a given UIC in 2012 who were at the same UIC in 2011. We used data from

the DMDC to calculate overlap rates. Because the DMDC does not provide information on prescribed tour lengths or minimum fill rates, we were unable to calculate overlap rates using these data.

To calculate average tour lengths, we used two sources of data. The DMDC provides information on the individual level, including the first and last day spent at a specific UIC. Using this information, we calculate actual tour lengths. The potential problem with using this information is that actual tour lengths do not provide information on prescribed tour lengths. For example, it is of interest to calculate average actual tour lengths for prescribed 3-year tours. To do this, we obtained orders data from the Navy that provide information on the individual level of the first day and last day an individual is assigned to a UIC. Using this information, we can calculate the average actual tour lengths for given prescribed tour lengths, such as the average tour lengths for all prescribed 3-year tours.

To calculate the number of holds and pulls, we use the orders data obtained from the Navy and the DMDC data on actual tour lengths. We define a hold as occurring if the actual tour length is 6 months or more than the prescribed tour length; a pull is defined as occurring if the actual tour length is 6 months or less than the prescribed tour length. To make values comparable between the actual data and the results of the simulation model, we calculate the percentage of tours that lead to a hold and the percentage of tours where a pull occurs. A caveat must be given when comparing results for holds and pulls. With the orders data and DMDC data, we have no way of knowing whether an individual was actually held or pulled because this information is not recorded. In our simulation model, we know with certainty whether a hold or pull has occurred.

To calculate PCS moves, we used the DMDC data. We considered a PCS move to occur when the UIC to which an individual was assigned changed. To make values comparable, we again calculated the percentage of personnel who experienced a PCS move each year. We then averaged over the years to obtain the average percentage of personnel who experienced a PCS during a year.

Table 9 shows the results on the outcomes of interest for the DMDC and orders data compared to results from our simulation model. When comparing values from this table, a few caveats apply. First, in our simulation model, we are able to distinguish between sea and shore units, and hence billets. With the DMDC and orders data this is not possible. Though we know the UIC to which an individual is assigned, this does not necessarily provide information on whether the billet was considered to be a sea or shore billet as both types of billets exist within a UIC. Second, the simulation model assumes that prescribed tours are either 3 or 4 years. In practice, and as shown in the SSFM, prescribed tour lengths, especially for sea tours, are longer than 3 or 4 years for many ratings. Because of potential concerns for comparisons, when possible we report “group level” results. For example, when looking at average tour lengths, we look at the average lengths of 3- and 4-year prescribed tours to make results more comparable.

**Table 9. Overlap Comparison**

|                                                 | DMDC/Orders<br>Data                       | Simulation Model              |       |                                      |       |
|-------------------------------------------------|-------------------------------------------|-------------------------------|-------|--------------------------------------|-------|
|                                                 |                                           | 3-year sea and shore<br>tours |       | 4-year sea and 3-year<br>shore tours |       |
|                                                 |                                           | Sea                           | Shore | Sea                                  | Shore |
| 1-Year<br>Overlap Rate                          | 52.89%                                    | 72%                           | 65%   | 76%                                  | 65%   |
| 2-Year<br>Overlap Rate                          | 27.37%                                    | 45%                           | 33%   | 54%                                  | 34%   |
| 3-Year<br>Overlap Rate                          | 10.37%                                    | 23%                           | 8%    | 34%                                  | 9%    |
| Average Tour<br>Length—3-<br>Year<br>Prescribed | 33.4 (first term)<br>32.4 (career)        | 37.2                          | 30.0  | --                                   | 30.0  |
| Average Tour<br>Length—4-<br>Year<br>Prescribed | 36.8 (first term)<br>36.7 (career)        | --                            | --    | 44.4                                 | --    |
| Holds—3-<br>Year<br>Prescribed                  | 14.21% (first<br>term)<br>10.29% (career) | 6.5%                          | 6.5%  | --                                   | --    |
| Holds—4-<br>Year<br>Prescribed                  | 13.44% (first<br>term)<br>9.56% (career)  | --                            | --    | 5.3%                                 | 5.3%  |
| Pulls—3-Year<br>Prescribed                      | 32.78% (first<br>term)<br>29.69% (career) | 1.1%                          | 1.1%  | --                                   | --    |
| Pulls—4-Year<br>Prescribed                      | 52.83% (first<br>term)<br>53.84% (career) | --                            | --    | 0.4%                                 | 0.4%  |
| PCS Moves                                       |                                           |                               |       |                                      |       |

Notes: Values were calculated using data for enlisted personnel. Results for the simulation model assume a 90 percent minimum fill rate for the sea unit.

When comparing results from the DMDC and orders data to the results from our simulation model, several features should be noted. The first is that the overlap rates in the simulation model are higher than actually observed. Second, we observe discrepancies between the hold and pull rates between the DMDC/orders data and the results of the simulation model. Last, average tour lengths are more similar than the results for the other outcomes of interest. Several potential reasons exist for these discrepancies. The first is that the conditions used in the simulation model to obtain results (e.g., tour lengths) are a

simplification. In the simulation model, we assume tour lengths are set equal for all individuals assigned to a unit. In practice this does not necessarily happen. Second, overlap rates for the DMDC data were calculated by averaging all tours and all years. This means we did not restrict our calculations to only 3- or 4-year prescribed tours and included tours with prescribed lengths of 1 or 2 years, leading to lower observed overlap rates. Because the initial conditions for the DMDC data and the simulation model are not the same, comparisons must be made cautiously. Third, the definitions we used to calculate holds and pulls are analogous to those used in previous research to calculate tour extension rates and incompletion rates, respectively, and differ from how they are calculated in our model. For example, the percentage of tours that involve a pull is much smaller in the simulation model. This is because we consider all incomplete tours to be pulls, which is clearly not the case as most tours are incomplete due to service members leaving the military. We are not able to determine whether an incomplete tour is due to a pull using the DMDC and orders data.

We believe that increasing the realism of the model by using more accurate baseline assumptions and incorporating attrition and recruiting rates from the military data would enable it to be used as tool for considering the impact of changing tour lengths in special communities or geographical areas. A primary benefit of this model is its ease of use and how it clearly demonstrates the interactions of manning requirements and tour lengths.

## 9. Findings and Recommendations

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The DoD asked IDA to assess the impacts of increasing tour lengths on retention and readiness. To this end, IDA conducted a literature review, developed a framework and model, identified data available to evaluate the model, and created a simulation demonstration.

The literature review covered changes in tour lengths and factors affecting retention and readiness. IDA found:

- Tour Lengths and Completion
  - The percentage of incomplete tours is higher for first term tours than career tours.
  - Longer sea tours lead to more incomplete sea tours; for example, increasing a tour from 3 years to 4 years increases actual tour length by approximately 3 to 4 months.
- Retention
  - Family factors and demographics play a large role in retention. Increased family separation due to longer sea tours may decrease retention.
  - Longer tours and tours in desirable locations positively affect retention.
- Readiness
  - Group cohesion has a positive impact on readiness as most activities are team-based. Increasing tour lengths may improve group cohesion.
  - More frequent moves typically reduce readiness.

Based on our literature review, we developed a conceptual framework that brings together the readiness and retention literature and incorporates tour length and location. The framework also considers the processes through which the input factors affect the outcomes of retention, readiness, and cost. We identified available data that can be used to evaluate the framework using structural equation modeling.

Finally, we developed a demonstration simulation model that could allow DoD to test scenarios of changing tour lengths. The simulation model is intended to be updated with results from the structural equation model. Minor improvements to the model (e.g., baselining to the military data and updating the assumptions) will provide an easily used tool for quantifying the impact of changing tour lengths on crew stability.



## Appendix A. Tour Length Exceptions

DoDI 1315.18, Change 3, Effective June 24, 2019; using Enclosure 4

### OCONUS

| <u>Page</u> | <u>Reference</u> | <u>Tour Lengths</u>                                                                                              |
|-------------|------------------|------------------------------------------------------------------------------------------------------------------|
| 25          | 1.a              | Joint Travel Regulations (JTR), TL - provides by location authorized tour lengths                                |
|             | 1.a(1) and 1.e   | Standard OCONUS Tour Length: 36 months accompanied/24 months unaccompanied. Many exceptions by location per JTR. |
|             | 1.a              | Except for AK and HI (36/36)                                                                                     |
|             | 1.a(2)           | MilDepts or Combatant Commanders may provide evidence of hardships in order to shorten duration,                 |

### Deviations, Exceptions, and Nuances from Standard OCONUS Tour

| <u>Page</u> | <u>Reference</u> | <u>Length</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25          | 1.c              | Small Groups                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 26          | 1.f              | Govt-Govt Contracts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|             |                  | If fewer than 25 Service members from only one Military Service are assigned to a country or specific overseas location without an established tour length, the Secretary of the Military Department concerned may establish an unaccompanied tour length for that location based on the tour length guidelines prescribed in Enclosure 7 of this instruction. When Service members are assigned to activities governed by government-to-government contracts, the tour lengths specified by the contract will be served, regardless of the prescribed tour lengths for the duty station. |

|    |     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----|-----|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26 | 1.g | Defense Attachés           | <p>The prescribed tour lengths for Service members assigned to the Defense Attaché System and whether these tours are accompanied or unaccompanied will be determined by the Director, DIA.</p> <p>The prescribed tours, including the tour length and accompanied or unaccompanied eligibility, for Service members assigned to SCOs (e.g., Office of Defense Cooperation, Office of Security Cooperation, Office of Military Cooperation, U.S. Military Groups) will be the same tours prescribed for Service members assigned to the Defense Attaché System at the same assigned location.</p>                                                                                        |
| 26 | 1.h | Security Cooperation       | <p>Tour lengths for Marine Corps security guards assigned to foreign service posts overseas are prescribed by the Memorandum of Agreement between the U.S. Department of State and the U.S. Marine Corps.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27 | 1.i | USMC Guards                | <p>For Marine barracks OCONUS, the tour length will be as prescribed for the location in Appendix Q of Reference (m), except that the unaccompanied tour for first term enlisted Marines is 18 months or the prescribed tour, if shorter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27 | 1.j | USMC Barracks OCONUS       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 27 | 1.K | Medical Officers           | <p>Medical officers with 2-year service obligations serving in certain shortage specialties, as determined by the Secretary of the Military Department concerned in consultation with his or her Surgeon General, are authorized to serve 2-year accompanied tours in long tour areas.</p>                                                                                                                                                                                                                                                                                                                                                                                               |
| 27 | 1.l | USMC Sea and Hardship Duty | <p>Tours of duty at sea and hardship duty with deployment-designated Marine Corps operating forces units primarily involve the Department of the Navy. Therefore, the Secretary of the Navy is delegated authority to establish accompanied and unaccompanied tour lengths for these tours.</p> <p>Reserve Component service members, other than Active Guard and Reserve Service members, ordered to active duty for training for 140 days or more at one overseas location or ordered to active duty other than training for more than 180 days at one overseas location are not required to serve the established overseas tour length for the country or overseas duty location.</p> |
| 27 | 1.m | Reserves (non-active)      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

|    |     |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----|-----|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27 | 1.n | FAOs                      | <p>Officers participating in Foreign Area Officer training assignments and education and broadening assignments may be authorized to serve 12 month accompanied tours.</p> <p>Only those positions where the continued presence of an officer, warrant officer, or senior enlisted Service member (i.e., E-8 or E-9) is determined to be absolutely essential to the mission of an activity or a unit or to the U.S. presence in that area will be designated a key billet. Such designations require the Service member to serve 24 months, even if he or she declines to serve the tour accompanied, and will be established only at overseas duty stations where the accompanied tour is at least 24 months.</p> |
| 28 | 3   | Key Billets               | <p>Service members assigned overseas and accompanied or joined by command-sponsored dependents will serve the prescribed accompanied tour. Service members will be given the opportunity to extend their obligated military service to qualify for and serve the accompanied tour.</p>                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 29 | 5.a | Voluntary Extension       | <p>Service members acquiring dependents while assigned overseas must request to serve the prescribed accompanied tour in order to obtain command sponsorship for their dependents.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 29 | 5.b | Acquire Dependents OCONUS | <p>Single Service members or those who either voluntarily or involuntarily are not accompanied or are not joined by command-sponsored dependents will serve the prescribed unaccompanied tour when assigned overseas. Career Service members who have no dependents in their household, are not married to another Service member, and are assigned to overseas locations authorized an accompanied long tour will be required to serve a minimum of the unaccompanied tour. The decision to require these Service members to serve the accompanied tour rests with the Secretary of the Military Department concerned.</p>                                                                                         |
| 30 | 5.c | Singles                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

|    |        |                                                                     |                                                                                                                                                                                                                                                                                                                                                                                         |
|----|--------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30 | 5.d(1) | Married<br>Military<br>Couples<br>(accompanied<br>by<br>dependents) | Married Service members accompanied or joined by command-sponsored dependents will serve the accompanied tour.                                                                                                                                                                                                                                                                          |
| 30 | 5.d(2) | Married<br>Military<br>Couples<br>(same<br>location)                | Married Service members assigned to or living in the same overseas location or locale will serve the accompanied tour when such a tour length is authorized for either Service member's duty station.                                                                                                                                                                                   |
| 30 | 5.d(3) | Married<br>Military<br>Couples<br>(different<br>locations)          | Married Service members assigned to different locations will serve the unaccompanied tour. However, if these Service members establish a joint residence, they will serve the accompanied tour if such a tour is authorized for the location or locale where they are residing.                                                                                                         |
| 30 | 5.d(4) | Married<br>couples (get<br>married while<br>OCONUS)                 | When a Service member marries another Service member while both are assigned overseas, their original tours are maintained. The only exceptions to this requirement are for those Service members who voluntarily agree to serve the longer (accompanied) tour at that location or when dependent command sponsorship is involved.                                                      |
| 33 | 7      | Policy:<br>Voluntary<br>Extension                                   | The Military Services will encourage eligible Service members to voluntarily extend their overseas tours, as such extensions provide a high degree of continuity in the unit of assignment, increase the stability of the Service member and his or her family, when accompanied, and reduce PCS costs by eliminating the Service member's move and the move of his or her replacement. |

|    |     |                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----|-----|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34 | 7.d | Involuntary Extensions                                             | <p>Service members may be retained in an overseas area beyond their original return date to the CONUS for investigation or trial by U.S. military or foreign authorities or for completion of actions such as non-judicial punishment, separation processing, or compliance with host-country custom regulations.</p> <p>The Service Personnel Chief, or equivalent, at the headquarters that directs assignment policies for the Military Service concerned may extend members involuntarily up to 180 days on a case-by-case basis under these circumstances: operational needs, training/education start does not coincide with tour completion date, and assigned to a unit being inactivated/deactivated or a base closure.</p> |
| 34 | 7.d | Involuntary Extensions                                             | <p>To reduce PCS turbulence, the Military Services will encourage eligible Service members to volunteer for and serve COTs. While it is preferred that COTs be done voluntarily, the Military Services may direct involuntary COTs. To maximize the benefits to be realized from COTs, the Military Services will ensure that tour obligations are met.</p>                                                                                                                                                                                                                                                                                                                                                                          |
| 35 | 8   | Consecutive Overseas Tours (COTS)<br>In-Place Consecutive Overseas | <p>Service members serving on either an accompanied or unaccompanied tour may request an IPCOT before completing the initial tour, to include voluntary extensions to that tour. By doing so, the Service member agrees to serve another tour within the local commuting area.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 35 | 8.a | Tour (IPCOT)                                                       | <p>To enhance stability for the Service member and his or her unit, and to offset the costs associated with overseas assignments, Service members will serve their assigned tour lengths. Although the demands of military service may require reassigning Service members before they complete their prescribed tours, such decisions by a Military Service must be kept to an absolute minimum. The Secretary of the Military Department concerned may grant a curtailment on a case-by-case basis if it is the only recourse available and is in the U.S. Government's best interest.</p>                                                                                                                                         |
| 38 | 10  | Curtailment of Overseas Tour                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



## **Appendix B.**

### **Overview of Locations**

---

#### **Naval Bases in Japan**

The U.S. Navy operates three major bases in Japan—Commander Fleet Activities Sasebo (CFA Sasebo), Commander Fleet Activities Yokosuka (CFA Yokosuka), and Naval Air Facility Atsugi (NAF Atsugi). Both CFA Sasebo and CFA Yokosuka have a primary mission of supporting the Seventh Fleet. NAF Atsugi’s primary mission is to provide facilities, material, and logistics support for Carrier Wing Five. CFA Yokosuka is a considerably larger base than the other two with a population of nearly 25,000 military and civilian personnel and family members. In contrast, the population at CFA Sasebo is around 7,500 and at NAF Atsugi around 9,300 (including members of the Japanese military).<sup>1,2,3</sup>

Based on data from the DMDC Active Duty Masterfile, from 2013 through 2018 the majority of personnel stationed in Japan were enlisted personnel with 38,254 (88 percent) being stationed in Japan. The remaining personnel consisted of 5,083 officers (12 percent).

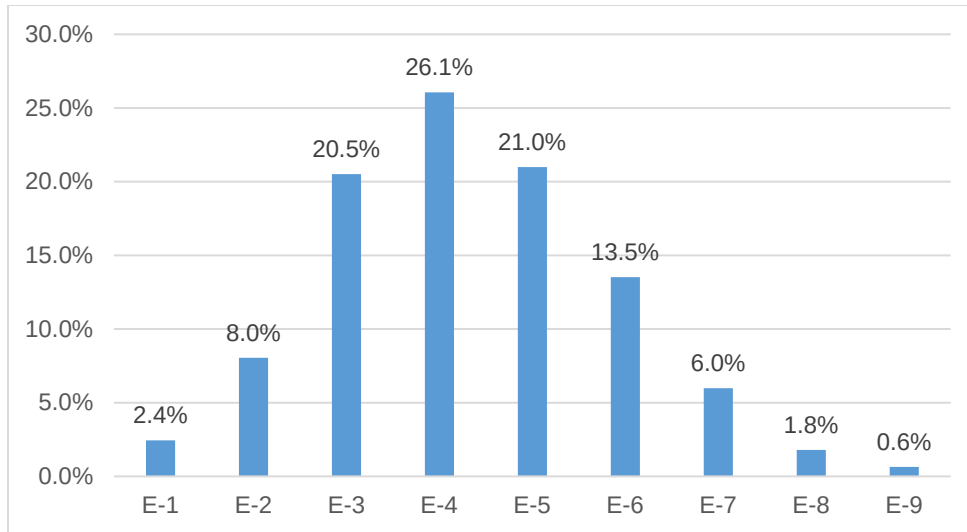
Figure B-1 and Figure B-2 display the distribution of ranks for enlisted personnel and officers, respectively. The majority of enlisted personnel (81.1 percent) are in the ranks E-3 through E-6 while the majority of officers (66.2 percent) are at the rank of O-3 or lower.

---

<sup>1</sup> Military OneSource, <https://installations.militaryonesource.mil/military-installation/commander-fleet-activities-yokosuka>, accessed January 10, 2020.

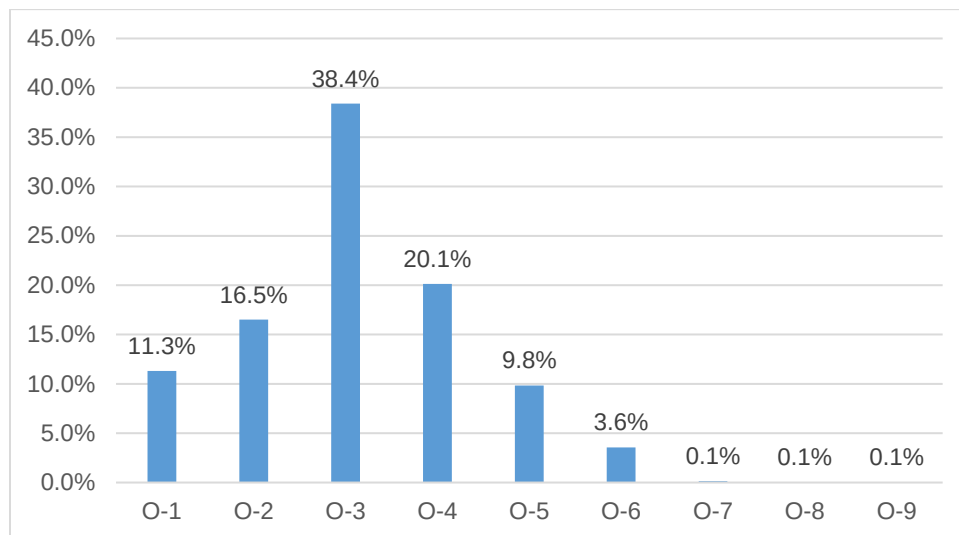
<sup>2</sup> Military OneSource, <https://installations.militaryonesource.mil/military-installation/commander-fleet-activities-sasebo>, accessed January 10, 2020.

<sup>3</sup> Military OneSource, <https://installations.militaryonesource.mil/in-depth-overview/naval-air-facility-atsugi>, accessed January 10, 2020.



Source: DMDC Active Duty Masterfile.

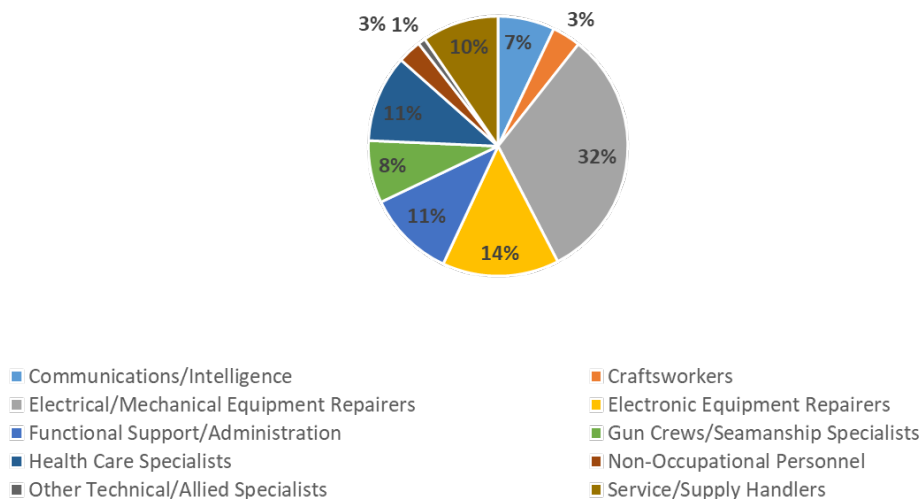
**Figure B-1. Distribution of Enlisted Personnel by Rank at Naval Bases in Japan**



Source: DMDC Active Duty Masterfile.

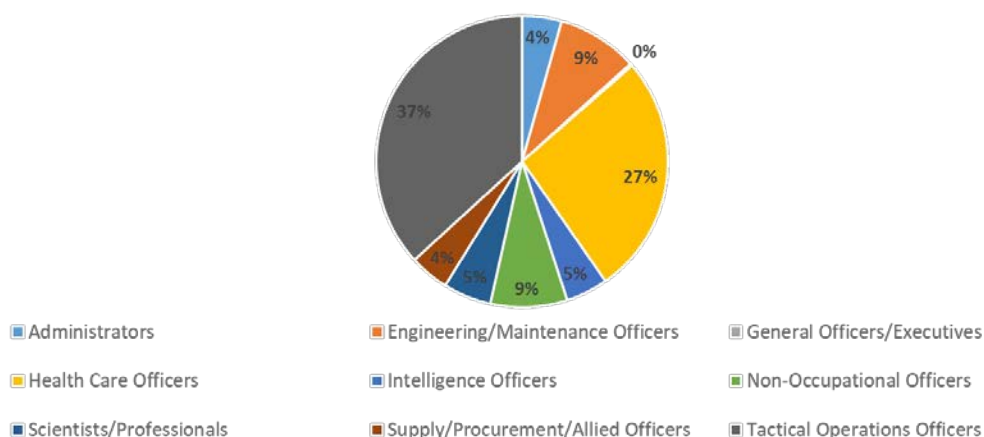
**Figure B-2. Distribution of Officers by Rank at Naval Bases in Japan**

The distribution of occupational categories of enlisted personnel and officers are found in Figure B-3 and Figure B-4, respectively. The most common occupation of enlisted personnel is electrical/mechanical equipment repairers (32 percent), while tactical operations officers (32 percent) and health care officers (27 percent) are the most common occupational categories.



Source: DMDC Active Duty Masterfile.

**Figure B-3. Occupational Categories of Enlisted Personnel at Naval Bases in Japan**



Source: DMDC Active Duty Masterfile.

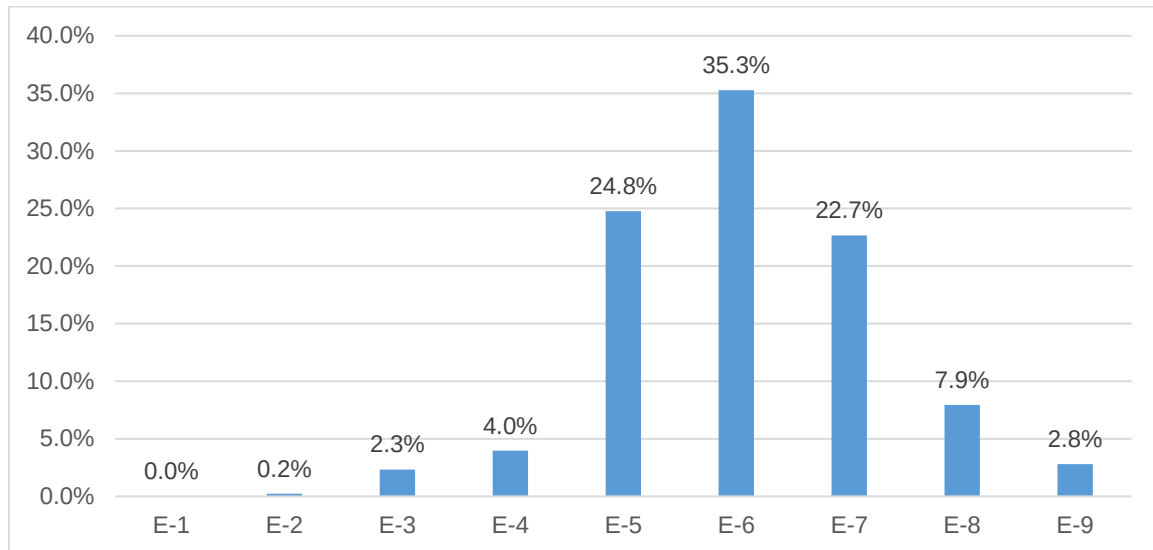
**Figure B-4. Occupational Categories of Officers at Naval Bases in Japan**

## Naval Base Guam

Naval Base Guam (NBG) is located on Apra Harbor, Guam, and along with Andersen Air Force Base is part of the joint military command Joint Region Marianas. The primary purpose of NBG is to support the U.S. Pacific Fleet as well as provide support to the warfighters based on, serviced, and supplied by NBG, the commands providing support to

the warfighters and the families of those stationed at NBG.<sup>4</sup> Currently NBG has 12,000 military members and their families.

Using data from the DMDC Active Duty Masterfile for the period from 2013 through 2018, on average 428 enlisted personnel were stationed in Guam with 486 officers. Most enlisted personnel (93.5 percent) are at the rank E-5 or above while most officers (80.9 percent) are at the rank of O-4 or higher. The distribution of personnel by rank is found in Figure B-5 for enlisted personnel and Figure B-6 for officers.

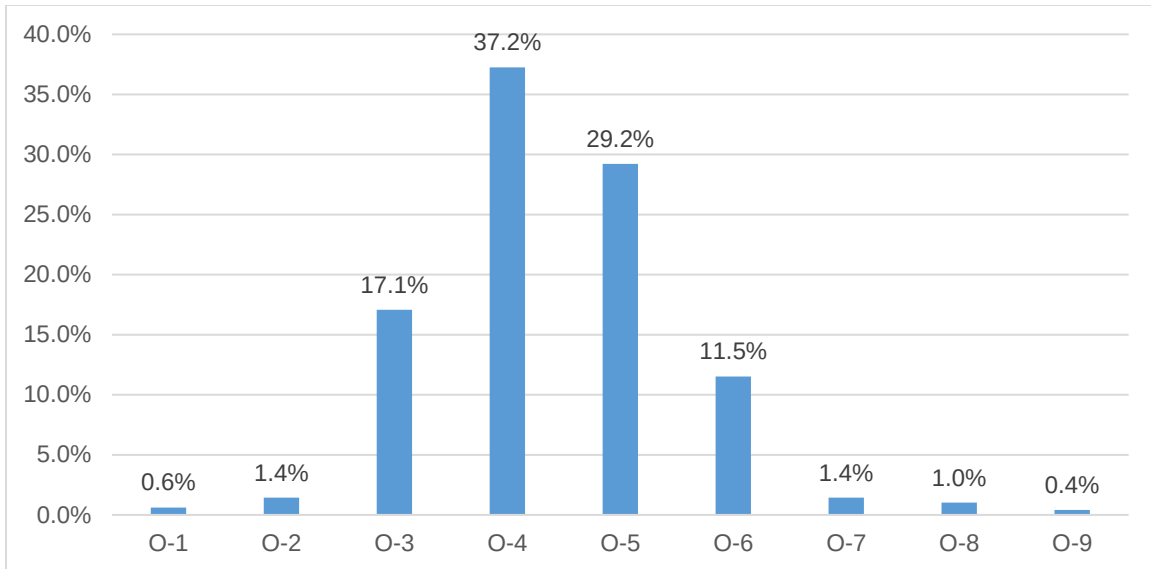


Source: DMDC Active Duty Masterfile.

**Figure B-5. Distribution of Enlisted Personnel by Rank at Naval Base Guam**

---

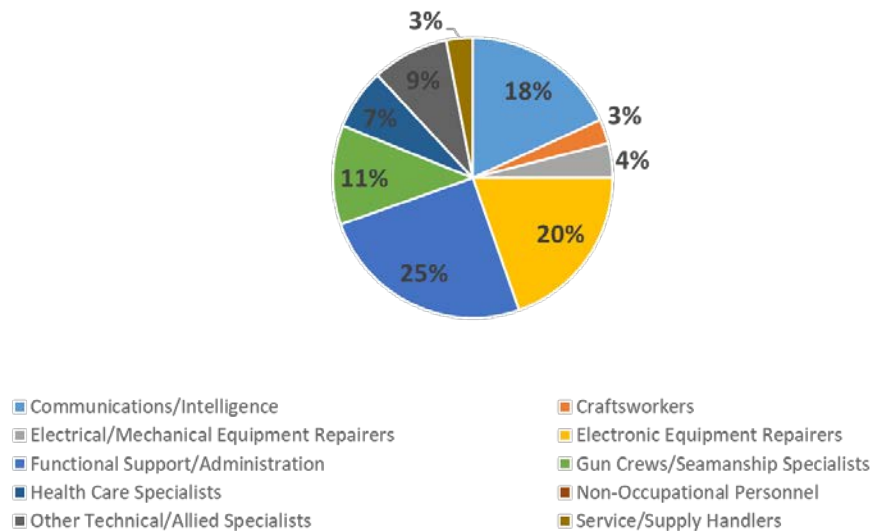
<sup>4</sup> Military OneSource, <https://installations.militaryonesource.mil/in-depth-overview/joint-region-marianas-naval-base-guam>, accessed January 10, 2020.



Source: DMDC Active Duty Masterfile.

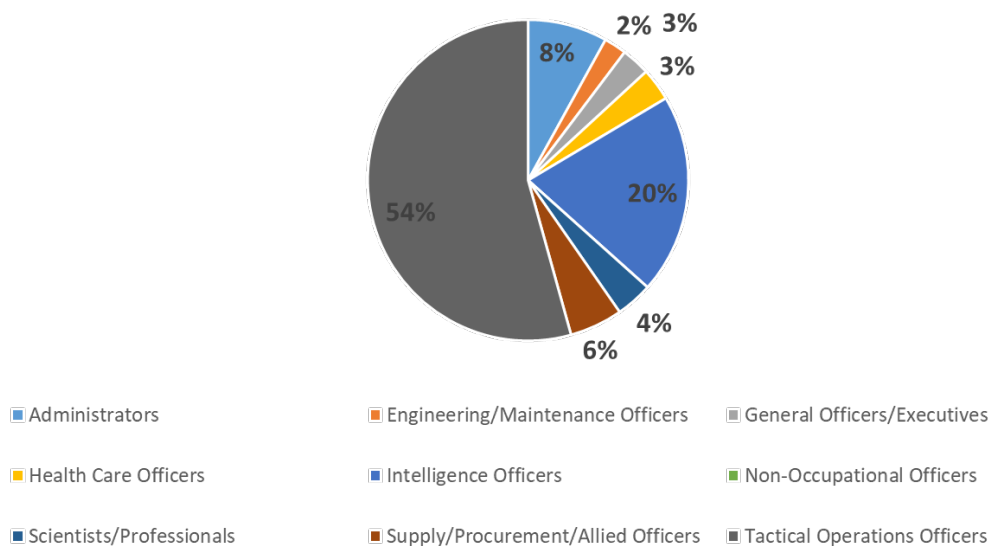
**Figure B-6. Distribution of Officers by Rank at Naval Base Guam**

As shown in Figure B-7 and Figure B-8, the most common occupational categories for enlisted personnel are in functional support/administration (25 percent), electronic equipment repairers (20 percent), and communications/intelligence (18 percent), while the most common occupational category for officers is tactical operations officers (54 percent).



Source: DMDC Active Duty Masterfile.

**Figure B-7. Occupational Categories of Enlisted Personnel at Naval Base Guam**



Source: DMDC Active Duty Masterfile.

**Figure B-8. Occupational Categories of Officers at Naval Base Guam**

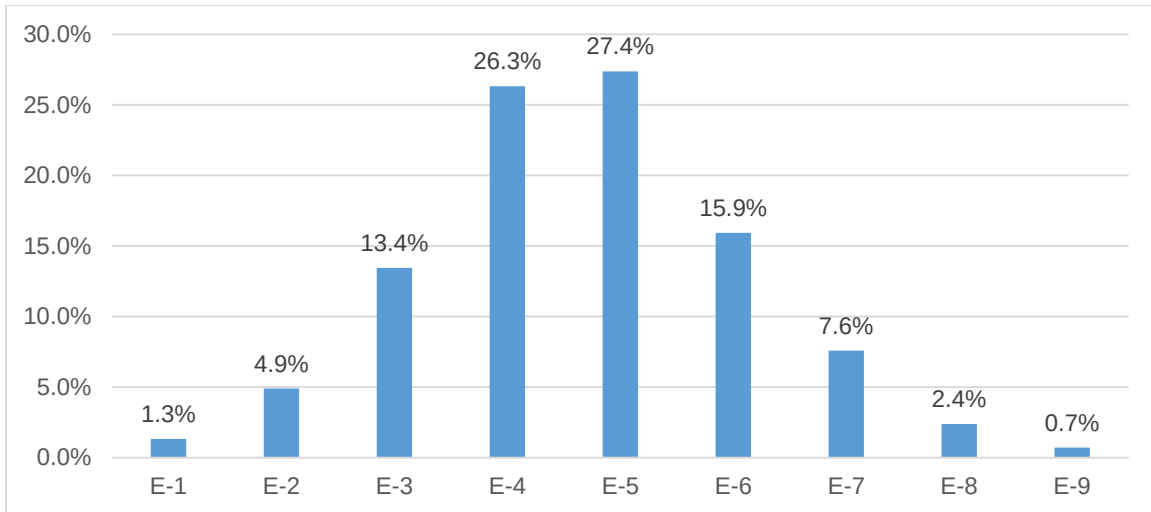
## Naval Station Rota

Naval Station Rota (NSR) is a naval base located in Rota, Spain. NSR is used jointly by Spain and the United States and is commanded by a Spanish Rear Admiral though fully funded by the United States. In addition to housing Navy personnel, NSR also houses U.S. Marine Corps personnel with small U.S. Army and U.S. Air Force contingents. The primary mission of NSR is to support U.S. and NATO operating forces; support the safe and efficient movement of U.S. Navy and Air Force flights and passengers; and provide cargo, fuel, and ammunition to other units in the region.<sup>5</sup> NSR is currently home to 3,000 active duty service members and their families.

Using data from the DMDC Active Duty Masterfile, during the period from 2013 through 2018, the majority of personnel were enlisted (2,397 or 84.2 percent) compared to 553 (15.8 percent) officers.

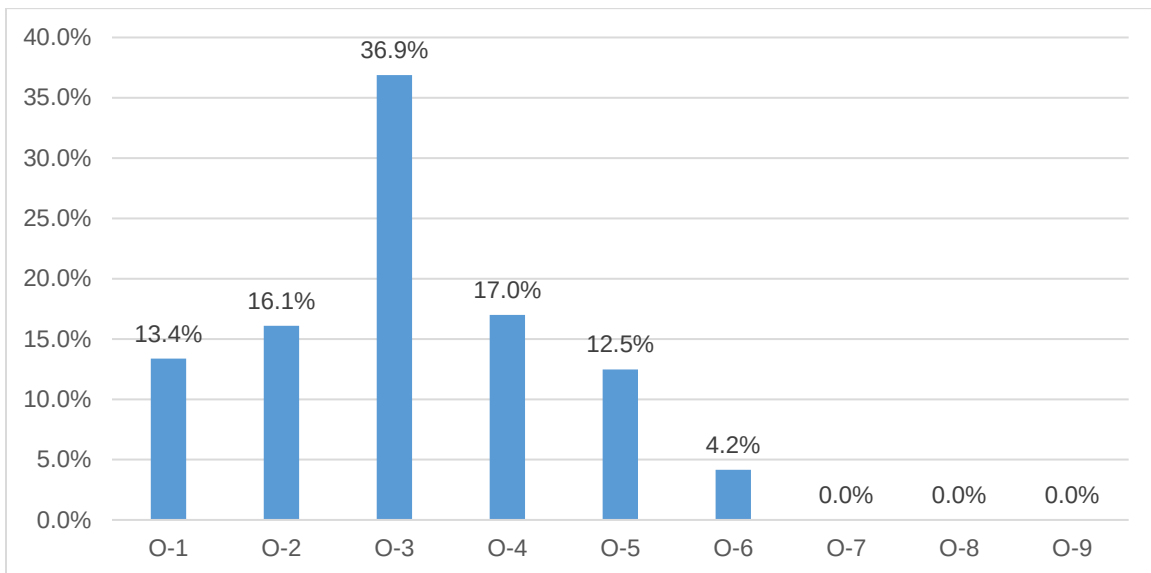
Most enlisted personnel (83.0 percent) are between the ranks of E-3 through E-6 while the majority of officers (66.4 percent) are of rank O-3 or lower. This information is shown in Figure B-9 and Figure B-10.

<sup>5</sup> Military OneSource, <https://installations.militaryonesource.mil/in-depth-overview/naval-station-rota>, accessed January 10, 2020.



Source: DMDC Active Duty Masterfile.

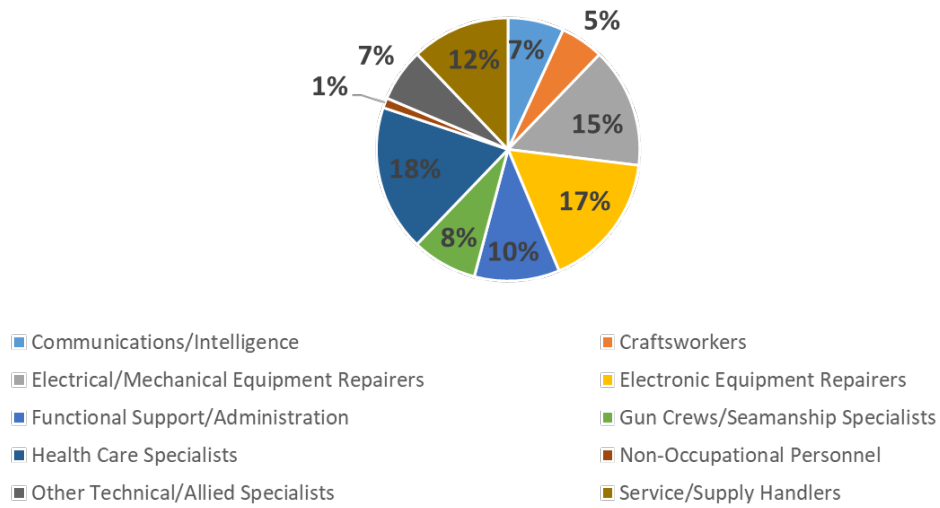
**Figure B-9. Distribution of Enlisted Personnel by Rank at Naval Station Rota**



Source: DMDC Active Duty Masterfile.

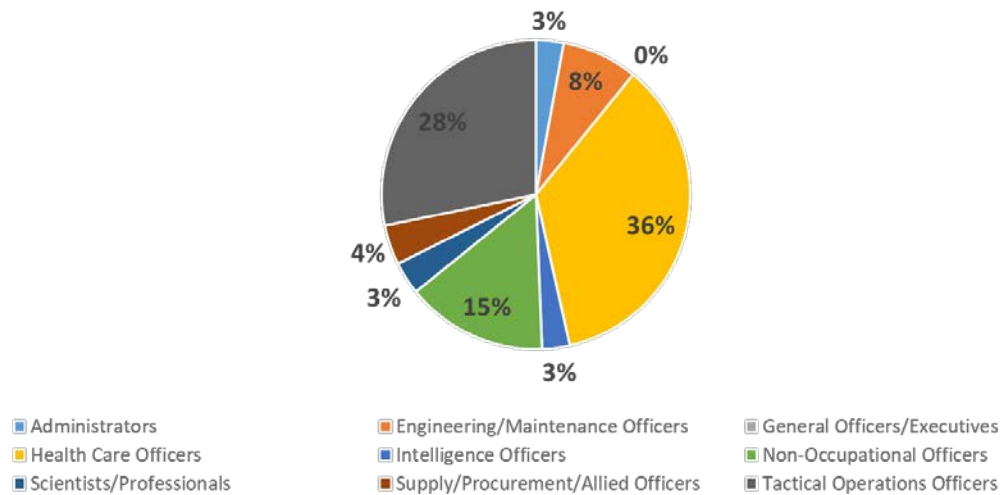
**Figure B-10. Distribution of Officers by Rank at Naval Station Rota**

Figure B-11 and Figure B-12 provide information on the occupational categories of personnel at NSR. For enlisted personnel, the most common occupational categories are functional support/administration (18 percent), electronic equipment repairers (17 percent), and electrical/mechanical equipment repairers (15 percent). For officers the most common occupational categories are health care officers (36 percent) and tactical operations officers (28 percent).



Source: DMDC Active Duty Masterfile.

**Figure B-11. Occupational Categories of Enlisted Personnel at Naval Station Rota**



Source: DMDC Active Duty Masterfile.

**Figure B-12. Occupational Categories of Officers at Naval Station Rota**

## **Appendix C.**

### **Tour Length Simulator 1**

---

This section describes Tour Length Simulator 1, an implementation of the AB-TLM model.

#### **Implementation**

TL-SIM1 has been developed in two sections: the simulation engine, which has been written using the R language; and the analysis and visualization module, implemented in Excel.

#### **Specification**

This section describes the business rules of TL-SIM1:

- The simulation will involve three units: Sea (A), Shore (B), and Training (T).
- The A unit has a guaranteed fill rate.
- The (T) unit has a maximum fill rate of 100 percent (i.e., cannot be overfilled).
- When a tour is completed, the individual moves to the other unit or to the T unit. This is determined randomly. For example, with 50 total slots (A+B+T) and if T has 5 billets, then the probability of going to training is 10 percent.
- If A would go under the guaranteed manning percentage, then individuals are held in the A unit; they will not be assigned to T or B.
- If that does not result in meeting the minimum percentage filled for A, then individuals in their last tour year at the B unit are pulled to the A unit.
- Every year, service members have a statistical chance of leaving the service given how many years they have served so far. This is derived from real-world data.
- If service members have served 20 years, they retire.
- Every year, enough new service members will join to keep the total number of people the same.

## Inputs

On the Specs page in the Excel file, the user can define scenarios and assign parameters to them. Each row is one scenario, and each scenario can be run multiple times. The parameters that can be specified are:

- **ScenarioID.** This is a user-specified key to name the scenario on this row.
- **numSimulations.** This indicates how many times the simulation engine should run this scenario. Summary statistics will be calculated for each run as well as for the overall scenario.
- **startYear, endYear.** Each run will start at startYear and end at endYear. The numbers themselves do not matter to the simulation engine but make the results somewhat more readable.
- **billetsA.** The number of billets assigned to the critical unit.
- **tourLengthA.** The tour length of the critical unit.
- **minFillPercentA.** The target minimal fill percentage of the critical unit. Every simulated year, the simulation engine will attempt to keep the critical unit filled to this percentage or higher, when possible.
- **billetsB.** The number of billets assigned to the support unit.
- **tourLengthB.** The tour length of the support unit.
- **billetsTraining.** The number of slots available for training each year.
- **tourLengthTraining.** The length of a training tour.
- **initialFillPercent.** The critical and support units are filled at this percentage at the beginning of the simulation.

## Attributes

Each simulated service member for each year will have the following attributes:

- **PersonKey.** A unique identifier for this person. This will be maintained for the same person year over year. New service members will receive a new PersonKey upon joining the simulation, and the key of members who exit the simulation will not be reused.
- **Rank.** Currently, all service members are simply assigned the rank of “Enlisted.” This is a placeholder for future enhancements.
- **YearsInService.** The number of years the member has been in the service. Initially assigned as a uniform random number from 2 to 18 and increased by one each year of the simulation.

- **UIC.** The current unit that the given member is assigned to.
- **YearsOnTour.** The number of years the member has been assigned to this unit.

The following are the derived attributes for each person:

- **TourLength.** The standard tour length for the assigned unit. This is a lookup from the Specs page and is simply assigned as a reference to make the data row more readable.
- **YearsRemaining.** The number of years left on the current tour, or  $\text{TourLength} - \text{YearsOnTour}$ . Note that this number can be negative if a service member is held an extra year.

## Simulation Process

### 1. Read in the scenario parameters

The simulator does a double loop: for each scenario, the parameters are read in, and then the scenario is run completely once for each of the numSimulations parameter.

### 2. Generate initial population

Service members are generated to populate each of the three units using the three billet parameters and the initialFillPercent.

YearsInService for each member is a uniform random number from 2 to 18.

YearsOnTour for each member is a uniform random number from 1 to the maximum number of years on tour for that unit (as specified on the Specs page).

### 3. Annual Loop

For each year of the simulation, the following steps are performed:

#### b. Create a new record for each service member

Generate a new service member to replace every member who exited the prior year.

For every service member who did not exit the service the previous year, create a new record with updated attributes:

- **PersonKey** stays the same as the previous year.
- **Rank** remains the same.
- **YearsInService** increases by 1.
- **UIC:** Now equal to the NextUIC of the previous year.

- **TourLength:** Look up the tour length for the assigned UIC.
- **YearsOnTour:** If the member was assigned to a new unit this year, start over at 1. Otherwise, increase last year's YearsOnTour by 1.
- **YearsRemaining:** TourLength – YearsOnTour

**c. Determine which members leave the service**

Every member who has reached 20 years will be assigned a NextAction of **EXIT**.

Every other member will exit randomly according to real-world statistics based on their years in service.

**d. Fill the critical unit to minimal fill (if possible)**

All individuals assigned to the critical unit with 1 or more years remaining on tour will be given a NextAction of **STAY**.

The general procedure for filling the critical unit is to calculate how many people (if any) are required to bring the unit to its minimal fill, and then create an availability pool of people who have the potential to fill the unit. Once the unit has been filled to its required minimum, the simulator passes to the next step without looking at any more availability pools. If at any time more people are in an availability pool than are needed, then a random selection of just those needed is assigned to the critical unit. The remaining service members will be assigned in subsequent steps of this procedure.

The first availability pool is service members who are in critical fields and have completed their tour (i.e., YearsRemaining = 0). These members will be given a NextAction of **HOLD**.

The next availability pool is service members who are in the support unit and still have 1 year remaining on tour. These members will be given a NextAction of **PULL**.

**e. Determine who receives training**

Any members who have completed their tour (YearsRemaining = 0) and have not yet been assigned to a new unit are now available for training. The chance of going to training is  $\text{billetsTraining} / (\text{billetsA} + \text{billetsB} + \text{billetsTraining})$ . If assigned, the member is given a NextAction of **PCS** and a NextUIC of **Training**. The Training unit will never be filled over its billet count but could be below that count in any given year.

**f. Place any remaining service members into the correct unit**

For all remaining unassigned service members:

If YearsRemaining is zero or less, assign a NextAction of **PCS** and send them to the other unit (that is, from critical to support or from support to critical).

If YearsRemaining is greater than zero, assign a NextAction of **STAY** and make the NextUIC equal to the current UIC.



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## Abbreviations

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|        |                                                 |
|--------|-------------------------------------------------|
| AB-TLM | Agent Based Tour Length Model                   |
| ACOL   | Annualized Cost of Leaving                      |
| BAH    | Basic Allowance for Housing                     |
| BAS    | Basic Allowance for Subsistence                 |
| BRF    | Blue Ribbon Families                            |
| CONUS  | Contiguous United States                        |
| COTS   | Consecutive Overseas Tour                       |
| DEERS  | Defense Enrollment Eligibility Reporting System |
| DES    | Discrete Event Simulation                       |
| DHA    | Defense Health Agency                           |
| DMDC   | Defense Manpower Data Center                    |
| DoD    | Department of Defense                           |
| DoDI   | DoD Instruction                                 |
| DRM    | Dynamic Retention Model                         |
| DRRS   | Defense Readiness Reporting System              |
| ETP    | Exception to Policy                             |
| GAO    | Government Accountability Office                |
| IDA    | Institute for Defense Analyses                  |
| IPCOTS | in-place consecutive overseas tours             |
| JTR    | Joint Travel Regulations                        |
| MCAM   | Military Career Analysis Model                  |
| NBG    | Naval Base Guam                                 |
| NEC    | Navy Enlisted Classifications                   |
| NSR    | Naval Station Rota                              |
| OCONUS | Outside Contiguous United States                |
| OFRP   | Optimized Fleet Response Plan                   |
| OSD    | Office of the Secretary of Defense              |
| P&R    | Personnel and Readiness                         |
| PCS    | Permanent Change of Station                     |
| RPM    | Retention Prediction Model                      |
| SRB    | Selective Reenlistment Bonus                    |

|         |                          |
|---------|--------------------------|
| SSFM    | Sea Shore Flow Model     |
| TL-SIM1 | Tour Length Simulator 1  |
| TOS     | Time on Station          |
| U.S.    | United States            |
| UIC     | Unit Identification Code |
| YOS     | Years of Service         |

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