NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

HOW INCREASED MANNING AFFECTS CREWMEMBERS' WORKLOAD INPORT AND UNDERWAY: RESULTS OF A STUDY ONBOARD TWO U.S. NAVY DESTROYERS IN BASIC PHASE

by

Benjamin D. Garbacz

September 2019

Thesis Advisor: Nita L. Shattuck
Second Reader: Jeffrey E. Kline

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2019	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE
HOW INCREASED MANNING AFFECTS CREWMEMBERS' WORKLOAD INPORT AND UNDERWAY: RESULTS OF A STUDY ONBOARD TWO U.S. NAVY DESTROYERS IN BASIC PHASE

5. FUNDING NUMBERS

6. AUTHOR(S) Benjamin D. Garbacz

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT	**12b. DISTRIBUTION CODE**
Approved for public release. Distribution is unlimited.	A

13. ABSTRACT (maximum 200 words)

After three collisions and one grounding of U.S. Navy warships in the SEVENTH Fleet in 2017, the Vice Chief of Naval Operations (VCNO) directed a Comprehensive Review (CR) of all significant surface force mishaps between 2007 and 2017 with recommendations to improve the Surface Fleet. The CR findings identified areas for improvement with themes such as teamwork, operational safety, assessment and culture. One recommendation, 8.3.2.3, serialized as CR53, directed the comparison of two Flight I Arleigh Burke class destroyers (DDG) with different manning levels during the Basic Phase of the Optimized Fleet Response Plan (OFRP). The goal was to determine if ship manning levels are associated with individual Sailor workload. That directive serves as the foundation for this thesis. Findings from the CR53 study showed that overall, Sailors reported 50.8 hours of activities compared to the 54 hours proposed inport Naval Availability Factor (NAF). Combined total productive and non-productive work hours in port was 48.0 compared to the NAF estimate of 46.6 hours. In contrast, reported hours of leave/special liberty during the CR53 study was 0.0 hours compared to the 7.4 hours designated in the inport NAF. During the single data collection event when manning was different between the two ships, crew members on the ship with increased manning reported working 0.8 hours less per day.

14. SUBJECT TERMS	**15. NUMBER OF PAGES**
NSWW, Navy Standard Workweek, Naval Availability Factor, NAF, Comprehensive Review, CR, CR53, Manning, FLT I DDG, DDG, Basic Phase, OFRP	149
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

HOW INCREASED MANNING AFFECTS CREWMEMBERS' WORKLOAD INPORT AND UNDERWAY: RESULTS OF A STUDY ONBOARD TWO U.S. NAVY DESTROYERS IN BASIC PHASE

Benjamin D. Garbacz
Lieutenant, United States Navy
BSCE, Purdue University, 2011

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 2019

Approved by: Nita L. Shattuck
Advisor

Jeffrey E. Kline
Second Reader

W. Matthew Carlyle
Chair, Department of Operations Research

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

After three collisions and one grounding of U.S. Navy warships in the Seventh Fleet in 2017, the Vice Chief of Naval Operations (VCNO) directed a Comprehensive Review (CR) of all significant surface force mishaps between 2007 and 2017 with recommendations to improve the Surface Fleet. The CR findings identified areas for improvement with themes such as teamwork, operational safety, assessment and culture. One recommendation, 8.3.2.3, serialized as CR53, directed the comparison of two Flight I Arleigh Burke class destroyers (DDG) with different manning levels during the Basic Phase of the Optimized Fleet Response Plan (OFRP). The goal was to determine if ship manning levels are associated with individual Sailor workload. That directive serves as the foundation for this thesis. Findings from the CR53 study showed that overall, Sailors reported 50.8 hours of activities compared to the 54 hours proposed inport Naval Availability Factor (NAF). Combined total productive and non-productive work hours in port was 48.0 compared to the NAF estimate of 46.6 hours. In contrast, reported hours of leave/special liberty during the CR53 study was 0.0 hours compared to the 7.4 hours designated in the inport NAF. During the single data collection event when manning was different between the two ships, crew members on the ship with increased manning reported working 0.8 hours less per day.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

3M	Material Maintenance and Management
ARG	Amphibious Readiness Group
AT	Anti-Terrorism
BA	Billets Authorized
BBD	Billet-Based Distribution
BSO	Budget Submitting Office
CASREP	Casualty Report
CFEMP	Crew Fatigue and Endurance Management Policy
CMC	Command Master Chief
CNA	Center for Naval Analysis
CNO	Chief of Naval Operations
CNO (N1)	Deputy Chief of Naval Operations (Manpower, Personnel, Training and Education)
CNSF	Commander, Naval Surface Forces
CNSL	Commander, Naval Surface Forces, Atlantic
CNSP	Commander, Naval Surface Forces, U.S. Pacific Fleet
CO	Commanding Officer
COB	Currently on Board
COMUSFLTFOR-COM	Commander, U.S. Fleet Forces Command
CONUS	Contiguous United States
CR	Comprehensive Review of Recent Surface Force Incidents
CR38	Comprehensive Review Recommendation 38
CR53	Comprehensive Review Recommendation 53
CRUDES	Cruiser-Destroyer ships
CS	Combat Systems
CSG	Carrier Strike Group
CSMP	Current Ship's Maintenance Project
DDG	Guided Missile Destroyer
DoD	Department of Defense
DoN	Department of the Navy
DOTMLPF-P	Doctrine, Organization, Training, Material, Leadership and Education, Personnel, Facilities and Policies

DSRA	Docking, Selected Maintenance Availability
DTIC	Defense Technical Information Center
ENG	Engineering Department
ESS	Epworth Sleepiness Scale
ETT	Engineering Training Team
EXPSAF	Explosive Safety
FDNF	Forward Deployed, Naval Forces
FLTMPS	Fleet Training Management and Planning System
FM	Facilities Maintenance
FMRD	Fleet Manpower Requirements Determination
FRTP	Fleet Response Training Program
FSO-M	Fleet Support Operations-Medical
FTA	Fleet Training Availabilities
FYDP	Future Year Defense Program
GAO	Government Accountability Office
GMT	General Military Training
ICAV	Inspections, Certifications, Assessments and Visits
INSURV	Board of Inspection and Survey
I/P	Inport
IQR	Interquartile Range
IRB	NPS Institutional Review Board
ISI	Insomnia Severity Index
JSN	Job Sequence Number
M-12	Manning Line Item #12
MAA	Master at Arms
MCA	Manning Control Authority
MCAF	Manning Control Authority Fleet
MD	Median
MFT	Mission, Function and Task
MOB-E	Mobility—Engineering
MPN	Military Personnel, Navy
MRD	Manpower Requirement Determination
NAF	Naval Availability Factor
NAV/ADMIN	Navigation, Admin & Exec Department
NAVMAC	Navy Manpower Analysis Center

NAVSEA	Naval Sea Systems Command
NEC	Navy Enlisted Classifications
NMP	Navy Manning Plan
NPS	Naval Postgraduate School
NSWW	Navy Standard Workweek
OFRP	Optimized Fleet Response Plan
OM	Operational Manning
OMMS-NG	Organizational Maintenance Management System Next Generation
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Office of the Chief of Naval Operations instruction
OPS	Operations Department
OPTEMPO	Operational Tempo
OUS	Own-Unit Support
PAF	Productive Availability Factor
PAQ	Present at Quarters
PB4T	Planning Board for Training
PESTO	Personnel, Equipment, Supply, Training and Ordinance
PM	Planned Maintenance
POD	Plan of the Day
POE	Projected Operational Environment
POM	Pre or Post Operational Movement
POMS	Profile of Mood States
PPBES	Planning, Programming, Budgeting and Execution System
PQS	Personnel Qualification Standards
PSQI	Pittsburgh Sleep Quality Index
PT	Planning & Tactics Department
R-ADM	Relational Administrative Data Management
RE	Readiness Evaluation
ROC	Required Operational Capabilities
RROC	Readiness and Reform Oversight Council
RRSG	Readiness Reform Steering Group
RS	Resource Sponsor
SD	Service Diversion
SFRM	Surface Force Readiness Manual
SMD	Ship Manpower Documents

SORTS	Status of Resources and Training Systems
SRR	Strategic Readiness Review
SUP	Supply
SWE	Surface Warfare Enterprise
TAD	Temporary Additional Duty
TER	Total Enlisted Requirements
TFMMS	Total Force Manpower Management System
TYCOM	Type Commander
U/I	Under Instruction
U/W	Underway
USFF	U.S. Fleet Forces Command
USN	United States Navy
VCNO	Vice Chief of Naval Operations
WEPS	Weapons Department

EXECUTIVE SUMMARY

A Comprehensive Review (CR) of all significant U.S. Navy surface force mishaps over the past decade (2007-2017) identified weaknesses in the Fleet and proposed recommendations to address them (Department of the Navy, 2017a). One of these recommendations (CR Recommendation 8.3.2.3, serialized as CR53) was to assess whether manning levels during the Basic Phase are associated with Sailor workload. Based on this recommendation, the Naval Postgraduate School (NPS) conducted a naturalistic longitudinal study onboard two Flight I Guided Missile Destroyers (DDG) that were entering the Basic Phase of training following an extended shipyard maintenance period. The control ship, Ship A, was scheduled to receive the standard level of manning. The test ship, Ship B, was slated to receive additional Sailors, increasing its manning to 100% of Ship Manpower Documents (SMD) levels, with considerably more Sailors than the control ship. Data were collected throughout the Basic Phase at three distinct time periods on both ships by Commander, Naval Surface Force, U.S. Pacific Fleet (CNSP), and the NPS Crew Endurance Team. Crewmembers (n = 296) from the two ships volunteered to participate in the study.

Initial efforts to increase manning on Ship B at the start of its Basic Phase were not realized; at one point in time, manning levels of Ship B even fell below that of Ship A. Because there was no difference in manning levels between the two ships for the first two data collection events, the ships could not be compared. Instead, data from the two ships were aggregated to describe the workload of Sailors underway and inport in the Basic Phase. Once the manning shortfall of Ship B was acknowledged, a manning action was initiated by CNSP whereby 30 additional Sailors were assigned to Ship B. These Sailors were added over the course of the final two months of the study, coinciding with the last of three data collection events. On both ships, data were collected for one- to three-week periods corresponding with major training or certification events that were chosen for observation due to potentially higher workloads for certain departments.

Participants were asked to note their daily activities on paper activity logs in 15-minute increments for the duration of each data collection period. Analysis focused on

the five-day workweek of Monday through Friday because at no point during the Basic Phase did crews of either ship work on weekends except those duties normally performed by an inport duty section. During inport operations, Sailors reported a daily average total work of 9.5 ± 2.8 hours per day (6.0 ± 3.8 hours of productive work and 3.4 ± 3.2 hours of non-productive work). These findings support the proposed daily inport Naval Availability Factor (NAF) being developed and validated.

CR53 activities associated with the inport NAF (i.e., maintenance, watch, service diversion, training, and leave/holiday), resulted in 50.8 ± 13.5 hours (MD ± IQR) hours per week. This amount is ~3.2 hours less than the anticipated 54-hour NAF value. That is, compared to the NAF inport holiday/leave time of 7.4 hours, participants in the CR53 study reported getting 0.0 ± 4.03 hours (MD ± IQR) leave/special liberty across both ships and all data collection periods ($p < 0.001$).

Sailors reported working a total of 48.0 hours per five-day work week, which is more than the expected inport NAF value of 46.6 hours per week. Non-productive work and service diversion times were both significantly higher than the respective expected values ($p < 0.001$).

Consolidated data from all Sailors during underway operations in the Basic Phase show Sailors reported daily average total work of 13.4 ± 2.9 hours per day (9.9 ± 4.3 hours of productive work and 3.4 ± 4.0 hours of non-productive work). Daily average non-available time underway was 10.6 ± 2.9 hours. Additionally, reported daily underway values were higher than at-sea available time by 1.7 hours, combined productive work is lower than expected at-sea NAF values by a negligible 6 minutes but reported non-productive work exceeds the planned amount by 1.4 hours per day.

Given that the two ships had equivalent levels of manning during the first two data collections (all $p > 0.600$), the two ships could only be compared during the third data collection event. The comparison between the two ships during Tactical Certification, a CIC-centric event, was conducted between Sailors from the departments that are primarily involved in combat watchstanding certification events. Observations during the comparison between ships showed Sailors on Ship A reported a median value

of 10.0 ± 2.75 hours and Ship B reported a median value of 9.2 ± 2.0 hours total work per day. Although not statistically significant, this 0.8-hr difference illustrates how higher manning levels reduces the workhours on Sailors.

The first recommendation from this study is to provide increased manning onboard ships prior to commencing Basic Phase events, regardless of whether a ship has exited the Maintenance Phase. Increases in appropriate numbers of Sailors (i.e., better Fit rates) reduced turnover of crew and increased length of time a Sailor is present onboard have previously been shown to increase operational readiness and training score results. Based on the current results, when Ship B had increased manning and improved Fit, Productive Work increased and overall total work decreased.

Second, recommend breaking the Inspections, Certifications, Assessments and Visits (ICAV) list into appropriate and concise categories using time categories within the NAF. This approach will lead to more accurate accounting of the requirements that drive the workload of Sailors.

Third, investigate requirements within the Basic Phase to improve accounting for time demands placed on ships. Delineation of requirements in this manner could enable proper "binning" of time for maintenance, own-unit support, service diversion or training, as applicable. Efforts to create and implement a new inport workload standard provides the opportunity to collaborate across organizations and echelons to provide a standard that accurately reflects planned Sailor workload during the Basic Phase. Rather than conducting data queries from a shipboard level, a consolidated and concise list of requirements outlining the explicit burden ships incur throughout the Basic Phase could further assist Navy Manpower Analysis Center (NAVMAC) in ensuring manpower models are valid.

Finally, defining ICAV list events in terms of the NAF can facilitate comparison between Commander, Naval Surface Forces (CNSF) required "burdens" to NAVMAC allocation of time. Presently, an overall time and resource burden list does not exist, making it difficult to accurately estimate the time and resources required for a ship to complete an event.

References

Department of the Navy. (2017a). Comprehensive review of recent surface force incidents [Memorandum]. Norfolk, VA: U.S. Fleet Forces Command.

Department of the Navy. (2017b). Inport workload assessment model beta test Jan-Jul 2017 [Action Memorandum, Ser 00/260]. Millington, TN: Department of the Navy.

ACKNOWLEDGMENTS

First, I would like to thank Dr. Shattuck, Dr. Matsangas, CAPT Good and all the members of the HSI lab for the guidance and assistance that allowed Mansfield and I to complete different aspects of this study for our theses. Second, I'd like to thank my mom, dad, brother, and Becca for the words of encouragement, support and always picking up the phone when I'd call; I don't think I would have made it this far without you guys. To my thesis partner, Mansfield, thanks for begrudgingly agreeing to join me on this adventure … we got it done without having to code in R or Python.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

After three collisions and one grounding of U.S. Navy warships in the Seventh Fleet in 2017, the Vice Chief of Naval Operations (VCNO) directed a comprehensive review of all significant surface force mishaps over the past decade (2007-2017). In response to this, the Commander, U.S. Fleet Forces Command (COMUSFLTFORCOM) assembled a 34-member team to investigate various areas of concern, including individual training, unit level training, material readiness, practical utility of navigation and combat systems equipment, force generation, and force employment. The document resulting from the team's findings, published in October 2017, identified weaknesses in Doctrine, Organization, Training, Material, Leadership and Education, Personnel, Facilities and Policies (DOTMLPF-P). Proposed recommendations for addressing these areas involved themes such as teamwork, operational safety, assessment, and culture and were categorized as immediate, near-term, and long-term corrections to these problems (Department of the Navy (DoN), 2017a).

Commander, Naval Surface Force, U.S. Pacific Fleet (CNSP) established a Comprehensive Review (CR) Working Group to consolidate and oversee CR recommendations with key stakeholders; recommendations were serialized to support management and tracking by the CR Working Group. One of these recommendations, Recommendation 8.3.2.3 serialized as CR53, is the basis for this thesis. It states:

> Based on the results to date from the study of DDG manning requirements, conduct a pilot to supplement manning on one unit in basic phase and validate expected improvements in individual workloads. A unit in a similar basic-phase schedule should be used for comparison. (DoN, 2017a, p. 105)

The objectives of the CR53 study are to validate post-CR manpower actions; inport workload studies by Navy Manpower Analysis Center (NAVMAC); Required Operational Capability (ROC) and Projected Operational Environment (POE) updates; and the Ship Manpower Document (SMD) review. To accomplish these goals, two Flight I Guided Missile Destroyers (DDG) of approximately the same age and stage of the Optimized Fleet

Response Plan (OFRP)—i.e., exiting an extended maintenance period and entering the Basic Phase of training—were selected as the two platforms for the study. In the study the control ship, Ship A, was scheduled to receive the standard level of manning onboard. The test ship, Ship B, in the study was slated to receive additional Sailors increasing its manning up to 100% of SMD levels. Data were collected throughout the Basic Phase on both ships by CNSP and the Crew Endurance Team at the Naval Postgraduate School (NPS) to assess potential differences between the two ships in Sailor workload, mood, sleep patterns, and fatigue levels. The CR53 study directive provided by CNSP is shown in Appendix A.

Two closely related thesis efforts emerged from the CR53 study. One thesis, this current effort, investigated impacts to self-reported workload and man-hours expended by Sailors during the Basic Phase. A second thesis, by LT Mansfield Murph, investigated the fatigue and sleep patterns of crewmembers on the same two DDGs during the Basic Phase.

Unlike previous NPS studies (Haynes, 2007; Green, 2009; Mason, 2009; Young, 2013; Kerno, 2014) where the primary focus was Sailors' sleep, fatigue, and work/rest patterns during underway periods, this thesis focuses primarily on periods of inport operations. It investigated whether the workload of Sailors is related to manning levels and how these workload findings compared to the proposed inport Naval Availability Factor (NAF). The NPS Crew Endurance Team applied principles learned from previous sleep and fatigue studies to conduct a longitudinal study of the crewmembers of these two ships during their notional 24-week Basic Phase of training.

B. OBJECTIVES

Limited research has been conducted on USN Sailor workload, man-hour expenditure, sleep and fatigue levels when a ship is not in the deployed period of the OFRP. Furthermore, no studies to date have specifically investigated workload expenditures during the Basic Phase of training for any ship class. These gaps in understanding must be addressed empirically and systematically to allow the U.S. Navy to make better informed decisions about the manning of its ships. Therefore, this thesis has the following objectives:

1. Describe the average workweek for a ship during the Basic Phase of training and compare it to the proposed inport NAF recommended by

NAVMAC. The study aims to provide information which can assist NAVMAC in creating a definitive inport NAF that reflects the actual demands placed on the crew of a DDG during the Basic Phase of training.

2. Determine whether manning level on a Flight I DDG affects workload of individual Sailors. Specifically, investigate whether increasing manning on a ship to 100% of SMD tangibly reduces the number of hours worked by individual crewmembers.

3. Determine if differences in manning levels are related to readiness and performance metrics during the Basic Phase of training.

C. RESEARCH QUESTIONS

In order to achieve the thesis objectives, the following questions drive this research.

1. Are the work hours of Sailors observed on the two ships in keeping with NAVMAC's proposed inport NAF?

2. How do different manning levels on a Flight I DDG affect the workload (i.e., number of hours worked per day and per week) of individual Sailors?

3. How does the difference in manning levels impact readiness and performance during the Basic Phase of training?

D. SCOPE

This report describes the hourly workweek expenditures for crews of two Flight I DDGs as the ships complete the Basic Phase of training. Self-reported Sailor workload, validated through comparison to telemetric actigraphic data gathered concurrently, is examined to see if different manning levels onboard each ship account for any differences. The data from the study will be compared to the proposed inport NAF created by NAVMAC.

THIS PAGE INTENTIONALLY LEFT BLANK

II. LITERATURE REVIEW

The Basic Phase is integral to force generation and represents a time where the largest "burden" is placed on a ship when manned at some of the lowest levels within the ship's 36-month life cycle. Official Navy manpower models are in the process of being validated to account for requirements incurred during inport operations; however, there is a gap between the Navy's manpower models and the requirements the models are intended to represent. The following literature review describes topics involved with force generation and the incorporation of inport operations into manpower models.

A. FORCE GENERATION

The Navy's force generation model is the Optimized Fleet Response Plan (OFRP) which is 36 months long and consists of the Maintenance, Basic, Integrated or Advanced and Sustainment phases. These phases are completed sequentially to support force employment of a unit (Department of the Navy (DoN), 2014). Transitions between phases occur when a ship can demonstrate proficiency in required material checks, assessments or certification meeting required exit criteria.

The framework supporting OFRP completion for the two ships participating in the CR53 study was COMNAVSURFPACINST/COMNAVSURFLANTINT 3502.3A, the Surface Force Readiness Manual (SFRM). At the time this study began, the SFRM was the operative document but has since been replaced by the Surface Force Training and Readiness Manual (SFTRM), which makes substantial changes to the Basic Phase timeline and methodology.

The following is a description of the SFRM completed by Ship A and Ship B. The SFRM "provides the overarching strategy and policy required to sustain surface ship material and operational readiness to perform operational tasking" (Department of the Navy (DoN) & Commander, Naval Surface Force Pacific/Atlantic (CNSP/L), 2016, p. iii). The SFRM consists of a six-phase Fleet Response Training Program (FRTP) aligned to each OFRP phase. The six phases of FRTP are Sustainment, Maintenance, Shakedown,

Basic, Advanced, and Integration. Table 1 depicts the phases and approximate corresponding timelines.

Table 1. OFRP/FRTP Component Comparisons within the SFRM. Adapted from DoN (2016).

<table>
<tr><td rowspan="2">OFRP</td><td colspan="2">24 weeks +/- 4 weeks</td><td colspan="2">24 weeks</td><td colspan="2">20 weeks</td><td>72 weeks</td></tr>
<tr><td colspan="2">Maintenance</td><td colspan="2">Basic</td><td colspan="2">Integrated or Advanced</td><td>Sustainment</td></tr>
<tr><td rowspan="3">FRTP</td><td rowspan="2">Maintenance</td><td rowspan="2">Shakedown</td><td colspan="2">Basic</td><td rowspan="2">Advanced</td><td rowspan="2">Integrated</td><td rowspan="2">Sustainment</td></tr>
<tr><td>Tier 1 (Mobility)</td><td>Tier 2 (Unit Tactical)</td></tr>
<tr><td>20 weeks</td><td>4 weeks</td><td colspan="2">22 weeks</td><td>4 weeks</td><td>16 weeks</td><td>72 weeks</td></tr>
</table>

The phases of the FRTP consist of training, evaluations, and assessments supporting material readiness and demonstrated proficiency across personnel, equipment, supply, training and ordinance (PESTO) pillars. Each phase of the FRTP has minimum levels of knowledge and performance that must be demonstrated through training, inspections, certifications, evaluations and assessments. Under the SFRM, a surface ship would undergo up to 238 material inspections, training assessments, or system evaluations during the 36-month OFRP cycle. These are collectively called Inspections, Certifications, Assessments and Visits (ICAV). A complete list of ICAVs required for completion by the two ships in the CR53 study can be found in Appendix A of the SFRM (DoN & CNSL, 2016). It is worth noting that since the start of the CR53, the ICAV list has been revised and reduced in size; these changes will be expounded upon in Section B and Section F of this chapter.

The Maintenance Phase of the OFRP is supported by the Maintenance and Shakedown phases of the FRTP. During this phase, a ship will receive maintenance and modernization activity from regional maintenance facilities. It is incumbent on the ship to account for any modernization or material upgrades received so as not to impact the follow-on training phases. It is also expected that members attached to the command will maintain watchstander proficiency and complete critical schools or training to support upcoming

training, certification and deployment requirements. To exit the Maintenance Phase, ships must demonstrate the ability to safely operate engineering equipment and be proficient for basic at sea operations through satisfactory completion of Readiness Evaluation 5 (RE-5) and Type Commander (TYCOM) Sea Trials.

The Basic Phase of the OFRP is supported by Mobility (Tier 1) and Unit Tactical (Tier 2) training within the FRTP. The goal of the Basic Phase is to train and certify a ship in all mission areas to support unit-level operations. During this phase, a ship will conduct material assessments, training, gain watch team skills and improve watchstanding, and demonstrate warfighting proficiency. Progression through the Basic Phase is incremental by design, building on previous training received.

Tier 1 events are intended to train, educate, and assess a crew in individual warfare or mobility areas and build core skills reinforcing the standards for proper ship operations, emergency response, communication, and navigation. Administration, program reviews, and preparation for material checks are conducted in 1.0 events; material assessments coincide with 1.1 events; theory or fundamental training occur in 1.2 events; individual and watchteam training occurs during 1.3 events; individual warfare proficiency is demonstrated during certification events and assessments during 1.4 events. Tier 1 events conclude with a ship passing a TYCOM led comprehensive assessment called RE-6.

Tier 2 events progress similarly to Tier 1, but are delineated by 2.0, 2.1, 2.2, 2.3 and 2.4 nomenclature. The Tier 2 events provide a ship the opportunity to conduct multi-area unit warfare requirements meeting the standard to support maneuvering and tactical employment of weapons. A ship will receive warfare area certifications after passing Unit Tactical Certification. Upon completing all certification events, a ship will receive a Basic Phase certification and progress to the Advanced Phase of training.

The Advanced Phase of the OFRP coincides with the Integrated and Advanced phases of the FRTP. At this point, a ship will progress from being capable of conducting individual operations into a Carrier Strike Group (CSG) or Amphibious Readiness Group (ARG) asset. This training aims to build multi-ship, multi-platform and multi-mission capabilities through execution of Surface Warfare Advanced Tactical Training, CSG

Group-Sail, and successful completion of unit-level advanced certification events. Skills honed during this phase will result in a ship receiving a Deployment Certification.

The longest phase of the OFRP is the Sustainment Phase, which is supported by the FRTP phase of the same name. Throughout this phase, a ship maintains readiness to conduct sustained combat operations. Critical elements to maintain proficiency include continued operational employment, mission area training and the completion of regularly scheduled maintenance, and shipboard work. The Sustainment Phase will normally include an overseas deployment for ships based in the Contiguous United States (CONUS), or operational patrols, exercises and shorter (~4 month) deployments for Forward Deployed Naval Forces (FDNF).

The 36-month OFRP was introduced in November 2014 in response to detrimental impacts to shipboard material condition incurred after years of deferred maintenance resulting from increased operational demands of the early 2000s. The use of a predictable schedule in the OFRP aims to balance force generation and force employment. Delays in any phase of the OFRP schedule will result in compressed time for conducting remaining maintenance, training, or sustainment operations. Shifting Fleet-wide focus to prioritize maintenance in order to preserve force employment has inherent challenges which are well documented. A U.S. Government Accountability Office (GAO) report (2016) focused on the impact to the Navy due to maintenance availability overruns in commercial shipyards and mounting maintenance backlogs. Navy officials continue to assess and update the OFRP to mitigate the risk to forces and better align the OFRP with the FRTP. Options available to Navy leadership when maintenance overruns, or major ship casualties, disrupt the schedule of operations include: (1) condense the Training Phase, (2) reduce time spent in either the Training or Sustainment Phases, (3) delay deployment or (4) surge another ship to meet deployment needs in the absence of the original ship (GAO, 2016).

Schedule changes and the impact to ship availability further exacerbates the imbalance between the number of assets available and increased operational mission requirements. To make up for these shortfalls, Commanders are required to condense Training Phase events or surge another qualified ship to meet operational requirements. Selecting either of these options requires an appropriate assessment of risk at the expense

of eroding training or material readiness. Challenges like these are not uncommon. The CR shed light on the fact that "escalating operational requirements took precedence over training and maintenance" (DoN, 2017a, pp. 73–74). This resulted in greater force employment at the expense of reducing available time for upkeep of equipment and certification of the crew. Adherence to a predictable force generation schedule assists a traditional force employment construct; however, questions exist as to whether the model in place is the most effective method for desired dynamic force employment.

B. REQUIREMENTS TO SUPPORT FORCE GENERATION

The Basic Phase is an integral part of preparing a ship to effectively deploy. Incorporated within are assessments and certifications which drive the workload of Sailors. Events supporting progression through the multi-tiered training structure are completed in addition to planned maintenance and watchstanding requirements. These events add up to quite a significant "burden" of work placed on Sailors. Unfortunately, the exact burden is an unknown quantity because, to date, no empirical studies articulate the overall time expected to complete each individual ICAV event.

As outlined in the SFRM, the goal of ICAVs is to ensure Sailors are properly prepared to deploy at peak readiness. The ICAV was created to consolidate and maximize shore-based assists and visits in order to minimize the impact to a ship and crew. At the time of the release of the CR, there were over 230 separate ICAV events required of a ship during a 36-month OFRP cycle that were delivered by multiple organizations. The magnitude of visits oftentimes results in duplicated efforts to support the various requirements, some of which overlap similar functional areas. Additionally, lack of objective feedback after an ICAV event concludes limits meaningful improvement at the ship level and prevents aggregation of data for trend analysis by Fleet Commanders. It was noted in the Comprehensive Review that "The scope and scale of assistance Sailors receive from outside organizations costs them valuable training time and often does not directly address their manning, training or equipment needs" (DoN, 2017a, p. 78).

Accordingly, the CR directed a review of all training and certification requirements published in the ICAV list. This Recommendation 7.3.4 (CR38) states:

> Perform a baseline review of all inspection, certification, assessment and assist visit requirements to ensure and reinforce unit readiness, unit self-sufficiency, and a culture of improvement. The goal of this review should be to reduce the overall burden on ships by eliminating low value engagements and refocus remaining actions on validating unit readiness, unit self-sufficiency, and improvement. (DoN, 2017a, p. 111)

This ICAV review was completed by CNSP in March 2018 with input from key stakeholders and was published by CNSF in April 2018. It identifies that the sheer number of visits it takes to complete these ICAVs places an immense time burden on ships and their Sailors. Time requirements, as presented in the CR38 final report, identified that Cruiser-Destroyer ships (CRUDES) incur the highest burden by time during the Basic Phase and Integrated Phase of the SFRM. Of 235 ICAV events reviewed, 107 were required during these two phases accounting for 47% of man-hour burden in the Basic Phase and 31% during the Integrated Phase. The breakdown of these burdens is depicted in Figure 1 as presented in the CR38 report. Recommended actions from the final CNSF report found 203 events should be retained without modification, five events consolidated, 20 events modified, and seven events deleted. A summary of recommendations is found in Figure 2 (Surface Warfare Enterprise (SWE), 2018).

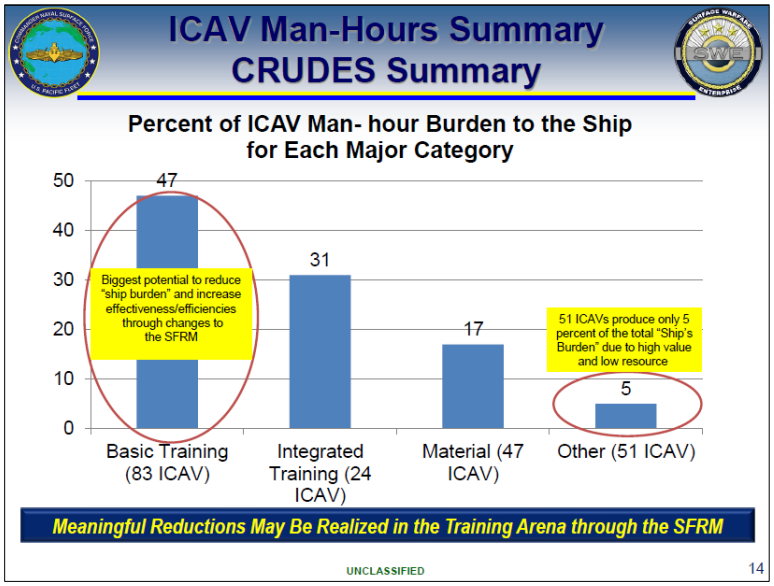


Figure 1. Summary of CRUDES Man-hour Expenditure, by ICAV Type. Source: CNSP (2018a, p. 14)

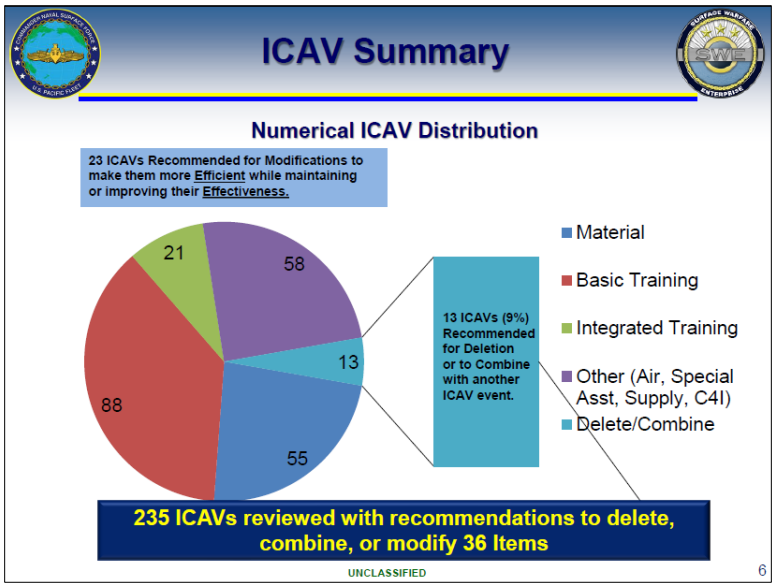


Figure 2. Summary of Recommended Changes to ICAV List. Source: CNSP (2018a, p. 6)

The time spent conducting these ICAV events are in addition to the planned watch and maintenance required from a crew whether the events are conducted inport or underway. Individual events presented in the final report also identify anticipated resources necessary to complete each event. These resources range from cost of inspection to number of ship's force and off-ship personnel required to support an event. Unfortunately, the total "burden" placed on the Sailors during any ICAV event is not expressed in a set standard. The man-hour burden was expressed in a variety of ways such as "man hours," "man days" and number of hours required for inspection. Figure 3 identifies the highest and lowest "burden" on Sailors expressed as "man day" expenditures.

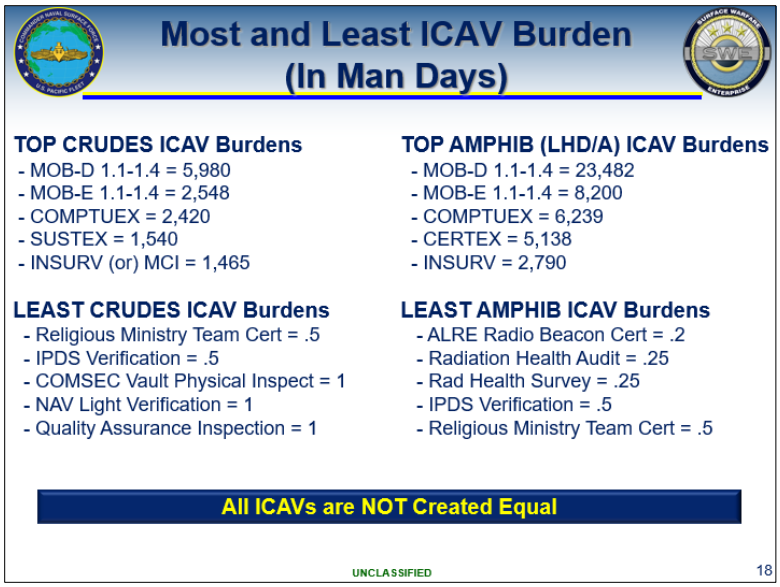


Figure 3. Example of Time Expenditures for Select ICAVs. Source: CNSP (2018b, p. 18)

The compression of training time, high workload associated with requirements, and perceived lack of "white-space" afforded to COs were all cited as areas for further study within the CR. Reducing the number of ICAVs, which were evaluated in the CR38 study and described in the new SFTRM, represents progress in the desire to fulfill this overarching directive for reduction of burdens placed on ships.

The CR38 study findings and recommendations were applied by CNSF to existing 238 ICAV requirements. This change resulted in retention of 202 events, modification of 23 events, the combination of 6 events, and elimination of 7 events. Additional reductions incorporated within the SFTRM eliminated another 53 discrete ICAVs by transitioning from the blocked phased training to focused training availabilities (FTA). In total, a net reduction of 60 ICAVs was realized representing a reduction of 32% from what was initially studied in the CR38 study (J. Eaton, personal communication, April 25, 2019).

In a conversation with CNSP N7 (personal communication, August 25, 2019), it was highlighted that the updates to ICAVs and implementation of the SFTRM are intended to buy back time for crews by introducing flexibility into the scheduling of events. However, it is impossible to calculate the amount of time expected to be returned (based

on these reductions) because neither individual man-hour or event time allocations are calculated or even considered. Any return of time due to reductions would be rough estimates due to the fact that ICAV events are not created with expected man-hours required to complete them in mind, and no method or model exists for this to be achieved based on how the events are written. It is not possible to estimate how much time it would take a ship to complete an event or overall certification. Under either the SFTRM or SFRM construct, only the number of times an outside entity visits a ship can be tracked.

Conducting a comparison between CNSF required "burdens" to NAVMAC allocation of time could enable a more precise determination of how much the reduction in ICAV events will impact the workload and man-hours of crews completing the events. Although such questions are beyond the scope of this work, this kind of study is required to determine the true man-hour burden these activities place on ships which could then be compared to the hours allocated to these activities in the Navy manpower models in use by NAVMAC. The inability to compare the two succinctly based on NAVMAC manpower models could continue to mask the true "burden" felt by Sailors.

C. MANPOWER POLICY AND PROCEDURE

Manpower determination is applicable to all surface, submarine, aviation and shore-based entities; however, the following description will pertain to the Surface Forces. The process is complex in that it takes input from multiple organizations and stakeholders at various echelons within the Department of the Navy (DoN). Fiscal constraints and future ship capabilities are considerations that must be incorporated into validated models used to create manpower requirements.

The Navy's process for determination of manpower requirements is published by the Deputy Chief of Naval Operations (Manpower, Personnel, Training and Education) (CNO (N1)) in OPNAVINST 1000.16L, *Navy Total Force Manpower Policies and Procedures*. The objective of this process is to provide the minimum manpower quantity and quality to accomplish the activity's mission (DoN, 2019a, p. 2–3). In direct support of the Department of Defense (DoD) directive that governs manpower management. DoD Directive 1100.4 states that manpower drivers should be fulfilled to meet national military

objectives with the minimum manpower organized to provide the maximum effectiveness and combat power (Department of Defense (DoD), 2005).

Per OPNAVINST 1000.16L CH-2 (2019a), manpower requirements are defined as the minimum quantitative and qualitative resources needed to perform a specific mission, function or task (MFT). Manpower resources are defined as the human resources available to be applied against the manpower requirement. Manning is defined as the specific inventory of personnel at an activity (i.e., ship) to carry out the MFTs of the activity.

a. The Process of Manpower Determination

First, the Navy needs to determine manpower requirements to carry out all wartime requirements. Second, it needs to fund the manpower to an acceptable level, balancing risk against operational capabilities based on the number of billets authorized (BA). Third, the Navy distributes available resources to the Fleet based on priority of Fleet assets and mission requirements compared to available manning. Finally, ships are manned to levels of Sailors currently on board (COB) (GAO, 2010). This process is depicted in Figure 4.

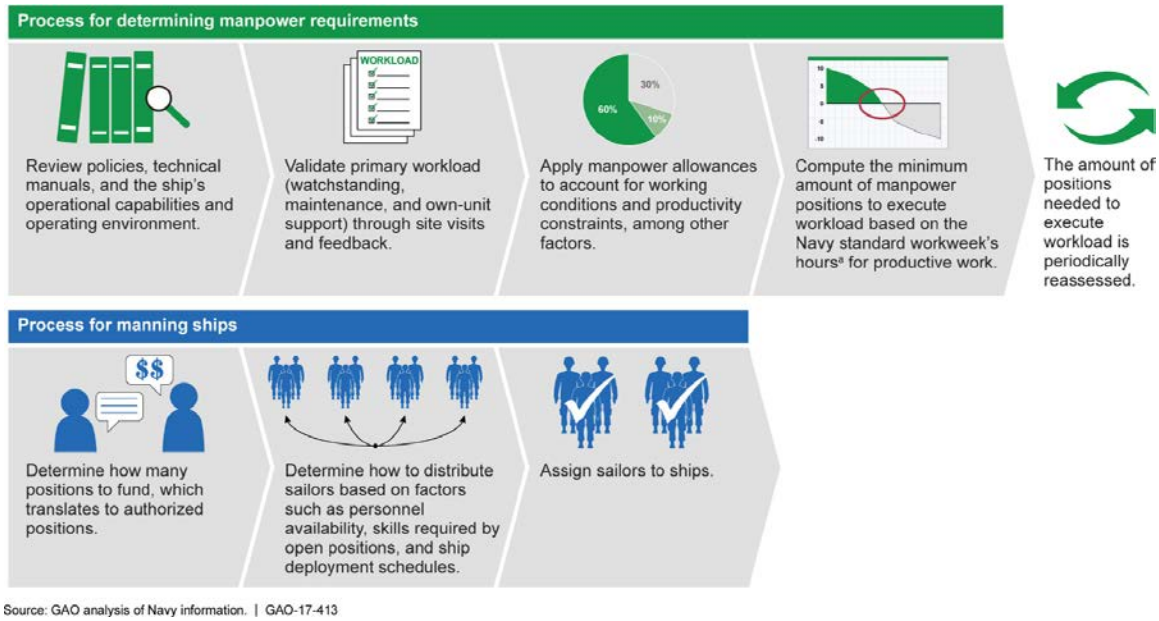


Figure 4. Navy Process for Determining Manpower Requirements and Manning of Ships. Source: GAO (2017a, fig. 1).

b. Wartime Requirement Calculation

According to the Department of the Navy (2019a), manpower requirements are identified as the kind of individuals (type, level and strength) required to perform the Navy's work and deliver Office of the Chief of Naval Operations (OPNAV)-approved capabilities. The total force manpower requirement must be based on fulfilling the approved Navy mission and is dependent on the type of command or unit. Personnel planned for shipboard manpower must be of the appropriate manpower quality, which constitutes the combination of rate or rating and Navy enlisted classification (NEC) codes, sufficient to meet requirements outlined in the SMD (DoN, 2019a).

The DoN also identifies Fleet manpower requirements determination (FMRD) are documents that establish manpower requirement determination (MRD) rules for ships, squadrons and other deployable units. Methodology for creating the FMRD are directed to be standards-based and supportable within the Planning, Programming, Budgeting and Execution System (PPBES). NAVMAC, in coordination with respective TYCOMS, proposes these requirements for approval from OPNAV N12 for publication as a SMD (DoN, 2019a).

SMDs are unique based on ship and submarine equipment configuration. Each SMD provides a total enlisted requirement (TER) representing the total number of Sailors needed to perform a ships mission (DoN, 2019a). For example, an Arleigh Burke Class DDG (DDG-51) has seven SMDs to reflect differing configurations of equipment and capabilities within the Flight I, II, IIA class of ships. The FMRD process and SMD are looked at in more detail in Section D.

c. Billet Authorization

The process to fulfill manpower requirements identified in an SMD generates a manpower demand signal to be assessed and resourced by Director, Surface Warfare OPNAV N96 and executed by USFF and TYCOMs. Manpower authorizations will never exceed the requirements identified. Manpower levels vary depending on availability of funds allocated in the future year defense program (FYDP). The practice of not funding all requirements is common, and permitted if constrained by paygrade compensation,

resources, or policy (DoN, 2019a). Any differences between total warfare requirements and funded billets come at the expense of balancing risk and mission.

d. Planning and Distribution

The responsibility of distributing Sailors to ships belongs to manning control authorities (MCA). MCAs distribute available manpower resources (manning) to ships based on operational priority dictated by mission requirements of a unit and resource availability. The MCA responsible for managing priority and distribution of manning to surface ships is referred to as the MCA Fleet (MCAF). At the time of writing this thesis MCAF was U.S. Fleet Forces Command; however, a shift of MCAF is under consideration. Signals for manning are delivered to the MCAF using the billet-based distribution (BBD) system which replaced the Navy manning plan (NMP) in February 2016. BBD is designed to lessen the time authorized billets are gapped onboard ships by permitting ships to send a demand signal to the MCAF to fill manning gaps when Sailors become available.

e. Current Onboard

A Sailor is considered COB when assigned to a ship in response to BA. The COB figure will be used to represent that a prospective gain is accounted for within the BBD system, whether physically onboard the ship or not.

To balance ship manning levels and account for differences between COB and BA, the MCAF assigns Sailors according to unit "Fit" and "Fill" numbers to minimize impacts to ship operations. Fit is the combination of rating and experience representing the Sailors ability to carry out the duty assigned from BA. Fill is the total number of all hands onboard versus the number of billets authorized which does not account for specific requirements identified in BA. The goal for manning DDGs is to have a minimum of 90% Fit and 90% Fill in the time period leading up to the Basic Phase. As a ship transitions into the Basic Phase manning goals alter to meet 92% Fit and 95% Fill prior to deployment.

The Navy's desire to increase Fit and Fill percentages for near-term deploying ships means that as available Sailors come up for orders, they will be assigned to deploying hulls. When this option is not available, Sailors may be temporarily sent to another ship, a process

known as cross-decking, from other platforms to assist ships in reaching minimum requirements to conduct underway operations or achieve warfare area certifications.

f. Accessible Manpower

Not having the appropriate number of Sailors onboard due to manning shortfalls or Sailors absent from ship muster detrimentally impacts a ship's ability to fulfill work planned for, and required of it, to conduct operations. Boschert (2018), in his NPS thesis, explored the potential impact that differences between BA, COB, and mustering on a given day (using a metric termed present at quarters (PAQ)). He defined PAQ as "a measurement of the number of Sailors who are physically onboard the ship on a given day" (Boschert, 2018, p. 55).

Boschert's study of Flight I DDGs listed several findings. For periods of inport operations, an average of 88% of COB Sailors were available for inport operations, resulting in approximately 207 Sailors were PAQ out of the 243 COB. For periods of underway operations, an average of 91% of COB Sailors were available for underway operations, with approximately 222 Sailors were PAQ out of 243 COB. The top three reasons for Sailor absences during inport periods were planned leave (52%), in rate schools (29%) and local ship support schools (9%); absences during underway periods were in rate schools (19%), local ship support schools (16%) and shore muster (14%) (Boschert, 2018).

Although the NAF and SMD has been updated since Boschert's thesis was published, these figures are stark reminders of the impact of inadequate manning aboard. Each Sailor absent reflects 54-hours per week inport and 67-hours per week underway of work that must be completed by the remainder of the crew.

D. MANPOWER REQUIREMENTS PROCESS

For a ship to conduct operations, it must be manned to a level that can support the requirements placed on it; otherwise, the "Do More with Less" mantra will continue to be manifested in daily shipboard operations. Manpower determination occurs within the FMRD model that takes OPNAV-approved capabilities, combined with watchstanding and maintenance requirements, to ultimately produce manpower requirements. Integral to

getting this model "right" is identifying the appropriate amount of work that is to be completed by a Sailor—whether it is driven by maintenance, watchstanding or requirements from outside entities.

The FMRD Program is managed by the Chief of Naval Operations, Total Force Requirements Division (CNO N12) and operated by NAVMAC. NAVMAC Code 40 creates manpower requirements to fulfill the minimum quality and quantity of people to fulfill prescribed mission areas for a unit. The goal of the FMRD model is to optimize the relationship between work and associated workload variables to create the minimum manpower requirements documented in the SMD (Technical Director, Navy Manpower Analysis Center (NAVMAC), 2017b). The SMD is developed through analysis of the regulations, policy and standards identified in Table 2. Each requirement identified in the SMD equals a manpower requirement and is assigned a billet level qualifier that defines duties, tasks, and functions. These requirements are represented as a combination of rank, rate, and NEC.

Table 2. Requirement Drivers for Ship Manpower Document. Adapted from DoN (2019a, sec. 3).

Requirement Drivers	Description
ROC and POE	Wartime mission, function and tasking statement which describes expected operating environment and necessary capability associated warfare areas implicit to shipboard capabilities.
Approved Staffing Standards	CNO(N1) approved standard to account for workload not accounted for or reflected in PAF.
NAF	Planned hours for Sailors to conduct work.
Warfare Publications	Concept of operations (CONOPS), Navy tactics, techniques and procedures (NTTP), Engineering department organization and regulation manual (EDORM), Navy ships technical manual (NSTM), combat systems doctrine.
Maintenance	Planned maintenance and corrective maintenance derived from maintenance and material management (3M) system; facilities maintenance derived from blueprints and site visits.
Training System Requirements	Navy training requirements identified in training program planning management documents.
Inport Workload	Maintenance, watches and own unit support associated with ROC/POE Condition V.

The manpower determination process incorporates multiple elements that affect the total number of Sailors required for ship operations. Table 3 provides a consolidated set of descriptions and the impacts these elements have on manpower requirements.

Table 3. Elements used in Manpower Determination Process. Adapted from DoN (2019a, sec. 3).

Driver	Element	Description	Impact
ROC/POE & I/P Workload	ROC and POE	Wartime mission, function and tasking statement which describes expected operating environment and necessary capability associated warfare areas implicit to shipboard capabilities.	Condition I, III, V warfare capabilities must be planned for execution in either "Full" or "Limited" capacity
Approved Staffing Standard	Directed Manpower Requirements	Requirements specified by CNO/OPNAV directives, often based on population size and not necessarily driven by measured workload.	Does not create demand for "work," however dictated by unit size; includes positions such as CMC, CCC, MAA, Chaplain etc.
Approved Staffing Standards	Staffing Standards	CNO(N1) approved standard to account for workload not accounted for or reflected in PAF.	
NAF & Warfare Pubs	Operational Manning (OM)	Quantitative and qualitative sum of work hours required to operate essential watchstations for the specified condition of readiness (see ROC/POE)	Designated to meet minimum watch station and skill level. CO has ability to augment as desired. Assumes 3 section underway and 6 section I/P rotation.
NAF & Maintenance	Preventative Maintenance (PM)	Work accomplished through scheduled maintenance requirements (PMS scheduled via SKED 3.2) to support ROC/POE Condition III and V.	Maintenance events scheduled on quarterly occurrence or less.
NAF & Maintenance	Corrective Maintenance (CM)	Work accomplished on an unscheduled basis due to failure or degradation of equipment or a unit's system. These are implemented through validated CM workload, as appropriate.	Workload standard of PM:CM ratio - 1:1 for electrical/electronic & 2:1 for mechanical.
NAF & Maintenance	Facilities Maintenance (FM)	Work accomplished to maintain cleanliness or sanitation, and preservation of hull or equipment against corrosion	Assigned based on ship drawings accounting for space measurements applied with a time standard.
NAF	Utility Tasking	Work actions required of an individual or group which is neither routine nor identified under any other workload category.	Underway examples—UNREP, flight quarters or sea and anchor detail.
NAF	Administrative Support	Work actions necessary for the upkeep of personnel records and administrative functions associated with the command.	Use of programs like SKED 3.2, RADM, OMMS-NG.
NAF	Support Action	Essential shipboard activities that are not included within categories of operational manning or maintenance and are indirect work actions required of personnel.	
NAF	Workload Allowances	Time allocations, factors or other adjustments built into MRPA, personal time, fatigue and the NAF. FMRD model applies these before articulating total work hours of an organization. Accounts for non-work time periods encountered due to work or as result of being present and available for work.	Manpower allowances must be reviewed when reports of significant changes to operational conditions within Condition I, III, V of ROC and POE are encountered.

a. ROC/POE

The purpose of *Required Operational Capabilities and Projected Operational Environment for (Arleigh Burke) Class Guided Missile Destroyers* (OPNAVINST F3501.311C) is to issue the ROC and POE for a specific class of ship. This document provides details that prescribe mission areas, environment, and operational capabilities a class of ship is designed and organized to accomplish. ROC elements specify desired levels of readiness; POE describes the expected operating environments within which readiness must be achieved. For a DDG 51 class ship, manpower requirements must be sufficient to simultaneously perform all assigned primary mission areas in the prescribed capacity. Conditions of readiness and readiness levels for warfare areas provided in Table 4 watch and/or maintenance necessary to carry out readiness conditions of warfare areas. ROC/POE Condition I, III and V are integral to the FMRD model and lay the foundation for the SMD. Manpower determination supports primary mission areas. The ICAVs are a consolidated list of requirements created to support a ship's ability to attain the readiness levels specified within the ROC/POE.

Table 4. Conditions of Readiness. Adapted from DoN (2017d).

Condition of Readiness	Characteristic
Condition I Battle Readiness	Meeting criteria to perform all offensive and defensive function simultaneously; keep all installed systems manned and operating for maximum effectiveness; accomplish only minimal maintenance that is routinely associated with watchstanding and urgent repairs. Maximum expected continuous crew endurance is 24 hours.
Condition III Wartime, Increased Tension and Forward Deployed Cruising Readiness	Manning to enable reduced defensive systems to a level sufficient to counter pop-up threats. Meet criteria to keep installed systems manned and operating as necessary to conform with prescribed ROCs; accomplish all normal underway maintenance, support and administrative functions; requirements to enable. Maximum expected crew endurance is 60 days.
Condition V In Port Readiness	Designated maintenance and training period. Meet criteria to keep installed systems manned and operating to the extent necessary for effective operation as dictated by existing situation; man watch stations as required to provide adequate security; meet anticipated inport emergencies and to perform inport functions as prescribed in unit ROCs; accomplish required maintenance, support and administrative functions. Maximum advantage must be taken for training and exercise opportunities; subject to the foregoing requirements, crew will be provided maximum opportunity for rest, leave and liberty.

b. Afloat Naval Availability Factor

The NAF accounts for a large majority of the manpower elements from Table 3. The NAF, previously called the Navy Standard Work Week or NSWW, is defined as "The total times expressed in average hours per week that are available per person to accomplish the required workload (including watches) of the various types of Navy units. NAF's are key elements in the calculation of Navy manpower" (DoN, 2019a, p. C-7). The NAF acts primarily as a planning tool to reflect expected requirements a ship will encounter when conducting Condition I/III steaming at sea; however, a recent change to the OPNAVINST 1000.16L added Condition V (inport) as a required consideration for manpower determination. A summary of the NAF adapted from OPNAVINST 1000.16L, CH-2 (DoN, 2019a) follows; further detail is devoted to its description and its application within the FMRD model as described in the instruction.

The NAF is broken down into two categories that group and assign expected hours of work to be completed by Sailors. These two categories constitute "productive work" and "non-productive work." Productive work times are consolidated into the Productive Availability Factor (PAF) and represent the amount of time a Sailor is expected to be working to support the ship during the week. The newest revision of the PAF changed the overall man-hour expenditure back to 67 hours; this reversal comes as the Fleet continues to make course corrections for decisions made during the Optimal Manning Initiative period of 2003 to 2012 when the PAF was increased to 70 hours to drive decreases in manpower requirements (GAO, 2017a). Non-productive work times are consolidated into a non-productive work availability factor that equals 14 hours per week. Combined, these two elements account for 81 hours of work expected to be accomplished by a Sailor in a seven-day week when a ship is underway, which equates to approximately 11.6 hours per day.

Productive work includes operational manning (OM), maintenance, and own unit support (OUS). Operational manning determination is tied to the number of watch stations required to meet the conditions of readiness outlined in the ROC/POE; the NAF allocates 56 hours per week to these functions. Maintenance is a combination of preventive maintenance (PM), corrective maintenance (CM) and facilities maintenance (FM). OUS is work associated with administrative, military, command, supply, utility tasking or evolution required for

sustained functioning of the ship (i.e., shipboard working parties). The combination of OUS and maintenance results in an allocation of 11 hours per week in the NAF. The combination of OM, OUS and maintenance creates the PAF and equals 67 hours per week.

Non-productive work includes service diversion (SD) and training; both sets of time allocations were updated in the most recent revision to the NAF. Service diversion includes actions required of personnel based on regulation or shipboard routine; 6 hours per week are allocated for these activities. Examples of SD include quarters, personnel inspections, administrative duties such as non-training related assemblies, and participation on boards, meetings or committees. Training constitutes activities instructional in nature that contribute to the combat readiness of the ship, such as unit training or mission-centric individual training but deducts from the individual's capability to do work; the NAF now allocates 8 hours per week to complete training. Of these eight hours, five are planned for all hands training events such as engineering or combat systems drills, three hours are factored for under-instruction (U/I) watches, completion of personnel qualification standards (PQS), or warfare training.

The remaining 87 hours in the week are allocated for non-available time. This time allows Sailors to conduct non-work-related activities such as messing, sleep or exercise. Independent allocations of hours are not delineated in the FMRD model; they are taken as an aggregate value when calculating how much time a Sailor will not be able to work. Although recommended hours are identified for sleeping, eating and personal time, these individual hours are not protected nor "required" under the FMRD model construct or implementation. Deviation from these hours is all too common, resulting in increased work at the expense of the activities included in "off-time".

In her NPS thesis, Fletcher extensively reviewed, documented and compiled historical policy changes, manpower decision, and changes to the operational environment which contribute to the excessive burden felt by Sailors in the current environment (Fletcher, 2018). Also identified were potential shortfalls in the USN manpower determination model along with recommendations for policy makers to better assist in accounting for and reducing the resulting burden. She concludes with a figure depicting workload demands of ships in Condition III steaming and what requirements are accounted for within the FMRD model

(Fletcher, 2018). This figure is provided in Appendix B. Changes to the NAF were made subsequent to this thesis which address some, but not all, of these concerns.

Updates to the NAF occurred in light of findings from the CR which cited excessive crew fatigue resulting from undermanned ships performing workload in excess of the planned productive and non-productive work allocations. Analysis conducted for the CR found that work hours exceeded the planned quantity. Specifically, the CR found that NAF categories of SD exceeded planned time by 64%, training by 58% and watchstanding by 29%. In order to make up for the overages in the NAF categories, non-available time was decreased in all categories—including sleep and personal time (DoN, 2017a, p. 99).

c. Additional Inputs

Workload allowances are time allocations, factors, or other adjustments used to account for circumstances that influence normal execution of work. Application of industrial engineering standards are applied to work requirements to account for time expended in support of work, however, not directly on conduct of work. Two adjustments are used in USN manpower determination. One is "make ready/put away allowance" to credit Sailors with time spent preparing for maintenance actions and restoring equipment following maintenance; this allowance is applied to PM only. The second adjustment is "personnel, fatigue and unavoidable delay allowance" that accounts for fatigue or conditions beyond the control of a Sailor; this second allowance is applied to OUS, CM and FM workload. Workload allowances are incorporated into required work determination factors and must be reviewed when changes to ROC/POE Condition I, III or V operational conditions are reported.

Directed manpower requirements are personnel positions incorporated into manpower documents based on CNO or OPNAV directives, regulations or policy. These manpower requirements are often based on the size of a command and not driven by measured workload. Examples of this type of position are the Command Master Chief (CMC), Master at Arms (MAA), or command career counselor. CNO(N1) staffing standards are implemented to incorporate workload and not accounted for or reflected in the PAF.

d. Inport Requirements

Changes to OPNAVINST 1000.16L were published in January 2019 and incorporated requirements to account for Condition V operations. Prior to this revision, manpower was only calculated to include underway steaming conditions corresponding to Condition I, general quarters, and Condition III, for wartime or deployed watchstanding.

E. INTRODUCTION OF INPORT REQUIREMENTS

The new requirement to incorporate inport operations, or Condition V steaming, into manpower models occurred after years of concern voiced about the overwork of crews during inport operations was detrimentally impacting underway operations. The CR cited that crews incurred excessive fatigue from performing more work than was allocated within both the productive and non-productive allowances (DoN, 2017a). A GAO report from 2017 titled *Navy Readiness: Actions Needed to Address Persistent Maintenance, Training, and Other Challenges Facing the Fleet* also stated that while the Navy has made headway in reversing the manning reductions incurred during "optimal manning," it continued to use a workweek standard not reflecting work completed by Sailors. Manpower determination, at the time, did not account for inport time where crews typically carry out work with fewer Sailors (GAO, 2017b, p. 9). Initial results of DDG SMD reviews indicate that more Sailors are needed to achieve minimum standards (DoN, 2017a). Boschert's 2018 NPS thesis supports this assessment from the 2017 GAO report; the combination of these factors could contribute to Sailors being overworked to account for the workload of multiple Sailors, adding to the strain that is felt during inport periods (Boschert, 2018). The subsequent call for a study of proposed inport NAF also supports these conclusions.

In July 2017, NAVMAC, COMFLTFORCOM, COMPACFLT and COMNAVSURFPAC collaborated to conduct a study to identify an inport NAF. The effort aimed to address growing concerns over the burden felt by ships while inport and correct the omission of this workload in existing manpower models. Internally, NAVMAC adapted a combination of sea and shore duty workload variables to anticipated inport requirements. The resulting calculation produced a 54-hour PAF for an inport workweek of five days (as

compared to the seven days included in underway calculations). A follow-on study of 12 Arleigh Burke Class Destroyers was conducted to verify the initial findings.

In this study, NAVMAC looked at 12 non-deployed DDGs. Of these, five were in the Maintenance Phase, four in the Basic Phase, two in the Advanced/Integrated Phase, and one in the Sustainment Phase of the OFRP. Three FLT I DDGs and one FLT II DDG were observed in the Maintenance Phase, the remaining ships were all FLT IIA DDGs observed in various stages of the OFRP. The average number of Sailors COB was 267 per ship, which is well below the 281 average requirement published in ROC/POE for Condition I/III steaming and also below the 277 requirement for current year authorization totals (DoN, 2017c).

The inport work is expected to be 54-hours for a 5-day workweek. The inport NAF includes watch, maintenance, OUS, training and service diversion. Productive work, incorporated into an inport PAF, equals 40 hours assigned to on-duty watch (14 hours per week) and divisional work (26 hours per week). Non-productive inport work and holiday/leave (7.4 hours) account for the remaining 14 hours. Non-productive work is a combination of training (4.2 hours) and service diversion (2.4 hours).

Workload variables contained within the inport NAF are similar to the at-sea NAF, which are seen in Table 5.

Table 5. Initial Summary of 70-hour Afloat NAF Compared to Proposed Inport NAF. Adapted from DoN (2017c, p. 81).

Underway Sea Duty NAF (7 days)		**Proposed Inport Sea Duty NAF (5 days)**	
Productive Work	70 hrs	Productive Work	49 hrs
Group Training	7 hrs	Group Training	4.2 hrs
Service Diversion	4 hrs	Service Diversion	2.4 hrs
Messing	14 hrs	Messing	14 hrs
Sleep	56 hrs	Sleep	56 hrs
Personal Time	14 hrs	Personal Time	44 hrs
Sunday Free Time	3 hrs	Holidays/Leave	7.4 hrs
Available Time: 81 hrs Non-Available Time: 87 hrs		Available Time: 54 hrs Non-Available Time: 114 hrs ** ** 17 hrs of N/A time accounts for duty, not on watch	

Watchstanding was broken down into two categories. One category constituted watches requiring 24-hour dedicated coverage where it is assumed that Sailors assigned to these watches will not perform additional work while on watch. Examples of these watches are officer of the deck, topside rover, central control system supervisor and combat systems maintenance control watch. A second category of watches represent duty section assignments that require a 24-hour availability, but do not impact a Sailor's ability to conduct other work while on duty. Examples of these watches include command duty officer, section leader, duty driver or duty armorer. Of note, force protection measures—specifically Force Protection Bravo (FPCON B)—were not calculated within watch requirements because it was determined these watches represent a surge in workload capacity not required to be accounted for within the model; it is assumed ships will compress duty sections to meet these needs if the necessity arises. Therefore, only nine watches were included in the calculation of inport watch requirements.

Maintenance is a combination of preventative, corrective and facilities maintenance which are calculated in the same manner as the afloat NAF. OUS covers the same activities as the at-sea model with the inclusion of "divisional work".

Two additional workload variables, called inport-centric variables, were introduced into the inport NAF. The goal of these two variables was to capture unique work performed inport that is not normally associated with more traditional/routine rating or duty section assigned work. Utility tasking reflects work associated with working parties, workcenter exercises, additional ship tasking and items not covered in OUS. Administrative tasking reflects ship's company support of external organizations who may be performing work onboard such as contractors, inspectors conducting pre-inspection or pre-deployment certifications.

In the context of the inport NAF, the values corresponding to maintenance and watch are "set" by standards within duty section watch and quarterly maintenance completion. This means that any additional requirement of Sailors during a work week are absorbed within service diversion and training. In times with high "burden," such as the Basic Phase and Advanced Phase of training, these two categories within non-productive work must be enough to account for these time demands. If this is not the case then

manpower planning incorporating inport operations may not be sufficient and time will have to be allotted from other categories to make up for the difference.

Non-available time accounts for the remaining 114 hours within the week. This time allocation includes personal time spent off ship, sleep, exercise, and eating. It is also expected that 17 hours represent Sailors who are on duty and will not be doing any additional work when not on watch. This assumption within the inport NAF may run contrary to standard practice within the Fleet.

As of August 2019, the inport NAF is undergoing validation for use within the FMRD process. Figure 5 is an updated comparison of the updated 81-hour afloat NAF compared to the interim inport NAF.

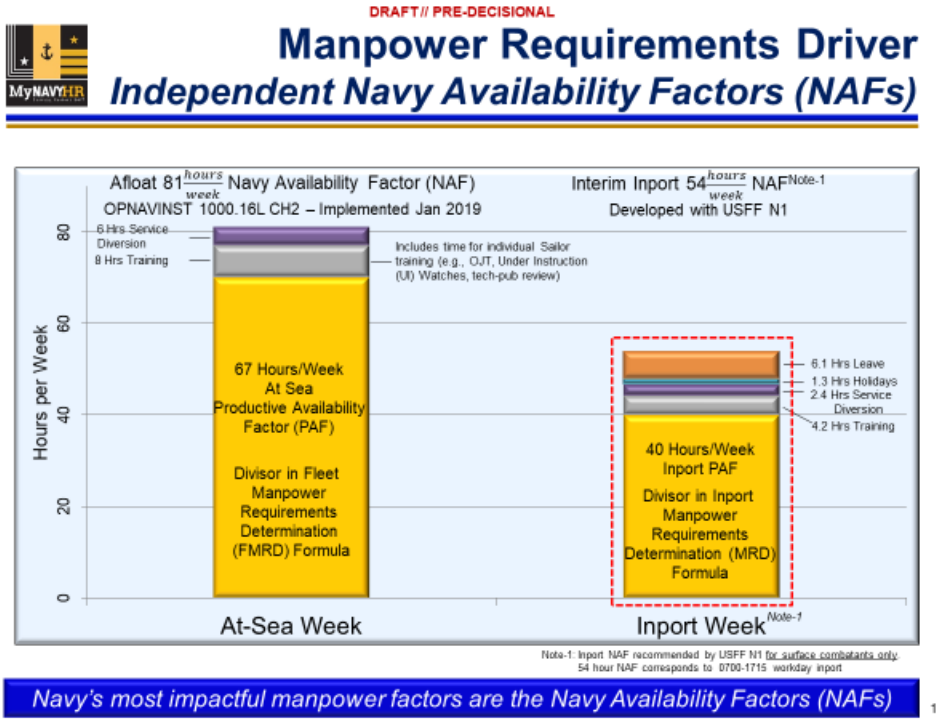


Figure 5. Comparison of 67-hour Afloat NAF Compared to Interim Inport NAF. Source: J. Eaton (personal communication, 13 August 2019).

Results obtained from the ships in the NAVMAC study supported the initial 54-hour proposed inport NAF. Implementation of the 40-hour inport PAF also showed a

potential 3% change in Enlisted manpower requirements, reflecting a decrease in existing ROC/POE Condition I/III manpower requirements from 298 to 290 Sailors. These changes are represented by an addition of 17 Enlisted billets, primarily in Engineering specific ratings, and a decrease of 25 Enlisted billets, primarily Operations Specialist, Seaman, and Quartermaster ratings (CO, NAVMAC, 2017c). These findings make sense intuitively if accounting for the maintenance and watchstanding demands encountered between inport and underway periods for these rates.

It is important to understand that the inport NAF will only be applied when a ship is moored. Anytime the ship is underway, whether for local operations, exercises or training events, the afloat NAF will come into effect, regardless of manning levels or Sailors PAQ. Shipboard requirements incorporated in a non-deployment period of the OFRP (Maintenance, Basic, Advanced and majority of the Sustainment Phases) must take both inport and afloat manpower requirement considerations into account.

In conversations with CAPT Steven Milinkovich, former NAVMAC Commanding Officer (CO), (personal communication, April 8, 2018), the values incorporated within the inport NAF are derived from policy and doctrine. He suggested the values for service diversion and training may not accurately reflect demands of the Fleet. Further investigation into these two activities may be warranted. The combination of the proposed inport NAF, approved afloat NAF, and application of recommendations from CDR Fletcher's notional at-sea workload model, were the foundation for the activity log variables, descriptions, and analysis that was used in the CR53 study. See Appendix H for a copy of the activity log.

F. CHANGES SINCE THE START OF CR53 STUDY

The CR Working Group (CRWG) was established with CNSP as the lead. Their job was to oversee and implement recommendations from the CR with key stakeholders. Upon release of the Strategic Readiness Review (SRR) in December 2017, the VCNO established the Readiness and Reform Oversight Council (RROC) and Readiness and Readiness Reform Steering Group (RRSG). The RROC and RRSG were established to ensure Echelon 1-level barrier removal and funding prioritization as required to support

CR/SRR implementation. Upon RROC establishment, CR/SRR recommendations were merged together to form the RROC Playbook (H.T. Workman, personal communication, August 21, 2019).

The RROC meets periodically to support outcomes identified within the RROC Playbook. Reports from the RRSG to the RROC occur monthly to report progress of the working group; the RROC then reports to SECNAV and CNO as directed. Quarterly reports to Congress on the RROC progress are expected, with reports being presented by the Chairs of the RRSG submitted to SECNAV, CNO, and Commandant of the Marine Corps (DoN, 2019b). Within the RROC construct, the CR53 study is listed as "Manning Line Item -12" (M-12).

CNSP-CNSLINST 3502.7 was signed on 01 November 2018 and took effect on 01 January 2019. The *Surface Force Training and Readiness Manual* (SFTRM) consolidated four documents into one to provide Commanding Officers (COs) the ability to better control time within the Basic Phase and promote a culture of excellence onboard their ships throughout the OFRP cycles. The four cancelled documents are: CNSP-CNSLINST 3502.3A, *Surface Forces Readiness Manual (SFRM)*; CNSP-CNSLINST 3500.11A, *Surface Force Exercise Manual*; CNSP-CNSLINST 3500.10A, *Readiness Evaluations*; and CNSP-CNSLINST 3502.5, *Mission Area Watch Team Continuity*.

The introduction of the SFTRM implemented the following four major changes to the training continuum. First, a new training strategy is aimed at training complete watchteams in mission area certifying requirements, before transitioning to certifying respective training teams (i.e., complete Mobility-Engineering (MOB-E) certification, and then training the Engineering Training Team (ETT). Second, removing block phase training to establish focused training availabilities (FTA) is required. This removal may potentially reduce redundant certification exercises if proficiency in a warfare area is demonstrated in an earlier training event prior to the traditional 1.4 or 2.4 certification event. Third, more time will be allocated for completion of contractor and TYCOM Sea Trials to allow for a Mariner Skills Week and completion of Bridge Resource Management workshop prior to the Basic Phase. Fourth, required mission area completions to achieve Basic Phase Certification are reduced. The following mission areas are no longer required

to be completed during the Basic Phase but will be included in the remainder of the 36-month OFRP: maintenance (3M), anti-terrorism (AT), explosive safety (EXPSAF), FSO-M, and supply (SUP) (COMNAVSURFOR SAN DIEGO CA, ALNAV Message, 310010ZOCT18).

Implementation of the SFTRM eliminated an additional 53 discrete ICAV requirements. The transition from the block-phased approach to FTAs permits ships to complete requirements not associated with warfare capabilities at times deemed appropriate by the COs of their ships. Other major changes include a fleet-wide crew fatigue and endurance management policy (CFEMP) designed to improve safety and operational performance of ships within CNSP-CNSLINST 3120.2. CNSF and NPS are collaborating to conduct studies aimed at identifying, addressing and correcting human performance factors that have been identified as causal factors in recent mishaps.

These are just a few of many changes implemented from the directed recommendations over the last two years. These changes, combined with other ongoing efforts, will assist the Fleet in better managing ship schedules and crews for more effective and efficient global force employment.

III. METHODOLOGY

A. PROCEDURE

This study was a naturalistic observation conducted onboard two Flight I DDGs. It was originally designed to compare the effects of manning on performance and fatigue levels of the crews of two similar ships in similar OFRP phases. In the original study design, one ship would be augmented to increase manning levels by approximately 10%, or an additional 27 Sailors to the BA level of 273, to match 100% SMD levels (300 Sailors). The influx of Sailors prior to the study would have allowed the research team to assess the effect of manning levels on individual Sailor sleep, fatigue and workload and compare ship-wide metrics, such as training certification scores. However, manning challenges did not permit the original study goal to be achieved. As a result, a secondary goal and multiple unique contributions were achieved, including an empirical study of the workload and fatigue level of Sailors and Officers during the Basic Phase encompassing both inport and underway periods.

The ship which acted as the control ship in the CR53 study, with no additional manning onboard, is referred to as Ship A. The ship which acted as the experiment ship in the CR53 study, which received additional manning in the latter part of the Basic Phase, is referred to as Ship B.

Data were collected onboard Ship A from 03 October 2018 to 18 January 2019 and onboard Ship B from 01 October 2018 to 26 April 2019. Officers and Enlisted members of the crew from all departments were encouraged to participate in the study. Due to the voluntary nature of the study and attrition inherent in these types of studies, the study had varying numbers of participants across the three phases of data collection.

On the first trip to recruit participants, crewmembers of both ships received a presentation by Dr. Nita Shattuck that included CR53 study requirements and collection methods. Sailors who volunteered to participate signed consent forms and filled out the pre-study questionnaire. Next, activity logs and actiwatches were issued. For data collection periods lasting longer than one-week, the post-study questionnaires were

included in the activity logs to be filled out at specific dates which normally corresponded to the Friday at the end of each week. Upon completion of each data collection period, the NPS Crew Endurance team returned to the ship to retrieve the actigraphs, activity logs, review logs for completeness and administer the post-study profile of mood state (POMS) questionnaire.

B. DATA COLLECTION PERIOD DESCRIPTION

The length of time between commencing Readiness Evaluation-5 (RE-5) and completion of Unit Tactical Certification for Ship A was 16 weeks and 27 weeks for Ship B. The departure from the notional 24-week Basic Phase was due to delays in exiting Maintenance Phase following mid-life modernization overhauls. This created a situation where the ships commenced the Basic Phase at different points in the certification timeline. A period of approximately three weeks, coinciding with the December/January Holiday Leave and Upkeep period, was included in the timelines of both ships.

The two ships schedules were compared to identify major training or certification events that could be observed onboard both ships under similar conditions. Events identified for comparison were: Readiness Evaluation 5 (RE-5) and TYCOM Sea Trials; Mobility-Engineering 1.3A (MOB-E 1.3A); Mobility-Seamanship 1.3 (MOB-S 1.3); Advanced Warfare Tactics Phase III (AWT PH III); 3M 1.3; and Tactical Certification (TACTICAL CERT) and Fleet Synthetic Training-Unit (FST-U). Table 6 and Table 7 show the list of events observed during the three data collection periods occurring on both ships.

Out of 88 ICAV events identified in the CR38 study as required for completion during the Basic Phase, 27 events were observed on Ship A (30.7% of all ICAV events required in the Basic Phase) and 25 events were observed on Ship B (28.4% of all ICAV events required in the Basic Phase). A complete day-by-day breakdown of shipboard events can be found in Appendix C and Appendix D.

Table 6. Basic Phase Events Observed Onboard Ship A

	Data Collection 1			Data Collection 2	Data Collection 3
Start Date	05 OCT 18	13 OCT 18	20 OCT 18	06 DEC 18	14 JAN 19
End Date	12 OCT 18	19 OCT 18	26 OCT 18	14 DEC 18	18 JAN 19
Nomenclature	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
Days Observed	8	7	7	9	5
Days Inport	5	3	7	9	5
Days Underway	3	4	0	0	0
Events	TYCOM SEA TRIALS RFSA NSFS 2.3 USW 2.2R	MOB-E 1.3A MOB-N 1.3 MOB-S 1.3 BMD ORE	AW 2.3 SW 2.3 CYBER 2.3C EW 2.3 INTEL 2.3 SUP 1.2 SUP 1.3 STW 2.2A	IAMD PH III BMD 2.3 EW LTT 3M 1.3 BMDEX 1903 (LTT) EW 2.3R LRTT SUPPLY LTT GUN SHOOT EXPSAF WALKTHROUGH CMAV 9A-1 PFA	TACTICAL CERT FST-U AW 2.4 SW 2.4 EW 2.4 CYBER 2.4 RATT 3M REMEDIATION COMMAND INDOC DC-U

Table 7. Basic Phase Events Observed Onboard Ship B

	Data Collection 1			Data Collection 2	Data Collection 3	
Start Date	16 OCT 18	22 OCT 18	27 OCT 18	04 MAR 19	11 APR 19	20 APR 19
End Date	21 OCT 18	26 OCT 18	02 NOV 18	08 MAR 19	19 APR 19	26 APR 19
Nomenclature	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
Days Observed	6	5	6	5	9	7
Days Inport	4	2	3	5	9	7
Days Underway	2	3	3	0	0	0
Events	TYCOM SEA TRIALS RFSA EW/JTT VIS MITES FSOM 1.3 MOB-A 1.4B COMMAN D INDOC	TYCOM SEA TRIALS SEAL BEACH AMMO ONLOAD	FSOM 1.3 MOB-E 1.3A	IAMD PH III USW 2.3B USW 2.4A FATS SUP 1.4	BMDQ 3M 1.3 DC-U CMAV 9A3	TACTICAL CERT FST-U AW 2.4 SW 2.4 EW 2.4 INT 2.4 AMAT VMAT GTMAT ELMAT RIBMAT WTDMAT COMMSMAT SUPP LTT CMAV 9A3

C. PARTICIPANTS

Sailors on both ships volunteered to participate in the study. NPS Institutional Review Board (IRB) approved the study protocol on 06 July 2018 (NPS IRB# NPS.2017.0022-AM10-EP4&7), with subsequent continuations approved on 14 September 2018 (NPS.2017.0022-AM11-EP4&7-A) and 12 February 2019 (NPS.2017.0022-CR02-EP4&7A). Examples of participant consent forms can be found in Appendix E.

Overall number of unique participants who volunteered for the CR53 study was 296 when combined for both ships. In the event some participants signed up for multiple data collection periods, they retained their initial participant ID which enabled the aggregation of data by participant at the end of the study.

To account for promotions that may have occurred over the course of the Basic Phase, the rate and rank information provided during initial data collection period was used throughout. Reported ranks were consolidated in order to correspond with Fit/Fill percentages provided by CNSP manning documents. Throughout the analysis, these are identified as "Rank Group." Table 8 represents the consolidation of rank that is used for the analysis.

Table 8. Rank Groups Used for Analysis

Apprentice	Journeyman	Supervisor	Officer
E1, E2, E3, E4	E5, E6	E7, E8, E9	O1, O2, O2E, O3, O4, O5

Departments reported by Sailors were updated to align across both ships. These changes were made due to differences in workcenter assignments between the two ships. Table 9 represents the re-aligned rates to departments for comparison throughout the analysis.

Table 9. Department and Corresponding Rates Used for Analysis

Department	Division or Workcenter	Rates
Engineering (ENG)	MP, EM, EA, ER	DC, EM, FN, GS, GSE, GSM, MM
Combat Systems (CS)	CC, CE, CF	ET, FCA, IC, IT
Weapons (WEPS)	CG, CM	FC, GM
Plans and Tactics (PT)	CA, OT	CTT, IS, STG
Operations (OPS)	OD, OI	BM, OI
Navigation/Exec (NAV/EX)	NN, EX, HM	PS, HM, YN, NC, QM, MA
Supply (SUP)	S1, S2, S3	CS, LS, SH

1. Ship A

Ninety-six participants volunteered for the three-week Data Collection 1 onboard Ship A. Due to participants withdrawing or incomplete data, 35 were included in Ship A Data Collection 1 Week 1 (R1_W1), 31 in Ship A Data Collection 1 Week 2 (R1_W2), and 30 in Ship A Data Collection 1 Week 3 (R1_W3) analysis. Due to missing data, 59 participants were excluded from R1_W1, 63 were excluded from R1_W2, 64 were excluded from R1_W3 and 2 participants withdrew from Ship A Data Collection 1. Figure 6 depicts Ship A participants who were included in Data Collection 1 analysis.

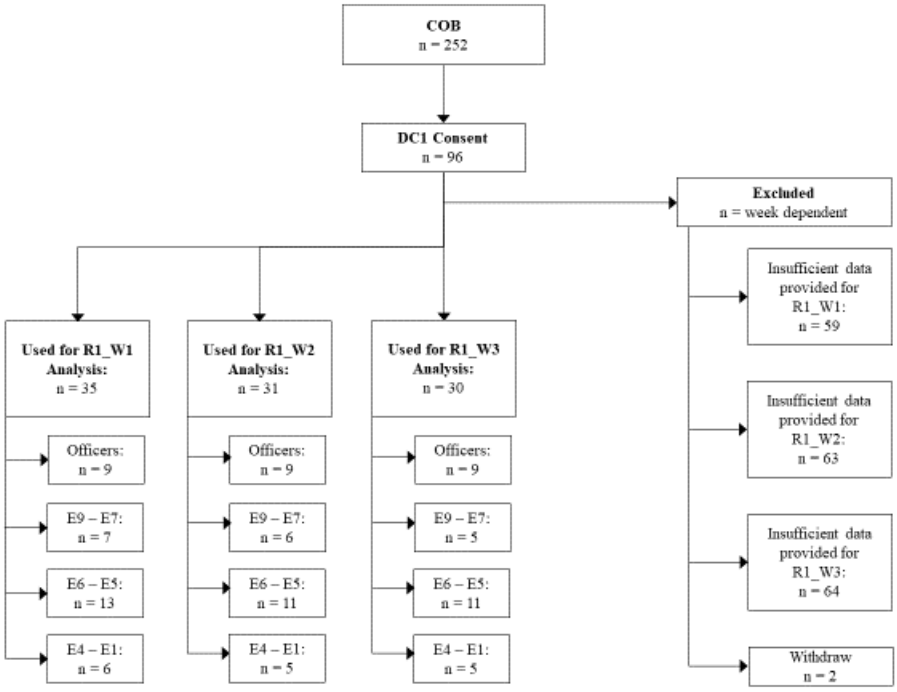


Figure 6. Consort Table for Ship A Data Collection 1

Twenty-four participants volunteered for the one-week Data Collection 2 onboard Ship A. Due to participants withdrawing or incomplete data, 13 individuals were included in Ship A Data Collection 2 Week 1 (R2_W1) analysis. Due to missing data, 11 participants were excluded from R2_W1 and no participants withdrew from Ship A Data Collection 2. Figure 7 depicts the number of Sailor that were included and excluded from Data Collection 2 analysis. Figure 7 depicts Ship A participants who were included in Data Collection 2 analysis.

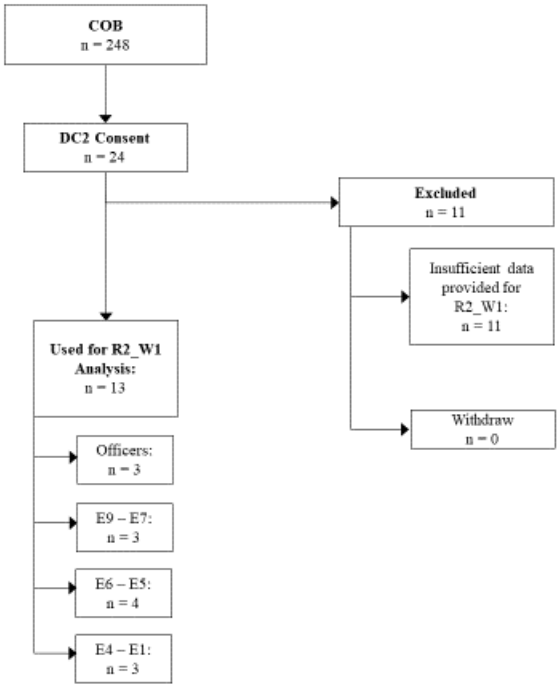


Figure 7. Consort Table for Ship A Data Collection 2

Twenty-five participants volunteered for the one-week Data Collection 3 onboard Ship A. Due to participants withdrawing or incomplete data, 19 individuals were included in Ship A Data Collection 3 Week 1 (R3_W1) analysis. Due to missing data, 5 were excluded from R3_W1 and 1 participant withdrew from Ship A Data Collection 3. Figure 8 depicts Ship A participants who were included in Data Collection 3 analysis.

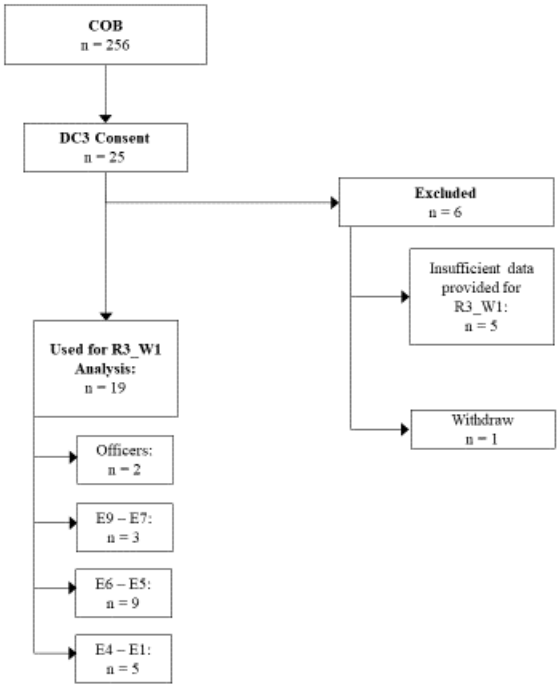


Figure 8. Consort Table for Ship A Data Collection 3

Table 10 is a summary of the total number of participants included in analysis for each data collection period. A complete breakdown of participants from Ship A included in the activity log analysis for each phase of data collection is located in Appendix F.

Table 10. Final Number of Activity Log Participants Used for Analysis from Ship A

	Data Collection 1			Data Collection 2	Data Collection 3
Ship Fit/Fill	89.92% / 94.87%			84.88% / 90.84%	86.05% / 93.77%
Start Date	05 OCT 18	13 OCT 18	20 OCT 18	06 DEC 18	14 JAN 19
End Date	12 OCT 18	19 OCT 18	26 OCT 18	14 DEC 18	18 JAN 19
Nomenclature	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
COB	252	252	252	248	256
Final # Of Participants	35	31	30	13	19
% of Crew	13.9%	12.3%	11.9%	5.2%	7.4%

2. Ship B

One hundred thirty-five participants volunteered for the three-week Data Collection 1 onboard Ship B. Due to participants withdrawing or incomplete data, 50 were included in Ship B Data Collection 1 Week 1 (P1_W1), 45 in Ship B Data Collection 1 Week 2 (P1_W2), and 49 in Ship B Data Collection 1 Week 3 (P1_W3) analysis. Due to missing data, 80 participants were excluded from P1_W1, 85 were excluded from P1_W2, 81 were excluded from P1_W3 and 5 participants withdrew from Ship B Data Collection 1. Figure 9 depicts Ship B participants who were included in Data Collection 1 analysis.

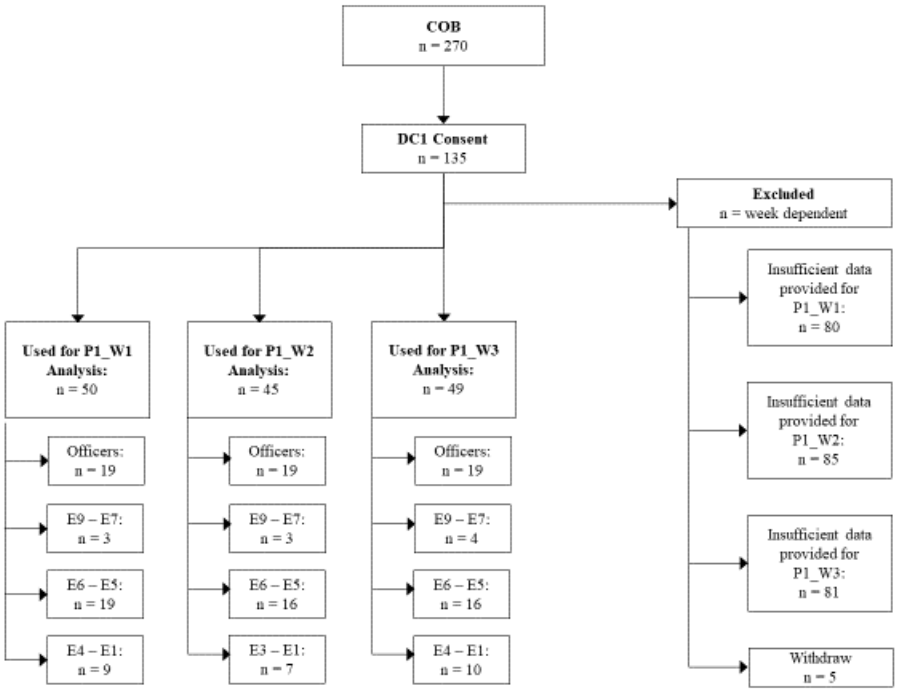


Figure 9. Consort Table for Ship B Data Collection 1

Seventy-four participants volunteered for the one-week Data Collection 2 onboard Ship B. Due to participants withdrawing or incomplete data, 52 individuals were included in Ship B Data Collection 2 Week 1 (P2_W1) analysis. Due to missing data, 21 participants were excluded from P2_W1 and 1 participant withdrew from Ship B Data Collection 2. Figure 10 depicts Ship B participants who were included in Data Collection 2 analysis.

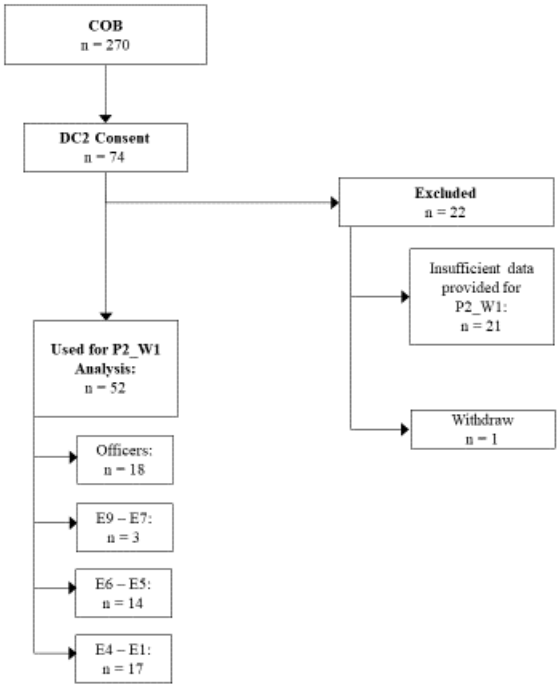


Figure 10. Consort Table for Ship B Data Collection 2

Sixty-three participants volunteered for the three-week Data Collection 1 onboard Ship B. Due to participants withdrawing or incomplete data, 32 were included in Ship B Data Collection 3 Week 1 (P3_W1) and 32 in Ship B Data Collection 3 Week 2 (P3_W2) analysis. Due to missing data, 29 participants were excluded from P3_W1, 29 from P3_W2 and 2 participants withdrew from Ship B Data Collection 3. Figure 11 depicts Ship B participants who were included in Data Collection 3 analysis.

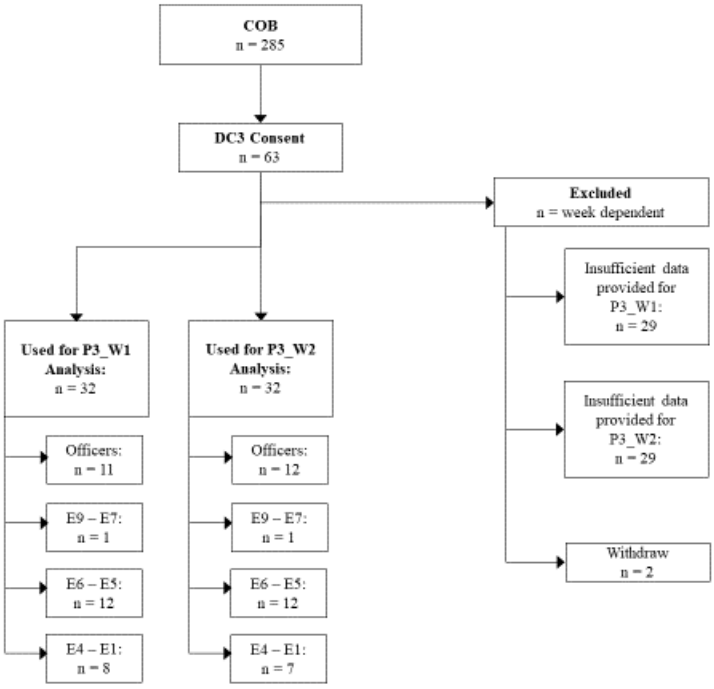


Figure 11. Consort Table for Ship B Data Collection 3

Table 11 is a summary of the total number of participants included in analysis for each data collection period. A complete breakdown of participants from Ship B included in the activity log analysis for each phase of data collection is located in Appendix G.

Table 11. Final Number of Activity Log Participants Used for Analysis from Ship B

	Data Collection 1			Data Collection 2	Data Collection 3	
Ship Fit/Fill	85.27% / 98.90%			87.60% / 98.90%	93.41% / 104.40%	
Start Date	16 OCT 18	22 OCT 18	27 OCT 18	04 MAR 19	11 APR 19	20 APR 19
End Date	21 OCT 18	26 OCT 18	02 NOV 18	08 MAR 19	19 APR 19	26 APR 19
Nomenclature	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
COB	270	270	270	270	285	285
Final # Of Participants	50	45	49	52	32	32
% of Crew observed	18.5%	16.7%	18.2%	19.3%	11.2%	11.2%

D. EQUIPMENT

1. Actigraphy

Philips Respironics Spectrum Actiwatches were used to assess sleep/wake patterns. Participants were instructed to wear a wrist-worn activity monitor for the duration of data collection periods, excluding activities that could damage the equipment or endanger the participant such as ammunition handling or maintenance on electronic or electrical equipment.

Actigraphy data were scored using Actiware software Version 6.0.9. For the purpose of this thesis, the actiwatches and corresponding data were used to validate the accuracy of activity logs to account for periods of activity and rest. Analysis of sleep and fatigue data corresponding to data collection periods described in this effort can be found in LT Mansfield Murph's thesis (2019).

2. Activity Logs

Participants were asked to note their activities on paper activity logs in 15-minute increments for the duration of each data collection period. Activities included in the log corresponded to workload variables included in the at-sea and proposed inport NAF. Variables included in the activity log are as follows.

Maintenance/Work is denoted by "M" and accounts for time allocated to gather tools, travel to and conduct maintenance on equipment. Enlisted rates with minimal or no maintenance were instructed to use this variable for the time in a day associated with carrying out duties required within the rating but not considered maintenance in the traditional sense as assigned through the 3M system. Watch is denoted by "W" and accounts for time spent standing assigned watches either inport or underway.

Administrative duties are denoted by "A" and account for time spent using programs of record supporting Navy requirements such as SKED, OMMS-NG, or R-ADM; duties include building watchbills, creating job sequencing numbers (JSN), CASREPs or updating 8 o'clock reports; work related emails and administration required for updating service related personal records are also included within this category. Meetings are

denoted as “D” and account for time spent in maintenance meetings, planning board for training (PB4T) or quarters; this category also accounts for time spent at khaki call, department head call or an all hands call. Professional development is denoted “PD” and accounts for time conducting advancement exams, completing PQS, on the job training (OJT), or mentoring sessions.

Shipboard level training is denoted as “T” and accounts for time dedicated for briefs, equipment walkthroughs and the completion of warfare related drills, assessments or certification independent of location (i.e., in a classroom or shipboard environment); this category also includes any duty section training. General military training (GMT) is denoted as “G” and accounts for general military training or navy wide training. Personal/Free Time is denoted as “P” and included time spent working out, hygiene, grooming, time “off work” during the evening of a workday or on a weekend when not on holiday/leave/POM period or special liberty. Leave or Liberty is denoted as “L” and associated with time spent on approved leave (as annotated by the participant), pre/post overseas movement (POM), or 24–96 hour special liberty (as annotated by participant, or if interpolated, by referencing POD). Commuting is denoted as “C” and accounted for time spent traveling to and from work. Two other variables are Eating and Sleeping/Napping denoted with an “E” and “S.” One additional variable denoted with an “R” was used when the watch was removed from the wrist.

Consolidation of CR53 activity log variables deriving work and non-available times applied throughout this section are represented in Table 12.

Table 12. CR53 Activity Log Variable Combination

<table>
<tr><td rowspan="3">NAVMAC I/P NAF (planned time)</td><td colspan="6">Inport NAF (54 hours)</td></tr>
<tr><td colspan="2">Productive Work (PAF) (40 hours)</td><td colspan="2">Non-Productive Work (6.6 hours)</td><td colspan="2">Leave/Holiday (7.4 hours)</td></tr>
<tr><td>Operational Manning/Watch (14 hours)</td><td>Divisional Work (26 hours)
Maintenance & OUS</td><td>Service Diversion (2.4 hours)</td><td>Training (4.2 hours)</td><td>Leave (6.1 hours)</td><td>Holiday (1.3 hours)</td></tr>
<tr><td>Activity Log Abbreviation</td><td>W</td><td>M</td><td>A + PD + D</td><td>G + T</td><td colspan="2">L</td></tr>
</table>

Table 13 depicts variables identified in the NAF. The variables are grouped by corresponding categories in the NAF and represent how previous studies incorporated them into analysis.

Table 13. CR53 Activity Log Variables for NAVMAC NAF and NPS Study Comparison

		Afloat NAF	Afloat NAF Variable	Previous NPS Activity Logs (for at-sea use)	Proposed I/P NAF (from I/P Beta Model)	CR-53 Activity Log Variables
NAF	Productive Work (PAF)	Operational Manning (OM)	Operational Manning (OM)	Watch	Watch	Watch (W)
		Maintenance	Planned Maintenance (PM)	Maintenance/ Work	Planned Maintenance	Maintenance/ Work (M)
			Corrective Maintenance (CM)		Corrective Maintenance	
			Facilities Maintenance (FM)		Facilities Maintenance	
		Own Unit Support (OUS)	Own Unit Support (OUS)		Own Unit Support (OUS)	
	Non-Productive Work		Service Diversion (SD)	Service Diversion (SD) Meetings	Utility Tasking Administrative Tasking	Meetings (D) Administrative Work (A) Professional Development (PD)
			Training	Training		GMT (G)
						Unit Training (T)
			Personal Time	Personal/Free Time Sleep/napping		Personal/ Free Time (P)
						Sleep/Napping (S)
						Eating (E)
						Leave/POM/ Liberty (L)
						Commuting (C)

3. Questionnaires

At the start of each data collection period, participants completed a pre-study questionnaire and Epworth Sleepiness Scale (ESS) (Johns, 1991). Demographic items included age, gender, rate/rank, assigned department, years on active duty, number of times deployed, total months deployed, and previous underway watch rotation. Additional questions included nicotine use and frequency, prior diagnosis of insomnia or obstructive sleep apnea, and current medication use. The ESS was used to assess daytime sleepiness. Individuals indicated their likelihood of falling asleep in eight situations using a 4-point Likert scale from 0 to 3. The higher the sum of scores corresponds to an increase in

excessive daytime sleepiness; a score of 10 or greater represents above normal daytime sleepiness (Johns, 1992).

At the end of each data collection week, participants completed the post-study questionnaire, which included the ESS and two other standardized tools: the Insomnia Severity Index (ISI) and the Pittsburgh Sleep Quality Index (PSQI). The ISI consists of seven questions assessing perception of symptoms of insomnia, to include difficulty sleeping and waking up, as well as satisfaction of sleep quality and impacts to daily functions due to sleep quality (Bastien, 2001; "Insomnia severity index (ISI)," n.d.). The PSQI consists of 19 self-rated questions assessing subjective sleep quality, to include factors such as sleep quality, duration, latency and frequency and severity of specific sleep-related problems. Items are grouped into seven component scores and rated on a 0–3 scale. A global PSQI score is achieved by summing component scores within a range of 0–21. The higher the score, the worse the sleep quality reported (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The post-study questionnaire included two sets of questions delineating between days spent inport and underway. Each set of questions asked participants to annotate their associated watch standing schedule; a 5-point Likert scale was used to assess workload during their last "data collection period" and indicate the adequacy of their own and peers' sleep quality.

In the event a data collection period lasted longer than one week, these three standardized questionnaires (i.e., ESS, ISI, and PSQI) were included in the activity log at the end of each week. At the conclusion of a data collection period, the Profile of Mood State (POMS) was administered. The POMS is a measure of mood state and assesses mood over a set time period. Scores are calculated using a standard 65-item inventory consisting of six subscales within the survey. Factors identified are tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment (McNair, Heuchert, & Lorr, 2005). POMS scales were administered with the instruction "Describe how you felt during the past week." Activity log and questionnaires used in the CR53 study can be referenced in Appendix H.

E. DATA PROVIDED BY CNSP

The office of the Commander, Naval Surface Force, U.S. Pacific Fleet (CNSP) was responsible for collecting and consolidating data deemed appropriate for evaluation of impacts to Sailor productivity, efficiency and overall ship performance. The intention was to evaluate differences that could be observed as a result of manning differences onboard the two ships. Metrics were gathered from programs of record, Naval Sea Systems Command (NAVSEA), Naval Safety Center, and pre-determined points of contact onboard who would provide maintenance, training or personnel data.

The only data provided by CNSP that was used for analysis for this thesis is the breakdown of Sailors COB from each ship. The breakdown of Sailors by rank, rate and the differing values of COB was used to determine whether differences between ships exist based on manning and Fit percentages. A comprehensive list of these data can be found in Appendix I.

F. ANALYTICAL STRATEGY

The preparation of data for analysis occurred in a three-step process. First, activity log data and questionnaire responses were entered and verified. Second, actigraphic data were downloaded, processed using un-interpolated activity logs, and imputed as required. Third, activity logs were interpolated. Participants who had less than 24 hours of data corresponding to three days in a week were removed from the analysis. Therefore, each week of observation within a data collection periods produced a varying number of participants for analysis based on completion of data available.

1. Activity Log Data Cleaning and Reduction Process

Data from activity logs were entered into an excel sheet, screened and verified for accuracy and completeness and, if necessary, interpolated. Interpolation occurred when data were missing, participants indicated that the actigraphic watch was removed, discrepancies with actigraphy data were identified, or when activity codes deviated significantly from the instructions. Self-reported activities aligned with prescribed activity codes identified in Section D.2 and Table 13 were not altered.

One method of interpolation was to compare activities of days surrounding missing data to identify routines. A second method required comparing the day and time in question with the ship schedule, PODs, watchbills and responses to post-study questionnaires. Criteria for interpolation was (a) completeness of activity log during data collection period (b) pattern of activity in surrounding days (c) length of missing data and (d) corresponding actigraphy data. The identification of patterns of activity, recorded to a 15-minute interval, was of utmost importance for analysis within this thesis; interpolation was used when deemed necessary; however, this practice was kept to a minimum in order to not skew results or introduce bias.

Initial data entry and validation were conducted with the goal of ensuring self-reported data, and survey questions were accurately entered. The next step constituted initial cleaning of data to rectify entries not aligned with requested activity codes and to conduct basic interpolation. Basic interpolation occurred for empty entries and the periods annotated with an "R." In this step of the process, days were removed from consideration for analysis if a lack of 15-minute self-reported intervals was unable to be interpolated. The final step for cleaning involved removal of days that could not be interpolated to produce a complete 24-hour period for analysis. Efforts were made to interpolate days with less than 1.75 hours, or 1 hour and 45 min, of missing data; any day not able to be interpolated according to this criterion was excluded from final analysis.

Original entry of Ship A raw data included 984 observed days across the three data collection periods with 85,168 data points. Each data point corresponded to one 15-minute activity period. Activity log cleaning and reduction for Ship A resulted in the following quantities of data used for analysis in this effort. Final Ship A data included 781 days across three data collection periods with 74,976 data points; of these, 3,923 (5.23% of 74,976 total data points) were interpolated. Partial interpolation was applied to 354 days (45.3% of 781 total days used in analysis); total day interpolation occurred for 3 days (0.38% of 781 total days used in analysis).

Original entry of Ship B raw data included 1842 observed days across the three data collection periods with 176,832 data points. Each data point corresponded to one 15-minute activity period. Activity log cleaning and reduction for Ship B resulted in the following

quantities of data used for analysis in this effort. Final Ship B data included 1359 days across three data collection periods with 130,464 data points; of these, 9,060 (6.94% of 130,464 total data points) were interpolated. Partial interpolation was applied to 488 days (35.9% of 1359 total days used in analysis); total day interpolation occurred for 27 days (2.0% of 1359 total days used in analysis).

2. Analytical Strategy

The NPS Crew Endurance Team intended to compare the hours worked by crews of Ship A to Ship B. However, the increased manning level on Ship B did not occur during Data Collections 1 and 2. It was not until Data Collection 3, when Fit levels were significantly different, that the two ships could be compared.

Results are broken down into ship-wide demographics, Enlisted participant comparisons and Officer comparisons. Results are analyzed separately for Enlisted and Officers because the NAF only applies for Enlisted manpower determination. Participant productive work, non-productive work, total work and sleep are presented as mean ± standard deviation (M ± SD) for both inport and underway periods. Comparisons of Enlisted results between ships, and to the inport NAF categories, are presented as M $\pm$ SD or Median $\pm$ Interquartile Range (MD $\pm$ IQR) as annotated.

First, demographics characteristics for each data collection is presented as M ± SD. Second, analysis of Enlisted activity log data across the Basic Phase of the entire population (i.e., combined Ship A and Ship B participants) using a grand mean across the Basic Phase. Consolidated Sailor work and sleep is compared during similar Basic Phase events during Data Collection 1 and 2 for both inport and underway periods. A comparison between Ship A and Ship B during the Tactical Certification in Data Collection 3 is conducted using a Wilcox Rank Sum test. Third, combined Enlisted activities are compared to inport NAF categories and values (NAVMAC, 2017) using either a t-test of Wilcox Rank Sum test as appropriately needed. Fourth, an analysis of combined Ship A and Ship B Officers work and sleep for inport and underway periods is conducted using a grand mean across the Basic Phase.

Data normality was assessed with the Shapiro-Wilk W test. An alpha level of .05 was used to determine statistical significance. Effect size metrics were calculated for statistically significant differences. Statistical analysis was conducted with the statistical software package JMP Pro 14.0 (SAS Institute; Cary, NC).

No differentiation between duty days and non-duty days was considered within this analysis due to lack of fidelity and inability to determine days of duty by participating Sailors. Analysis is completed for a 5-day workweek of Monday through Friday because at no point during the Basic Phase did either ship work on weekends. Because of this it was assumed that weekends would be 48 hours dedicated to non-available time.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. RESULTS

Manning actions were intended to deliver an additional 27 Sailors to Ship B to increase COB from 273 to 300 for the duration of the Basic Phase. The goal was to have the additional manning onboard the Ship B prior to starting the Basic Phase, which was in mid-October 2018 (CNSP Force Personnel Officer [N13], personal communication, September 4, 2018). The 300 Sailors corresponds to 100% SMD for a Flight I DDG and were supposed to be delivered through the creation of Refillable Excess billets (D. Wilkinson, personal communication, February 03, 2018).

Unfortunately, these initial manning actions were not delivered at the start of the Basic Phase; over time, manning levels on Ship B even fell below the manning level of Ship A. At this point the manning shortfall was noted by CNSP and USFF when, in February 2019, a manning action was initiated to increase the number of Sailors onboard Ship B. Over the course of two months, between February and April 2019, 30 Sailors were assigned to Ship B. A total of 22 Sailors arrived in time to participate in Ship B Data Collection 2; an additional 8 Sailors, for a total of 30 Sailors, were assigned to Ship B in time for Data Collection 3. Of these 30 Sailors, 21 were there on 120-day TAD orders and 2 were on 179-day TAD orders. Of note, only 12 of these TAD Sailors came from CRUDES platforms. Figure 12 depicts manning levels onboard both ships throughout the Basic Phase.

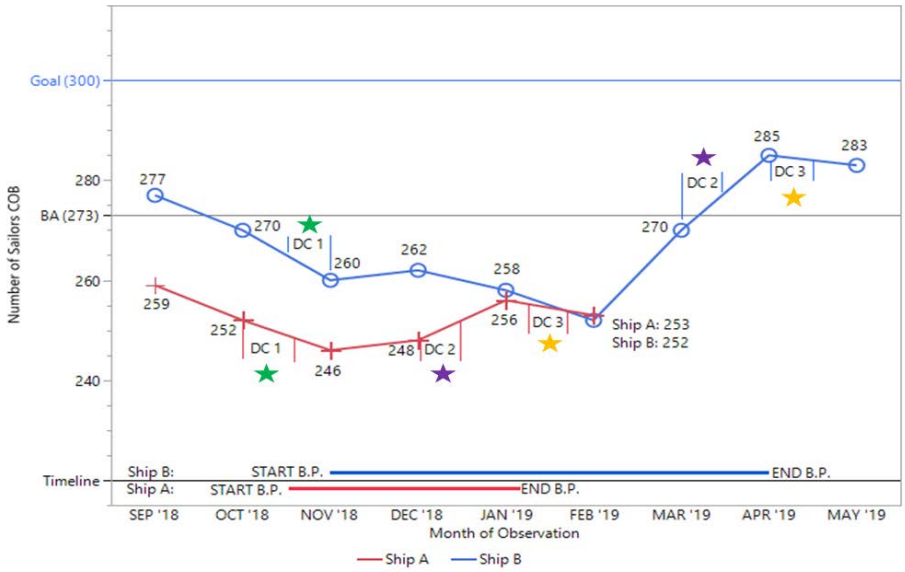


Figure 12. Manning Levels Onboard CR53 Ships During the Basic Phase

The original goal of the CR53 study is to compare two ships with different manning levels and Fit/Fill percentages during the Basic Phase of training. The initial step in analysis was to determine if differences in manning actually did exist, in light of the aforementioned challenges. A Fisher's exact test was conducted between data collection periods 1, 2 and 3 based on Fit percentages aggregated for each department, represented in Table 9.

Based on the Fisher's exact test, it was determined that Ship A and Ship B did not differ in terms of percentage Fit by department during Data Collection 1 (Fisher's exact test, p=0.609) or Data Collection 2 (Fisher's exact test, p=0.695). However, during Data Collection 3, the two ships did differ in terms of percent Fit (Fisher's exact test, p=0.005). Therefore, a comparison between the two ships could not be conducted for the first two data collections. It was not until the final data collection period (R3_W1 versus P3_W2), the Tactical Certification, that the two ships could be compared. As a result of these findings, a secondary goal was implemented for Data Collections 1 and 2 in which both sets of activity log data were combined. The percent Fit/Fill timeline of events throughout the Basic Phase is shown in Figure 13.

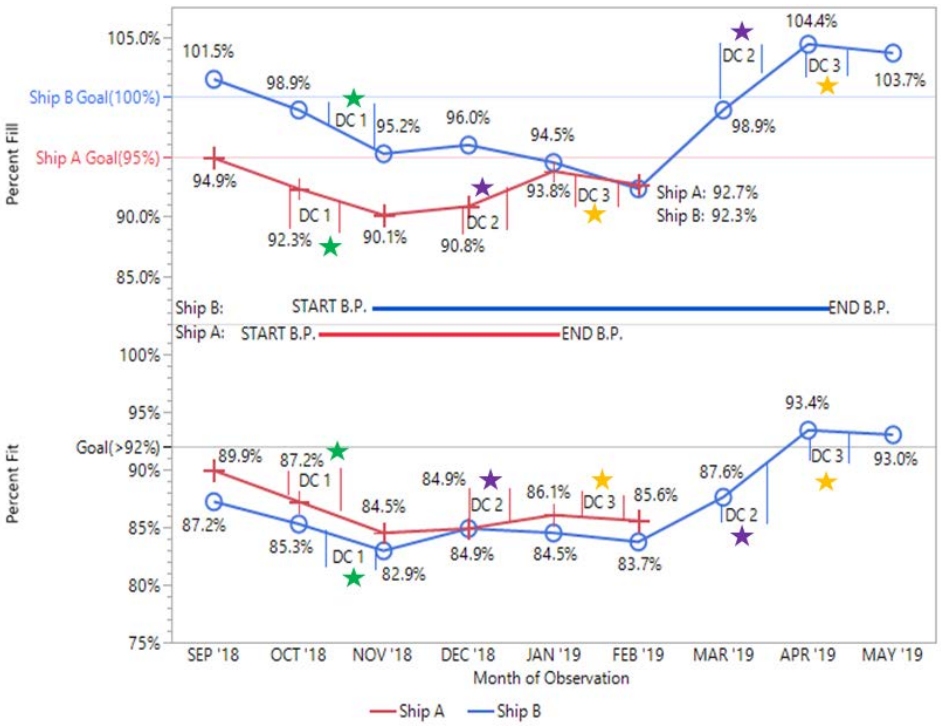


Figure 13. Percent Fit and Fill Onboard CR53 Ships During the Basic Phase

Results are broken down into ship-wide demographics, Enlisted participant comparisons and Officer comparisons. Results are analyzed separately for Enlisted and Officers because the NAF only applies to Enlisted manpower determination.

A. PARTICIPANT SUMMARY & DEMOGRAPHIC DATA

Figure 14 shows the number of Sailors who volunteered to participate in the study by ship and data collection phase. Included in the diagram are the number of Sailors who participated in more than one data collection period. For example, five Sailors from Ship A participated in DC1, DC2 and DC3.

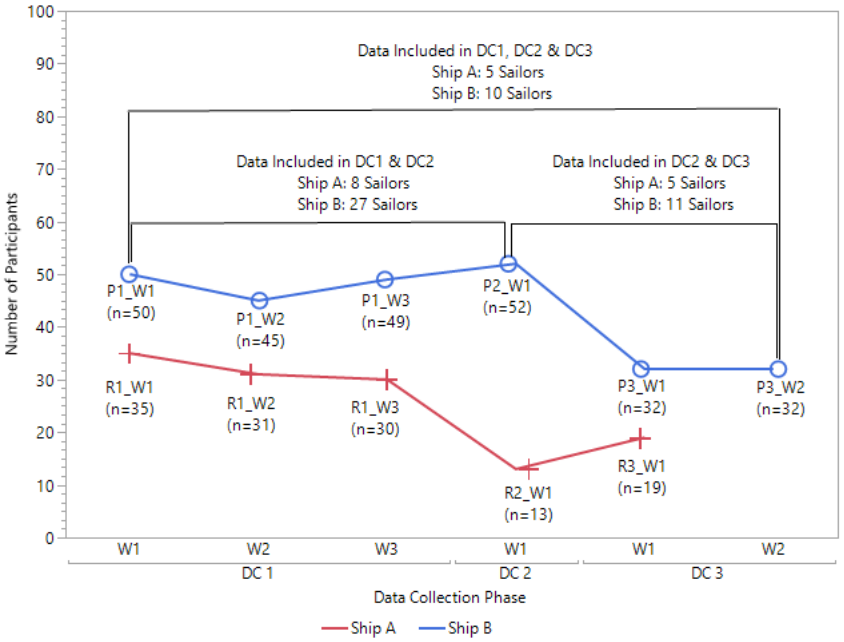


Figure 14. Continuity of Participants Across Data Collection Periods in the Basic Phase

1. Ship A

Participants' demographic information by data collection is shown in Table 14 to Table 16. Detailed description of participant demographic information by Department and Rank Group is included in Appendix J.

Table 14. Ship A Data Collection 1 Demographic Information

Demographics	R1_W1 n= 35	R1_W2 n= 31	R1_W3 n= 30
Age in Years, M ± SD	30.4 ± 6.9	30.8 ± 6.8	30.0 ± 6.5
Gender, # (%)			
Males	25 (71.4%)	21 (67.7%)	20 (66.7%)
Females	10 (28.6%)	10 (32.3%)	10 (33.3%)
Rank, # (%)			
Officers	9 (25.7%)	9 (29.0%)	9 (30.0%)
Enlisted	26 (74.3%)	22 (71.0%)	21 (70.0%)
Years on Active Duty, M ± SD	8.4±6.7	8.5±6.7	8.1±6.7
Total Months Deployed in months, M ± SD	18.1±20.7	18.0±20.0	18.4±20.4

Table 15. Ship A Data Collection 2 Demographic Information

Demographics	R2_W1 n= 13
Age in Years, M ± SD	29.8±8.4
Gender, # (%) Males Females	 10 (76.9%) 3 (23.1%)
Rank, # (%) Officers Enlisted	 3 (23.1%) 10 (76.9%)
Years on Active Duty, M ± SD	8.6±7.1
Total Months Deployed in months, M ± SD	21.8±22.8

Table 16. Ship A Data Collection 3 Demographic Information

Demographics	R3_W1 n= 19
Age in Years, M ± SD	30.6±7.6
Gender, # (%) Males Females	 13 (68.4%) 6 (31.6%)
Rank, # (%) Officers Enlisted	 2 (10.5%) 17 (89.5%)
Years on Active Duty, M ± SD	7.4±6.7
Total Months Deployed in months, M ± SD	15.3±18.0

2. Ship B

Participants' demographic information by data collection is shown in Table 17 to Table 19. Detailed description of participant demographic information by Department and Rank Group is included in Appendix J.

Table 17. Ship B Data Collection 1 Demographic Information

Demographics	P1_W1 n= 50	P1_W2 n= 45	P1_W3 n= 49
Age in Years, M ± SD	27.6±4.8	28.2±5.0	27.8±5.2
Gender, # (%) Males Females	 34 (68.0%) 16 (32.0%)	 30 (66.7%) 15 (33.3%)	 33 (67.3%) 16 32.7%)
Rank, # (%) Officers Enlisted	 19 (38.0%) 31 (62.0%)	 19 (42.2%) 26 (57.8%)	 19 (38.8%) 30 (61.2%)
Years on Active Duty, M ± SD	5.7±5.2	6.3±5.6	5.9±5.5
Total Months Deployed in months, M ± SD	10.2±15.0	10.0±15.0	10.1±15.2

Table 18. Ship B Data Collection 2 Demographic Information

Demographics	P2_W1 n= 52
Age in Years, M ± SD	27.5±6.3
Gender, # (%)	
Males	37 (71.1%)
Females	15 (28.9%)
Rank, # (%)	
Officers	18 (34.6%)
Enlisted	34 (65.4%)
Years on Active Duty, M ± SD	6.6±6.3
Total Months Deployed in months, M ± SD	11.7±16.8

Table 19. Ship B Data Collection 3 Demographic Information

Demographics	P3_W1 n = 32	P3_W2 n= 32
Age in Years, M ± SD	27.1±6.0	26.8±6.0
Gender, # (%)		
Males	23 (71.9%)	25 (78.1%)
Females	9 (28.1%)	7 (21.9%)
Rank, # (%)		
Officers	11 (34.4%)	12 (37.5%)
Enlisted	21 (65.6%)	20 (62.5%)
Years on Active Duty, M ± SD	5.0±4.6	4.9±4.6
Total Months Deployed in months, M ± SD	8.2±12.8	8.0±12.9

B. CR53 ENLISTED RESULTS

1. Work and Non-Available Time During the Basic Phase

Participants included in the ship-wide comparison of work and non-available time are represented in Table 20 and Table 21. Daily work and non-productive work over the course of the Basic Phase is represented in Figure 15.

During inport operations, Sailors reported a daily average total work of 9.5 ± 2.8 hours. Total work inport was comprised of 6.0 ± 3.8 hours productive work and 3.4 ± 3.2 hours non-productive work per day. Daily average non-available time was 14.5 ± 2.8 hours.

During underway operations, Sailors reported a daily average total work of 13.4 ± 2.9 hours. Total work underway was comprised of 9.9 ± 4.3 hours productive work and 3.4 ± 4.0 hours non-productive work per day. Daily average non-available time was 10.6 ± 2.9 hours.

Table 20. Enlisted Participants During the Basic Phase, by Rank Group

	Apprentice	Journeyman	Supervisor
Ship A	13	19	7
Ship B	31	36	5

Table 21. Enlisted Participants During the Basic Phase, by Department

	Department						
	CS	ENG	NAV/EX	OPS	PT	SUP	WEPS
Ship A	9	10	1	6	6	3	4
Ship B	15	17	11	7	9	3	0

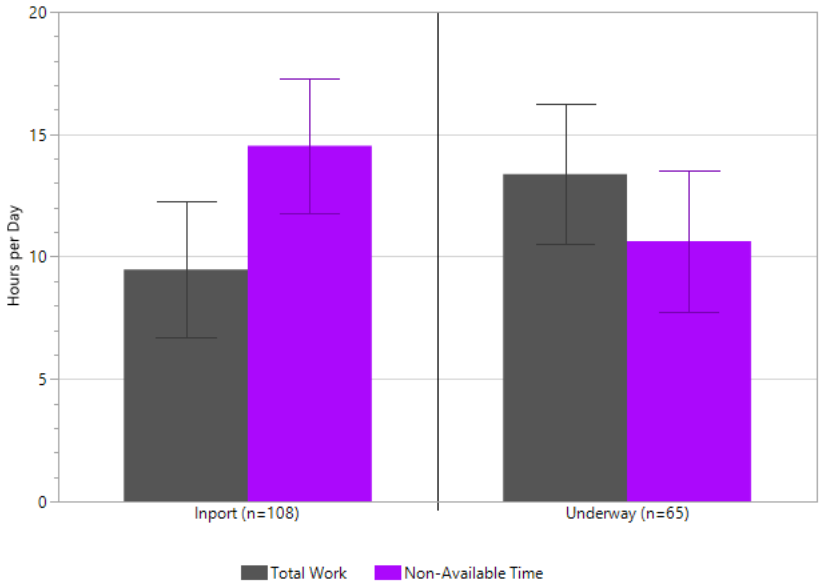


Figure 15. Combined Ship Total Work and Non-Available Time Reported by Sailors during the Basic Phase. Data Presented as M ± SD.

2. Daily Summaries by Data Collection

a. RE-5: R1_W1 and P1_W1

The RE-5 event occurred on Ship A and Ship B during the first data collection period (Ship A: R1_W1; Ship B: P1_W1). Personnel from all Departments participated in the RE-5. Figure 16 shows overall work from all participating Sailors during RE-5 for inport and underway operations. Data is represented as M ± SD.

During days of inport operations, Sailors across both ships reported a daily average total work of 8.8 ± 3.3 hours per day. Total work inport was comprised of 5.6 ± 4.4 hours productive work and 3.2 ± 3.1 hours non-productive work per day.

During days of underway operations, Sailors across both ships reported a daily average total work of 12.5 ± 3.0 hours. Total work underway was comprised of 9.5 ± 4.5 hours productive work and 3.0 hours ± 3.7 hours non-productive work per day.

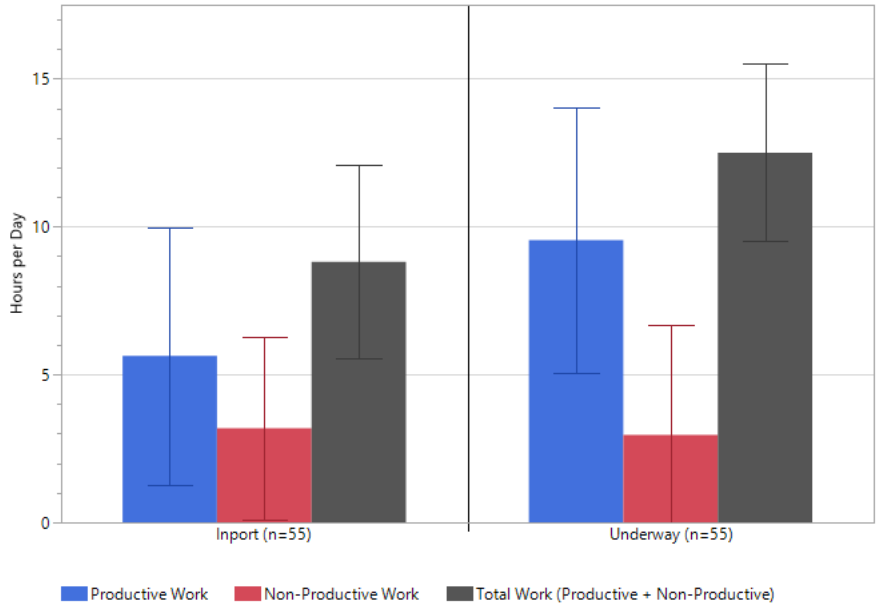


Figure 16. Combined Ship RE-5 Daily Total Work Reported by Sailors. Data Presented as M ± SD.

b. MOB-E 1.3: R1_W2 and P1_W3

The MOB-E 1.3 event occurred on Ship A and Ship B during the first data collection period (Ship A: R1_W2; Ship B: P1_W3). Figure 17 shows overall work of Sailors in Engineering Department during MOB-E 1.3 for inport and underway operations. Data is represented as MD ± IQR.

During days of inport operations, Sailors onboard both ships reported a daily median total work of 10.75 ± 4.4 hours. Total work inport was comprised of 9.0 ± 6.6 hours of productive work and 1.75 ± 8.0 hours of non-productive work per day.

During days of underway operations, Sailors onboard both ships reported a daily median total work of 16.9 ± 5.4 hours. Total work underway was comprised of 11.2 ± 9.6 hours productive work and 2.3 ± 9.3 hours non-productive work per day.

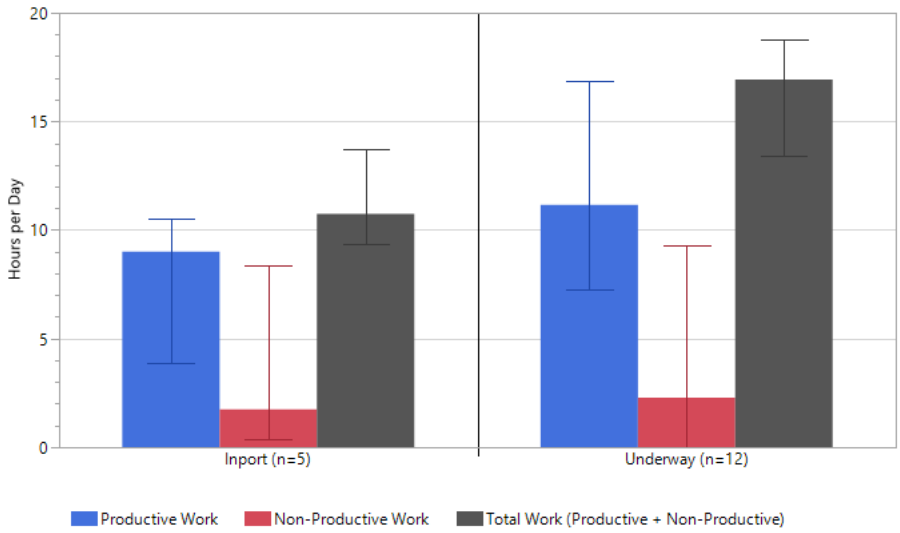


Figure 17. Combined Ship MOB-E 1.3 Daily Total Work Reported by Sailors. Data Presented as MD ± IQR.

c. Tactical Certification: R3_W1 versus P3_W2

The Tactical Certification event occurred on Ship A and Ship B during the third data collection period (Ship A: R3_W1; Ship B: P3_W2). Personnel from OPS, CS, PT, and WEPS Departments participated in the Tactical Certification, 12 participants from Ship A and 8 from Ship B. Figure 18 shows the overall work of these Sailors during Tactical Certification. Data are shown as MD ± IQR. Sailors onboard Ship A reported a daily median total work of 10.0 ± 2.75 hours, approximately 48 minutes (8%) more than Sailors onboard Ship B who reported a daily median total work of 9.2 ± 2.0 hours (Wilcoxon Rank Sum test, $p = 0.217$; effect size $r = 0.28$).

Median productive work reported by Sailors onboard Ship A was 2.9 ± 5.4 hours, approximately 66 minutes (53% difference) less than Sailors onboard Ship B who reported 5.0 ± 7.0 hours (Wilcoxon Rank Sum test, $p = 0.671$; effect size $r = 0.10$).

Median non-productive work reported by Sailors onboard Ship A was 6.5 ± 6.3 hours, approximately 156 minutes (50% difference) more than Sailors onboard Ship B who reported 3.9 ± 5.7 hours (Wilcoxon Rank Sum test, p = 0.512; effect size r = 0.147).

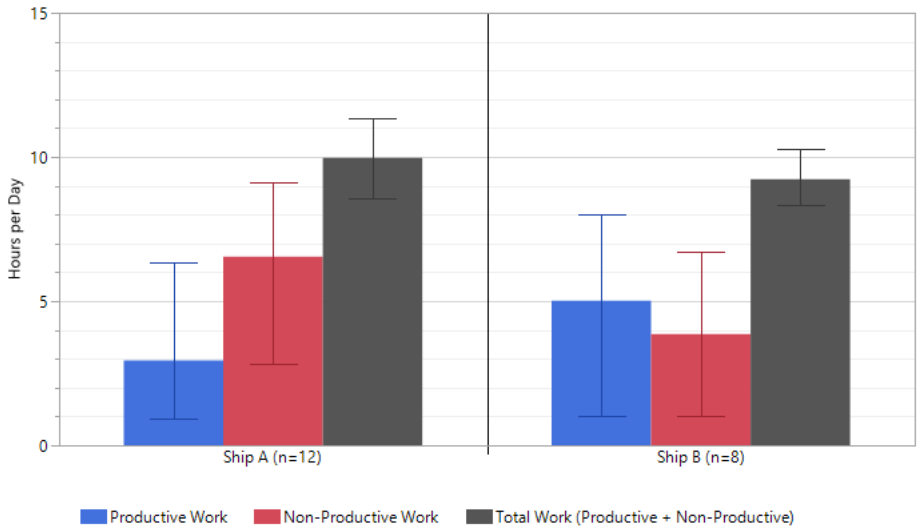


Figure 18. Comparison of Tactical Certification Daily Total Work by Sailors. Data Presented as MD ± IQR.

C. CR53 ENLISTED RESULTS COMPARED TO INPORT WORKLOAD ASSESSMENT

1. Inport NAF

Table 22 provides a description of variables included in the CR53 activity logs and values compared to the corresponding inport NAF categories and criteria. Sailors worked 50.8 ± 13.5 hours (inport NAF presented as MD ± IQR), that is ~3.2 hours less than the NAF criterion of 54 hours (Wilcoxon Signed-Rank test, p = 0.013). More than 50% of median values observed are below the expected NAF value.

Table 22. Activity Log Variable Conversion to Inport NAF Categories

I/P NAF	Weekly (hours)	Comparison to I/P NAF (hours)	p-value
Inport NAF, MD ± IQR	50.8 ± 13.5	54	0.013 [A]
Productive Work, M ± SD	30.2 ± 19.1	40	< 0.001 [B]
Watch, MD ± IQR	6.6 ± 13.9	14	< 0.001 [A]
Maintenance, MD ± IQR	18.3 ± 27.3	26	0.003 [A]
Non-Productive Work, MD ± IQR	11.6 ± 27.2	6.6	<0.001 [A]
Service Diversion, MD ± IQR	5.4 ± 12.2	2.4	< 0.001 [A]
Training, MD ± IQR	2.0 ± 9.3	4.2	0.815 [A]
Leave/Special Liberty, MD ± IQR	0 ± 4.03	7.4	< 0.001 [A]

[A] Wilcoxon Signed-Rank test; [B] t-test

a. Productive Work (PAF)

CR53 activities associated with productive work are watch and maintenance; OUS activities are accounted for within descriptions of these two activities, therefore no variable is included in the activity log to encompass it. Sailors performed 30.3 ± 19.1 hours of productive work while inport (results presented as M ± SD), that is ~9.7 hours less than the NAF criterion of 40 hours (t-test, $p < 0.001$).

(1) Operational Manning/Watch

Operational manning is accounted for through the activity described as watch. A Wilcoxon Signed-Rank test was conducted to compare watch to the inport operational manning/watch. Sailors performed 6.6 ± 13.9 hours of watch (data presented as MD ± IQR), that is ~7.4 hours less than the NAF criterion of 14 hours (Wilcoxon Signed-Rank test, $p < 0.001$). More than 50% of median values observed are below the expected NAF value.

(2) Divisional Work/Maintenance

Divisional work is accounted for through the activity described as maintenance/work. A Wilcoxon Signed-Rank test was conducted to compare maintenance to the inport divisional work criterion. Sailors performed 18.3 ± 27.3 hours of divisional work/maintenance (data presented as MD ± IQR), that is ~7.7 hours less than the NAF criterion of 26 hours (Wilcoxon Signed-Rank test, $p = 0.003$). More than 50% of median values observed are below the expected NAF value.

b. Non-Productive Work

CR53 activities included in the non-productive work group are admin, meetings, professional development, GMT and training. The non-productive work activities correspond to NAF variables of service diversion and training. Sailors performed 11.6 ± 27.2 hours of non-productive work while inport (data presented as MD ± IQR), that is approximately 5.0 hours more than the NAF criterion of 6.6 hours (Wilcoxon Signed-Rank test, $p < 0.001$).

(1) Service Diversion

Service diversion is accounted for within CR 53 activities described as administrative duties, meetings and professional development. Sailors participated in 5.4 ± 12.2 hours of service diversion activities while inport (data presented as MD ± IQR), that is 3 hours more than the NAF criterion of 2.4 hours (Wilcoxon Signed-Rank test, $p < 0.001$). More than 50% of median values observed are below the expected NAF value.

Average daily reported admin time was 1.1 ± 2.1 hours equating to 5.6 ± 10.5 hours for a 5-day workweek. The median daily time spent on administrative duties was 0.05 ± 1.11 hours, that is 0.3 ± 5.55 hours on a weekly basis.

Average daily reported time spent in meetings was 0.5 ± 0.7 hours equating to 2.5 ± 3.3 hours in a 5-day workweek. The median daily time spent in meetings was 0.375 ± 0.74 hours, that is 1.9 ± 3.73 hours on a weekly basis.

Average daily reported professional development was 0.3 ± 1.2 hours. This accounts for 1.7 ± 6.2 hours in a 5-day workweek. Median daily professional development was 0 ± 0.17 hours, that is 0 ± 0.83 hours on a weekly basis.

(2) Training

Training is included in the activities described as (GMT) and shipboard level training. Sailors participated in 2.0 ± 9.33 hours of training while inport (data presented as MD ± IQR), that is ~2.2 hours less than the NAF criterion of 4.2 hours (Wilcoxon Signed-Rank test, $p = 0.815$).

Average daily reported training was 1.4 ± 2.3 hours. This accounts for 6.9 ± 11.4 hours in a 5-day workweek. Median daily reported training was 0.34 ± 1.6 hours; weekly training was 1.75 ± 7.9 hours.

Average daily reported GMT was 0.05 ± 0.2 hours. This accounts for 0.2 ± 0.8 hours in a 5-day workweek. Median daily and weekly reported GMT was 0 ± 0 hours.

c. Leave/Holiday

Leave/Holiday time is accounted for within CR53 activities described as leave/liberty. Sailors reported 0 ± 4.03 hours of leave/holiday while inport (data presented as MD ± IQR), that is ~7.4 hours less than the NAF criterion of 7.4 hours (Wilcoxon Signed-Rank test, $p < 0.001$).

2. Non-Available Time

CR53 activities associated with non-available time are sleep, personal time, commuting, and eating. Inport workweek values associated with these are recommended, not directed. Table 23 provide a description of CR53 activity log variables to the corresponding non-available time categories and values. Sailors spent 69.3 ± 13.6 hours in non-available time while inport (data presented as MD ± IQR), that is 3.3 hours more than the NAF criterion of 66 hours (Wilcoxon Signed-Rank test, $p = 0.012$). More than 50% of median values observed are above the expected value.

Table 23. Activity Log Variable Conversion to Inport Non-Available Time Categories

	Non-Available Time (66 hours)		
NAVMAC I/P NAF (planned time)	Sleep (40 hours)	Personal (16 hours)	Eating (10 hours)
Activity Log Variables (observed time)	Observed Non-Available Time (69.3 ± 13.6 hours; Wilcoxon Signed-Rank, p = 0.012)		

Average daily reported personal time was 4.5 ± 1.8 hours; weekly personal was 22.7 ± 9.3 hours. Median daily personal time was 4.5 ± 2.2 hours, that is 22.5 ± 10.9 hours on a weekly basis.

Average daily commuting time was 0.9 ± 0.8 hours; weekly commuting was 4.6 ± 3.8 hours. Median daily commuting time was 0.8 ± 1.0 hours, that is 3.9 ± 0.8 hours of commuting on a weekly basis.

D. CR53 OFFICER RESULTS

During inport periods, Officers reported a daily average total work of 10.8 ± 1.9 hours. Total work inport was comprised of 2.9 ± 1.7 hours productive work and 7.9 ± 1.7 hours non-productive work per day. Average non-available time inport was 13.2 ± 1.9 hours. In contrast, Officers reported a daily average total work of 13.7 ± 2.2 hours during underway periods. Total work underway was comprised of 8.0 ± 2.3 hours productive work and 5.6 ± 2.2 hours non-productive work per day. Average non-available time underway was 10.3 ± 2.2 hours.

The largest differences between inport and underway periods appear within two categories: productive work which shows a 179% increase during underway days, and watchstanding which has a 222% increase in time reported per day. The amount of time reported for meetings decreases 18 minutes from inport to underway operations; however, administrative duties decrease 24% in time spent conducting that area of non-productive work. Personal time decreases by almost 2 hours per day; however, self-reported sleep remains approximately the same.

Daily work and non-productive work over the course of the Basic is shown in Figure 19. Officer work by inport and underway observations are shown in Figure 20. Table 24 shows the daily duration of Officer CR53 activities during inport and underway periods. Officer participation per data collection period is located in Appendix J.

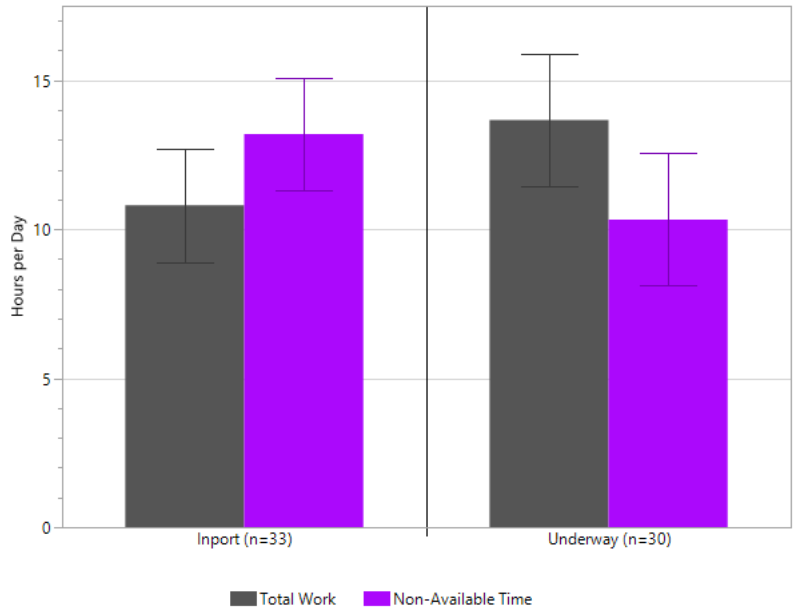


Figure 19. Combined Ship Total Work and Non-Available Time Reported during the Basic Phase by Officers. Data Presented as M ± SD.

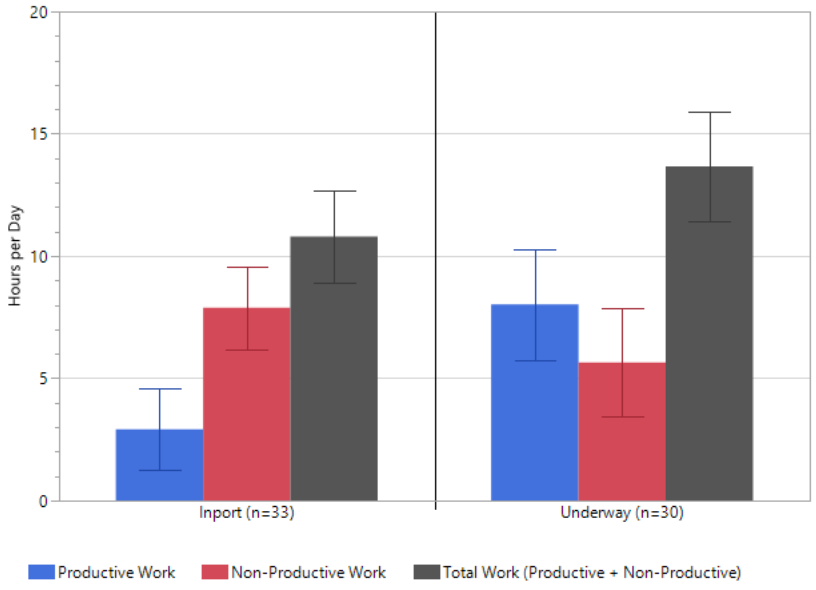


Figure 20. Combined Ship Daily Work Reported during the Basic Phase by Officers. Data represented as M ± SD.

Table 24. Summary Statistics for all Officers during Inport Operations. Data represented as M ± SD

Activity	Inport (M ± SD hours/day)	Underway (M ± SD hours/day)	Δ%
Total Work	10.8 ± 1.9	13.7 ± 2.2	27%
Productive Work	2.9 ± 1.7	8.0 ± 2.3	176%
Maintenance/Work	0.7 ± 0.7	0.7 ± 0.9	0%
Watch	2.3 ± 1.6	7.4 ± 2.2	222%
Non-Productive Work	7.9 ± 1.7	5.6 ± 2.2	-29%
Admin	4.6 ± 1.9	3.5 ± 2.2	-24%
Meetings	1.5 ± 1.1	1.2 ± 1.0	-20%
GMT	0.1 ± 0.1	0.0 ± 0.1	-100%
Training	1.1 ± 1.1	0.7 ± 0.8	-36%
Professional Development	0.6 ± 0.9	0.2 ± 0.4	-67%
Non-Available Time	13.2 ± 1.9	10.3 ± 2.2	-22%
Personal	3.9 ± 1.5	1.8 ± 1.0	-54%
Sleep	6.6 ± 0.7	7.0 ± 1.4	6%
Messing	1.0 ± 0.4	1.2 ± 0.4	20%
Leave/Special Liberty	0.6 ± 1.1	0.1 ± 0.3	-83%
Commuting	1.1 ± 0.5	0.3 ± 0.4	-73%

Δ% = [(Underway duration - Inport duration) / Inport duration]

V. DISCUSSION

The initial goal of this study was to determine whether additional manning affected the workload, mood, sleep and fatigue of Enlisted Sailors during the Basic Phase. For reasons stated previously, the manning levels of the two ships failed to reach the levels required to make a valid comparison for much of the Basic Phase. It was possible to combine the data from both ships for the first two data collections in the Basic Phase and, thereby, use this information to describe the Sailor workload and specific activities both inport and underway. The combined inport dataset was compared to the provisions of the inport Naval Availability Factor (NAF) to assess whether our observations supported the proposed values. For the third data collection period, the two ships had Fit/Fill levels that allowed the comparison of Enlisted Sailor's workload between ships. Therefore, only the final data collection period, which included Tactical Certification for both ships, was used to compare enlisted activity results between the two ships. Finally, the workload of Officers over the course of the Basic Phase is described in detail.

A. SAILOR INPORT WORKLOAD DURING THE BASIC PHASE

In general, combined results from Sailors across the Basic Phase support the proposed inport NAF. CR53 activities associated with the NAF, which are maintenance, watch, service diversion, training and leave/holiday, correspond to 50.8 hours. This is ~3.2 hours less than the anticipated 54-hour value and is statistically significant ($p = 0.013$).

The total work reported, which is all NAF categories minus leave/special liberty, was reported by Sailors to be higher than the 46.6 hours expected. A comparison of total work reported (48.0 hours) is not statistically different but does represent a higher reported amount of work being completed than expected.

Discrepancies between NAF recommended productive work (maintenance and watch) and non-productive work (service diversion and training) and CR53 observations warrant further investigation. This could lend itself to the fact that values for service diversion and training are derived from policy and doctrine vice the time demands associated with what is incorporated within requirements (S. Milinkovich, personal

communication, April 8, 2018). Time associated with what is interpreted as service diversion and training may not accurately reflect demands of the Fleet. Time required for shipboard training and certification must be accounted for outside the watch and maintenance values which are also set by policy. Further investigation and refinement of the requirements within the Basic Phase to align with categories associated with the NAF could permit a better accounting method for time demands placed on ships.

To accomplish this a concise list of explicit time allocations for training, maintenance or meeting requirements, the number of required personnel could be compared to manpower models from the NAF. To date, a list like this does not exist. Subsequent conversations with members from CNSP staff code N7 (personal communication, August 25, 2019) stated that NAF values are not considered when creating, updating or implementing ICAV requirements. Furthermore, it is not possible to estimate how much time it would take a ship to complete an event or overall certification because there is not a set standard for calculating the time or resources required to complete training, certification, or assessment onboard a ship.

The combination of these conversations, along with supporting documentation gathered through research for this thesis, may lend credence to the idea that manning employment (from CNSF) using the validated manpower planning practices (from NAVMAC) are not aligned. Rather than conducting data queries from a shipboard level, a consolidated and concise list of requirements outlining the explicit burden ships incur throughout the Basic Phase could further assist NAVMAC in ensuring manpower models are validated to support requirements used for manning employment by the Fleet during inport operations. A delineation such as this could enable proper “binning” of time for maintenance, own-unit support, service diversion, and training, as applicable. The inability to accurately quantify demands represented as requirements for force generation in the ICAV list could continue to mask the “burden” felt by a ship during training phase operations.

Efforts to create and implement a new inport workload standard provides an opportunity to collaborate across organizations and echelons to provide a standard that

accurately reflects planned Sailor workload during the Basic Phase for both inport and underway operations.

B. SAILOR LEAVE AND SPECIAL LIBERTY DURING THE BASIC PHASE

One reason the proposed NAF values and reported NAF values differ could be related to the differences between holiday/leave time planned for in the NAF and observed during the CR53 study. Results from the CR53 study show that Sailors are reporting leave/liberty at lower levels lower than proposed NAF criterion. Even though each ship reported one 72-hour special liberty during periods of observation, less than 10 Sailors who participated reported taking approved leave during the Basic Phase.

Although Condition V steaming for inport operations is where the "maximum opportunity for rest, leave and liberty" will be provided to the crew, that the "situation on hand" does not permit leave to be taken during inport operations of the Basic Phase.

C. SAILOR UNDERWAY WORKLOAD DURING THE BASIC PHASE

Underway workdays reported by Sailors showed an average total work of 13.4 hours comprised of 9.9 hours productive work and 3.4 hours non-productive work. Of the 54 Sailors included for underway workday analysis, 78.5% (51/65) reported greater than 11.6 hours of total work in a day, 55.4% (36/54) reported greater than 9.6 hours productive work in a day, and 47.7% (31/65) reported greater than 2 hours non-productive work in a day.

Comparing the underway results of CR53 underway data to 3/9 and 5/10 watch rotation values reported in a 2015 study (Shattuck, Matsangas, & Brown, 2015) correspond to total work values for CR53 being higher than reported times under both 3/9 and 5/10 rotations. CR53 productive work is higher than the 9.6 hours reported under 3/9 rotation but lower than the 10.6 hours of 5/10 rotations; and non-productive work in the CR53 study is double that of the 3/9 and 5/10 rotations. Additionally, compared to the underway NAF reported daily total work values were higher than underway available time by 102 minutes (1.7 hours), combined productive work is lower than expected at-sea PAF values by a

negligible 6 minutes (0.1 hours) but reported non-productive work exceeds the planned amount by 84 minutes (1.4 hours per day).

It appears that Sailors doing work during underway Basic Phase events can expect to see increases in work compared to the at-sea NAF. Although both ships reported complying with a circadian rhythm watch rotation, it appears the demands required of these two ships while conducting shorter underway operations created a situation where most Sailors worked more hours than planned and could not work 3/9 or other circadian-based watchbills.

D. SAILOR COMPARISON BETWEEN SHIPS

A comparison between the two ships during Tactical Certification was conducted between Sailors from Departments primarily involved in combat watchstanding certification events. The four departments were Operations, Planning and Tactics, Weapons, and Combat Systems. During this period, the Sailors in these four departments (n=8) on Ship B reported working 48 minutes less than Sailors in these same departments (n=12) on Ship A. Because the sample sizes for the two ships was extremely small, this difference was not statistically significant.

Additional impacts from increased manning Fit and Fill rates for Ship B could result in increased maintenance completion rates, enhanced material condition of equipment, and/or improved training and certification scores. Anecdotally, during periods of increased manning and improved Fit onboard Ship B, certification events scores improved in comparison to Ship A. Additionally, during Tier 2 events, Ship B performed higher than any other ship within the CSG as Ship B transitioned into the Advanced Phase of training (C. Good, personal communication, September 04, 2019).

Historical case studies have investigated these relationships on USN ships and their results are statistically significant. One such study by Quester and Marcus (1989) found that adding new enlisted crewmembers to ship's company (i.e., Sailors onboard less than three months prior to deployment), detrimentally impacted a ship's ability to deploy in C1 training. This study found that when the number of new crewmembers was greater than 11%, a ship had a high chance of not deploying C1 in training (Quester & Marcus, 1989).

Another study conducted by Holzbach and Williams (1976) investigated the relationship between operational effectiveness and manning levels of selected enlisted ratings. This study found manning variations impacted certification scores for functional areas. Differences in manning among enlisted rates and also paygrade manning for different departments impacted certification scores ship-wide (Holzbach & Williams, 1976). Similar to the CR53 study, the length of the Holzbach and Williams study did not allow them to observe long-term impacts of crew size on operations. Combining results of these two studies with the Sailor workload results from the CR53 study provides an argument to increase manning of ships earlier in the Basic Phase to support operational readiness and improved certification scores throughout the training phases.

Although the CR53 study did not include the number of Sailors who were actually onboard the ship (PAQ), the reduced workhours on Ship B observed in the last data collection period may be reflective of the observations from the Boschert (2018) thesis. Increased manning levels at the COB, resulting in increased PAQ numbers, permits a more well-rounded balance of work accomplishment throughout the week. Further analysis of the information collected by CNSP, alongside previous studies of operational readiness, manning, and crew turnover could lend additional support to the idea for incorporating and reduce Sailor workload.

Appropriate manpower planning and adequate funding must be allocated to muster an end-strength for USN ships so that it can meet its requirements. Taking strides to increase overall numbers of Sailors PAQ through funding additional billets and better quantifying Sailor workload during increased periods of work will positively impact a ship's ability to support the OPNAV-approved capabilities for which it is designed.

E. OFFICER COMPARISON

The NAF only applies to Enlisted manpower determination models; Officers are not represented in the NAF. To date, no studies have assessed Officer workload either inport or underway during the Basic Phase. Data obtained through this study represent a unique opportunity to look at these numbers.

Officers performed on average 10.8 hours of total work during inport workdays across the entire Basic Phase with approximately 73% of the Officers working more than 10 hours per day. Inport work included 2.9 hours of productive work and 7.9 hours of non-productive work. In contrast, Officers performed on average 13.7 hours of total work during underway workdays, with approximately 50% of the Officers working more than 14 hours per day. The difference between productive and non-productive inport work is expected because traditionally Officers do not conduct preventative or corrective maintenance. The role of USN Officers are traditionally more managerial and oversight in nature.

Daily average personal time for Officers was 4.9 hours, with commuting taking up an average of 1.1 hours (66 minutes) of personal time per day. We attribute these long commute times to the location of the ships, San Diego, CA, where affordable family housing may require lengthy commutes.

Differences between productive work completed inport and underway are expected and could be attributed to the fact that most Officers stand more watch in controlling stations such as CIC and the Bridge, which are not necessarily required during inport periods. Another aspect that bears consideration is that the wide range of watches associated with underway evolutions, such as sea and anchor detail for entering/exiting port, small boat operations, UNREPS, and DC drills require additional watchstanders to safely complete the evolution.

The fact the ship was exiting an extended maintenance phase also provides opportunities for non-qualified Officers to gain experience and complete requirements for progression through the SWO qualification process. Due to this situation, under-instruction (U/I) watches are stood by unqualified Officers to increase the number of available watchstanders for future watch rotations. Increases in U/I watchstanding activities within the activity log were reported as training, watch and professional development; however, per the NAVMAC time allocation, U/I watch standers are accounted for as service diversion categories under OJT.

The combined Officer data collected during this study represents a complete Wardroom onboard a DDG and could be considered the baseline from which future studies can be compared.

F. STUDY LIMITATIONS

This study has several limitations. The required Fit/Fill manning levels were not achieved for all data collection periods. Consequently, comparisons between ships could only be made at the third Data Collection period.

All work hours and activities were self-reported and are therefore subject to bias. Attrition rates were higher than anticipated for several reasons. The overall length of the Basic Phase and the longitudinal nature of the study made it challenging to retain participants. Attrition of participants occurred both during and across data collection periods; even Sailors who volunteered did not consistently fill in activity logs as instructed, resulting in further exclusion of Sailors from analysis.

Data were collected from only two ships. It is not known whether these two ships are representative of the entire fleet. In addition, both ships knew that they were being studied and this knowledge could have resulted in behavioral changes, commonly known as the Hawthorne effect.

Another potential confounding factor is that the participants in the study may not be representative of the crew. In other words, self-censoring, or the refusal to participate because they deemed themselves to be “too busy,” could have occurred. Other potential confounding factors such as command climate and morale were not taken into consideration for this study but could have played a role in the performance of the crew.

G. EPILOGUE

As of September 2019, all Sailors who were assigned with TAD orders to Ship B have returned to their original commands. Ship B will now have to regain and retrain Sailors to replace those who were onboard only for the CR53 study. As the ship progresses towards deployment, efforts will have to be redoubled to deploy with acceptable watch teams, albeit different from those teams the ship originally certified.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. RECOMMENDATIONS

The first recommendation from this study is to provide increased manning onboard ships prior to commencing Basic Phase events, regardless of whether a ship has exited the Maintenance Phase. Increases in appropriate numbers of Sailors (i.e., better Fit rates), reduced turnover of crew and increased length of time a Sailor is present onboard have previously been shown to increase operational readiness and training score results. Based on the current results, when Ship B had increased manning and improved Fit, Productive Work increased and overall total work decreased.

Second, recommend breaking the Inspections, Certifications, Assessments and Visits (ICAV) list into appropriate and concise categories using time categories within the NAF. This approach will lead to more accurate accounting of the requirements that drive the workload of Sailors.

Third, investigate requirements within the Basic Phase to improve accounting for time demands placed on ships. Delineation of requirements in this manner could enable proper "binning" of time for maintenance, own-unit support, service diversion or training, as applicable. Efforts to create and implement a new inport workload standard provides the opportunity to collaborate across organizations and echelons to provide a standard that accurately reflects planned Sailor workload during the Basic Phase. Rather than conducting data queries from a shipboard level, a consolidated and concise list of requirements outlining the explicit burden ships incur throughout the Basic Phase could further assist NAVMAC in ensuring manpower models are valid.

Finally, defining ICAV list events in terms of the NAF can facilitate comparison between CNSF required "burdens" to NAVMAC allocation of time. Presently, an overall time and resource burden list does not exist, making it difficult to accurately estimate the time and resources required for a ship to complete an event.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A. CR53 STUDY DIRECTIVE FROM CNSP

UNCLASSIFIED
INFORMATION PAPER
COMMANDER, NAVAL SURFACE FORCE PACIFIC
COMPREHENSIVE REVIEW ITEM #53

PURPOSE: To provide a summary of COMNAVSURPAC's current plan to implement Comprehensive Review (CR) Recommendation #53.

BACKGROUND: CR Item #53 (pg. 105 para 8.3.2 (3)) states: "Based on the results to date from the study of DDG manning requirements, conduct a pilot to supplement manning on one unit in basic phase and validate expected improvements in individual workloads. A unit in a similar basic-phase schedule should be used for comparison." CR completion date is 31 Mar 18.

DISCUSSION: Based on the current DSMD in staffing and NAVMAC's inport workload study, depending on configuration CNSP sees 27 additional enlisted requirements on a Flight 1 DDG-51 ship (ships with SSEE INC install will increase by another 13). Since [redacted] and [redacted] do not have the SSEE INC equipment upgrade in NAVSEA planning over the next two years, they would realize the 27 requirement increase. Once OPNAV N12 approves the SMD, NAVMAC will upload these new requirements into within TFMMS so they will show in the Ship's Manpower Document and thereby populate the Billet Based Distribution database. Thus the ship would increase its overall requirements from 301 (28 Officers + 273 Enlisted) to 327 (27 Officers + 300 Enlisted). Most of the requirements are at the apprentice level (total overall increase of 20) and there are 7 journeyman increases. On the officer side there is an addition of one LTJG Information Professional and two losses of ENS Surface Warfare Officers.

My team with the assistance of the Manning Control Authority Fleet (MCAF) and PERS-4 would work an augmentation plan to get [redacted] these extra personnel in the March-May 2018 timeframe. As the majority of increases are apprentice Sailors, I believe we could push some extra "A" school grads to them. The remaining enlisted would require TYCOM Manning actions with MCAF support.

Current Manning: Current test ship [redacted] manning is: 86.4% Fit/92.7% Fill and at the beginning of the Basic Phase (early May 2018) is projected to be at 88%/102%. [redacted] (control ship) is currently manned at 91.5%/96.3% and is projected to start the Basic Phase (mid-April 2018) at 92.6%/99.3% Fit/Fill.

Manning Goal: Would be to get the control ship to 92%/95% Fit/Fill per MCAF Directive 15-1 based on the billets authorized. The test ship would be augmented with refillable excess apprentice Sailors and TEMADDs from the TYCOM for the extent of the Basic Phase, which is typically 25 weeks for a BMD-ship to achieve >92% Fit/100% Fill of the DSMD requirements.

Other Manning Actions: CNSP N1 is reviewing BBD to take complete a ship in the spotlight looking at required TYCOM Manning Actions to get the ship the required CNECs.

Validation Methods/Metrics:
- PQS Training Time: Time it takes personnel to qualify required watches (e.g. Basic/Advanced DC, ATFP Watches, 3M 301, QA Craftsman and watchstation quals tied to specific ratings). Source would be R-ADM.

CAPT Don Wilkinson/CNSP/N1/ (619) 437-3867/donald.wilkinson@navy.mil/3 Feb 17
UNCLASSIFIED

- Unit-Level / Mission-Area Training Performance: Success throughout Basic Phase training and certification events (as measured by Training Figure of Merit - TFOM) across all applicable mission areas. Also pay attention to portions of the training cycle that could be bypassed/waived due to outstanding shipboard/watchteam performance. The assumption here is that a ship with 100% manning will have more time to devote to ATG events and to fully implement the PBED process during the training cycle, yielding better results as each Sailor will have less overall workload. Source: ATG End-of-Mission Reports, TORIS-TFOM data.

- CASREP Data: Compare how many CASREPs are entered on the test ship compared with the control ship, particularly those requesting Tech Assist (both via Distance Support and via Onboard Tech Assist). Assumptions are the control ship, with more manning, should have fewer CASREPs, and fewer CASREPs requesting Tech Assist. Sources: CASREP messages; MFOM CASREP database.

- Ship's Force Worklist (SFWL)/CSMP: Compare how many TA4 (ship's force capable) jobs are listed on the CSMP between test and control ships, and how long they remain open in OMMS before resolution. The average time that the T4 jobs have been open will need to be known prior to the start of the pilot. Assumption is that the test ship should see a spike in TA4 work once manning comes up and then should see a decrease in TA4 work as the worklist gets knocked down. Additionally, duration of ships-force jobs being open in OMMS should decrease due to increased manning - less of an opportunity to be "too busy" to knock out ships-force work. Source: CSMP/OMMS-NG database.

- PMS Completion: Additional manning on the test ship should lead to higher PMS completion rates of pre-existing scheduled maintenance thereby leading to fewer deferred maintenance checks. The full range of PMS metrics could be compared, too - it would be interesting to see if the test ship had more satisfactory PMS spot-checks (or more Khaki completing them), more completed equipment validations, etc. since they would have more manning to support. Source: PMS Reports/SKED.

- Muster Reports: Measure the daily personnel onboard and those absent and the reasons for each absence. Critical to this data are those Sailors "left behind" when the ship gets underway.

- Changes in duty/watch sections – increases in qualified personnel could lead to covering more inport duty and/or underway watch sections thereby increasing inport Quality of Life and providing more hours at sea to conduct maintenance or training. The increased watch sections may also make a full Circadian Rhythm sleep pattern more attainable. It would be also good to know about flexibility in special evolution watchbills and FSA and ER09 staffing.

-Service Member Evaluation Tool – in order to look at positive and negative Sailor behaviors and own unit questionnaires to capture command triad reactions.

-CNSP N1 is working a Data Collection Plan with Naval Postgraduate School and plan to finalize by the end of February.

CAPT Don Wilkinson/CNSP/N1/ (619) 437-3867/donald.wilkinson@navy.mil/3 Feb 17

APPENDIX B. MARK IV AT-SEA SHIPBOARD WORKLOAD MODEL. SOURCE: (FLETCHER, 2018, APPENDIX H)

Depiction of workload demands of ships in Condition III steaming and requirements accounted for within the FMRD model. Color coding of green corresponds to what is included within the FMRD model, yellow is partially included and red is not included.

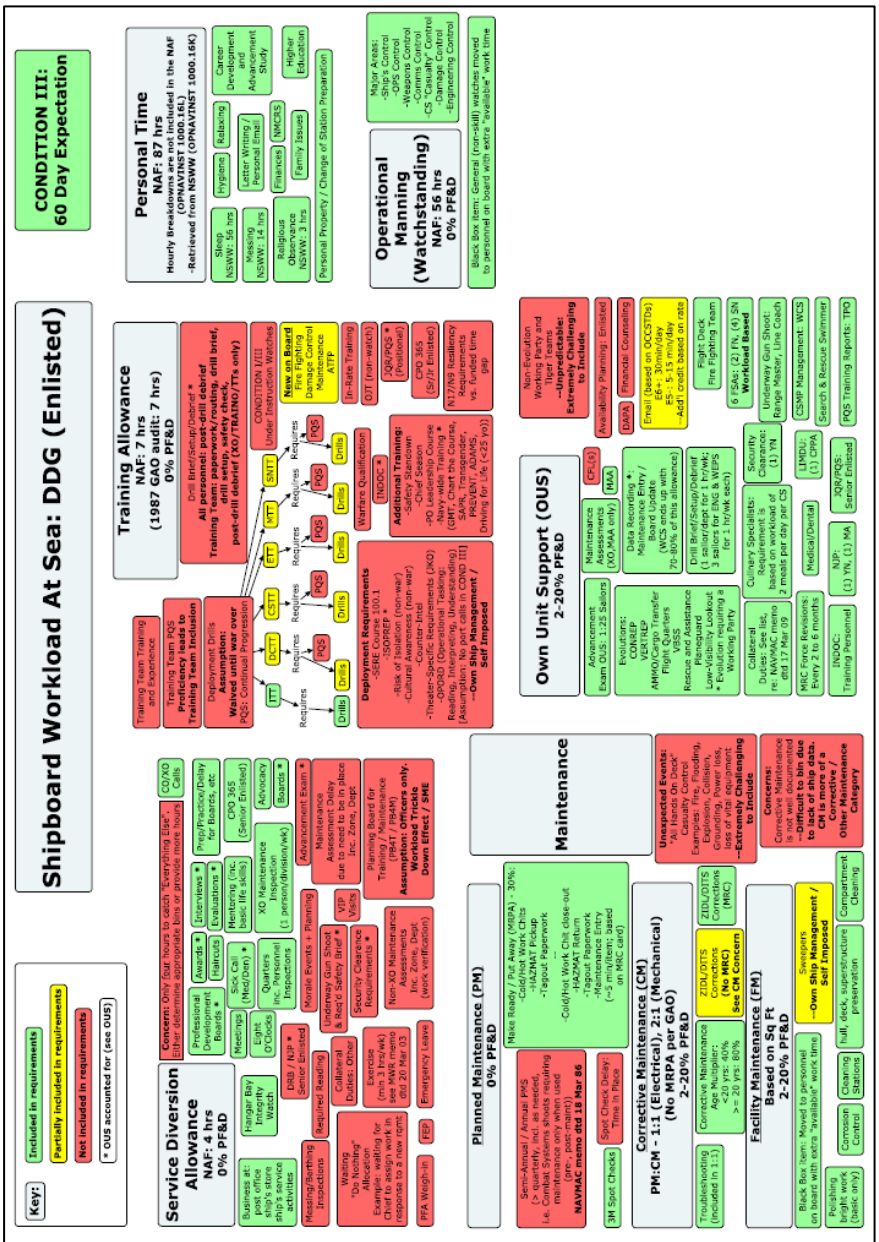


Figure H.1. Mark IV, At-Sea Shipboard Workload Model, February 2018.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C. DETAILED SCHEDULE FOR SHIP A

The following table contains a detailed schedule of activities that observed during data collection periods onboard Ship A. Data collection periods are comprised of dates and day of week observed along with ship operating environment of inport or underway. Ship scheduled events and notes were compiled from ship PODs. Shipboard evolutions and abnormal daily routines were annotated in the final column.

Table 25. Ship A Detailed Schedule During Data Collection Periods

DC PERIOD	DATE	DAY OF WEEK	SHIP I/P	SCHEDULED EVENTS	NOTES
R1_W1	10/5/18	FRI	Y	FAST CRUISE, NSFS 2.3	0630-1600: FAST CRUISE
	10/6/18	SAT	Y		
	10/7/18	SUN	Y		
	10/8/18	MON	Y		
	10/9/18	TUE	N	TYCOM SEATRIALS, RFSA	1200: U/W
	10/10/18	WED	N	TYCOM SEATRIALS, RFSA	
	10/11/18	THU	N	TYCOM SEATRIALS, RFSA	1730: MOORED
	10/12/18	FRI	Y	USW 2.2R	
R1_W2	10/13/18	SAT	Y		
	10/14/18	SUN	Y		
	10/15/18	MON	N	MOB-E 1.3A, MOB-N 1.3, MOB-S 1.3, BMD ORE	1000: U/W
	10/16/18	TUE	N	MOB-E 1.3A, MOB-S 1.3, BMD ORE	
	10/17/18	WED	N	MOB-E 1.3A, MOB-S 1.3, BMD ORE	
	10/18/18	THU	N	MOB-E 1.3A, MOB-S 1.3	
	10/19/18	FRI	Y	MOB-E 1.3A, MOB-S 1.3	1330: MOORED
R1_W3	10/20/18	SAT	Y		
	10/21/18	SUN	Y		
	10/22/18	MON	Y	AW 2.3, SW 2.3, CYBER 2.3C, EW 2.3, INTEL 2.3, SUP 1.2, SUP 1.3	
	10/23/18	TUE	Y	AW 2.3, SW 2.3, CYBER 2.3C, EW 2.3, INTEL 2.3, SUP 1.2, SUP 1.3, CHENG SUMMIT	
	10/24/18	WED	Y	AW 2.3, SW 2.3, CYBER 2.3C, EW 2.3, INTEL 2.3, SUP 1.2, SUP 1.3, STW 2.2A	
	10/25/18	THU	Y	AW 2.3, SW 2.3, CYBER 2.3C, EW 2.3, INTEL 2.3, SUP 1.2, SUP 1.3, STW 2.2A	

DC PERIOD	DATE	DAY OF WEEK	SHIP I/P	SCHEDULED EVENTS	NOTES
	10/26/18	FRI	Y	AW 2.3, SW 2.3, CYBER 2.3C, EW 2.3, INTEL 2.3, SUP 1.2, SUP 1.3, STW 2.2A	
R2_W1	12/6/18	THU	Y	IAMD PH III, BMD 2.3, EW LTT, PIERSIDE AMMO ONLOAD, PFA	
	12/7/18	FRI	Y	IAMD PH III, BMD 2.3, EW LTT, PFA	
	12/8/18	SAT	Y		
	12/9/18	SUN	Y		
	12/10/18	MON	Y	3M 1.3, BMDEX 1903 (LTT), EW 2.3R, LRTT, SUPPLY LTT, GUN SHOOT (NASNI), CMAV 9A-1	0245: BMDEX COMMS CHECKS 0400: BMDEX CIC SCENARIO 0700-1100: GUNSHOOT 1600-1900: GUNSHOOT
	12/11/18	TUE	Y	3M 1.3, BMDEX 1903 (LTT), EW 2.3R, LRTT, SUPPLY LTT, CMAV 9A-1	0245: BMDEX COMMS CHECKS 0400: BMDEX CIC SCENARIO
	12/12/18	WED	Y	3M 1.3, BMDEX 1903 (LTT), EW 2.3R, LRTT, SUPPLY LTT, DENTAL VAN, CMAV 9A-1	0245: BMDEX COMMS CHECKS 0400: BMDEX CIC SCENARIO
	12/13/18	THU	Y	3M 1.3, BMDEX 1903 (LTT), EW 2.3R, LRTT, SUPPLY LTT, EXPSAF WALKTHROUGH, CMAV 9A-1, DENTAL VAN, PRT SWIM	0245: BMDEX COMMS CHECKS 0400: BMDEX CIC SCENARIO
	12/14/18	FRI	Y	3M 1.3, BMDEX 1903 (LTT), EW 2.3R, LRTT, SUPPLY LTT, CMAV 9A-1, HOLIDAY PARTY	
R3_W1	1/14/19	MON	Y	TACTICAL CERT, FST-U, AW 2.4, SW 2.4, EW 2.4, CYBER 2.4, RATT, 3M REMEDIATION, COMMAND INDOC	
	1/15/19	TUE	Y	TACTICAL CERT, FST-U, AW 2.4, SW 2.4, EW 2.4, CYBER 2.4, RATT, 3M REMEDIATION, COMMAND INDOC	
	1/16/19	WED	Y	TACTICAL CERT, FST-U, AW 2.4, SW 2.4, EW 2.4, CYBER 2.4, RATT, DC-U, 3M REMEDIATION	
	1/17/19	THU	Y	TACTICAL CERT, FST-U, AW 2.4, SW 2.4, EW 2.4, CYBER 2.4, RATT, DC-U, 3M REMEDIATION, CPO EXAM	
	1/18/19	FRI	Y	TACTICAL CERT, FST-U, AW 2.4, SW 2.4, EW 2.4, CYBER 2.4, RATT, DC-U, 3M REMEDIATION	

APPENDIX D. DETAILED SCHEDULE FOR SHIP B

The following table contains a detailed schedule of activities that observed during data collection periods onboard Ship B. Data collection periods are comprised of dates and day of week observed along with ship operating environment of inport or underway. Ship scheduled events and notes were compiled from ship PODs. Shipboard evolutions and abnormal daily routines were annotated in the final column.

Table 26. Ship B Detailed Schedule During Data Collection Periods

DC PERIOD	DATE	DAY OF WEEK	SHIP I/P	SCHEDULED EVENTS	NOTES
P1_W1	10/16/18	TUE	Y	RFSA, GCCS-M, EW/JTT, VIS MITES, COMMAND INDOC, FSOM 1.3, TYCOM SEA TRIALS	
	10/17/18	WED	N	TYCOM SEA TRIALS, RFSA, MOB-A 1.4B, FSOM 1.3, COMMAND INDOC	0800: U/W ACTUAL ENG CASUALTY MASS GMT
	10/18/18	THU	N	TYCOM SEA TRIALS, MOB-A 1.4B, FSOM 1.3	1130: MOORED
	10/19/18	FRI	Y	FSO-M 1.3, FSOM DRILLS	MASS GMT
	10/20/18	SAT	Y		
	10/21/18	SUN	Y		
P1_W2	10/22/18	MON	N		1400: U/W
	10/23/18	TUE	Y	AMMO ONLOAD	0800: MOORED SEAL BEACH 0900-2100: AMMO ONLOAD
	10/24/18	WED	N	AMMO ONLOAD, TYCOM SEA TRIALS	1500: U/W
	10/25/18	THU	N	TYCOM SEA TRIALS	
	10/26/18	FRI	Y	TYCOM SEA TRIALS	1730: MOORED
P1_W3	10/27/18	SAT	Y		
	10/28/18	SUN	Y		
	10/29/18	MON	N	MOB-E 1.3A, FSOM 1.3	1100: U/W TO FUEL FARM 1200: MOORED FUEL FARM 1700: U/W
	10/30/18	TUE	N	MOB-E 1.3A, FSOM 1.3	
	10/31/18	WED	N	MOB-E 1.3A, FSOM 1.3	
	11/1/18	THU	N	MOB-E 1.3A, FSOM 1.3	

DC PERIOD	DATE	DAY OF WEEK	SHIP I/P	SCHEDULED EVENTS	NOTES
	11/2/18	FRI	Y	MOB-E 1.3A, FSOM 1.3	0800: MOORED FUEL FARM 1500: U/W 1630: MOORED
P2_W1	3/4/19	MON	Y	SUP 1.4, IAMD PH III, USW 2.3B, USW 2.4A, FATS, SENTRY COURSE	
	3/5/19	TUE	Y	SUP 1.4, IAMD PH III, USW 2.3B, USW 2.4A, SENTRY COURSE	
	3/6/19	WED	Y	SUP 1.4, IAMD PH III, USW 2.3B, USW 2.4A, SENTRY COURSE	
	3/7/19	THU	Y	SUP 1.4, IAMD PH III, USW 2.3B, USW 2.4A, SENTRY COURSE, E6 ADVANCEMENT EXAM	
	3/8/19	FRI	Y	SUP 1.4, IAMD PH III, USW 2.3B, USW 2.4A, SENTRY COURSE	0530: NSFS SCENARIO
P3_W1	4/11/19	THU	Y	CMAV 9A3, BMDQ, LFWP MPC, DC UNIVERSITY	
	4/12/19	FRI	Y	CMAV 9A3, BMDQ, DC UNIVERSITY	
	4/13/19	SAT	Y	CMAV 9A3	
	4/14/19	SUN	Y	CMAV 9A3	
	4/15/19	MON	Y	CMAV 9A3, 3M 1.3	
	4/16/19	TUE	Y	CMAV 9A3, 3M 1.3	
	4/17/19	WED	Y	CMAV 9A3, 3M 1.3	
	4/18/19	THU	Y	CMAV 9A3, 3M 1.3	
	4/19/19	FRI	Y	CMAV 9A3	72 HR LIBERTY
P3_W2	4/20/19	SAT	Y	CMAV 9A3	72 HR LIBERTY
	4/21/19	SUN	Y	CMAV 9A3	72 HR LIBERTY
	4/22/19	MON	Y	CMAV 9A3, AMAT, VMAT, GTMAT, ELMAT, RIBMAT, WTDMAT, COMMSMAT, AW 2.4, SW 2.4, EW 2.4, INT 2.4, FST-U, SUPP LTT	
	4/23/19	TUE	Y	CMAV 9A3, AMAT, VMAT, GTMAT, ELMAT, RIBMAT, WTDMAT, COMMSMAT, AW 2.4, SW 2.4, EW 2.4, INT 2.4, FST-U, SUPP LTT	
	4/24/19	WED	Y	CMAV 9A3, AMAT, VMAT, GTMAT, ELMAT, RIBMAT, WTDMAT, COMMSMAT, AW 2.4, SW 2.4, EW 2.4, INT 2.4, FST-U, SUPP LTT, FATS, PIERSIDE FUEL ONLOAD	
	4/25/19	THU	Y	CMAV 9A3, AMAT, VMAT, GTMAT, ELMAT, RIBMAT, WTDMAT, COMMSMAT, AW 2.4, SW 2.4, EW 2.4, INT 2.4, FST-U, SUPP LTT, FATS	
	4/26/19	FRI	Y	CMAV 9A3, AMAT, VMAT, GTMAT, ELMAT, RIBMAT, WTDMAT, COMMSMAT	

APPENDIX E. PARTICIPANT CONSENT FORM

A. NPS CONSENT FORM

Naval Postgraduate School
Consent to Participate in Research

NPS IRB	
Approved:	02/12/2019
Expires:	01/30/2020

Introduction. You are invited to participate in a continuation of the research project entitled *Predictive Value of the Servicemember Evaluation Tool (SET).* This study will compare performance of crews of two destroyers, one with standard manning and one with 27 additional Sailors added to the crew.

Procedures. Please check the options below which you are willing to participate in. No Personally Identifiable Information (PII) will be stored with the data.

☐ **Work and rest patterns**

Data will be collected from up to six periods of approximately 1 week that will comprise either inport, underway and/or a combination of the two (depending on ship schedule). In the beginning of each period, you will be asked to complete the Pre-study questionnaire, which will include questions about your sleep quality, sleep history, and cognitive readiness (approximately ~10 minutes). At the end of each period, you will complete the Post-study questionnaire to determine sleep history, and cognitive readiness (~15 minutes). Throughout the study period, you will be asked to wear an actigraph to measure the amount and quality of sleep you receive. The actigraph will be worn 24 hours a day for the duration of the study. You will keep a daily log of your sleep and activity. Completing the daily sleep/activity logs and will take approximately 10 minutes total per day to complete. Participation in this option of the study will require up to 42 days in total for up to six periods.

☐ **Saliva Collection for Telomeres/Stress Assessment**

Saliva will be collected at the beginning of up to six data collection periods.

In the beginning of each data collection period, you will be asked to participate in saliva sampling (spitting into a tube) using the Oragene•DISCOVER kit and the SalivaBio passive drool kit. The Oragene•DISCOVER collection is performed up to one time per data collection period, for telomere length analysis. The SalivaBio collection is performed up to three times per day on two consecutive days per data collection period for hormone analysis. Each sample collection will take approximately 5 minutes to complete.

No Personally Identifiable Information (PII) will accompany your saliva samples. The saliva samples will be stored in a locked facility onboard the ship before being sent to a laboratory for analyses of stress hormones and telomere length. Telomere analysis involves the analysis of genetic material (DNA), but it is not a "genetic test" or "genotyping" to diagnose the presence of a genetic variation linked to a predisposition to a genetic disease or disability in the individual or the individual's offspring.

If you agree, we will retain your saliva DNA samples for future research purposes that have not yet been identified, these may include genotyping which is analyzing the genes in your DNA. Only de-identified samples and data are released to researchers who have designed good studies and have the approval of an Institutional Review Board (IRB) that oversees research activities.

If you decide to withdraw from this study prior to its completion, or if you want to withdraw your saliva sample from future research, we will remove and destroy any and all saliva samples in our possession. If you wish to have your samples removed and destroyed, please inform the Principal Investigator, Dr. Nita Lewis Shattuck, of your decision in writing by emailing her at nlshattu@nps.edu.

Note: Up to six data collection periods

NPS IRB

Approved: 02/12/2019
Expires: 01/30/2020

Location. The study will take place shipboard during inport or underway periods.

Cost. There is no cost to participate in this research study.

Voluntary Nature of the Study. Your participation in this study is strictly voluntary. If you choose to participate, you can change your mind at any time and withdraw from the study. You will not be penalized in any way or lose any benefits to which you would otherwise be entitled if you choose not to participate in this study or to withdraw. The alternative to participating in the research is to not participate in the research.

Anticipated Benefits. There will be no direct benefit for the individual participants; however, this study may ultimately lead to increased operational efficiency through maximizing individual performance.

Compensation for Participation. No tangible compensation will be given.

Potential Risks and Discomforts.

Work and rest patterns - The potential risks of participating in this study are minimal. There is a minor risk of breach of privacy and confidentiality. All personal identifiable information will be concealed once the data from the study has been collected. All data will be presented based on group analysis; individual will not be singled out or identifiable. Raw data will not be disclosed to anyone outside the research team. There is a small risk of skin sensitivity or irritation with the use of the actigraph. The actigraph is designed for prolonged, continuous wear and is considered a low-risk medical device, however, skin irritation may develop. To reduce this risk, the actigraph should not be worn too tightly and the skin under the device should be kept clean and dry. If skin irritation does develop, stop wearing the watch and contact research personnel as soon as possible.

Saliva Collection for Telomeres/Stress Assessment - The potential risks of participating in this study are minimal. There is a minor risk of breach of confidentiality. All PII will be concealed once the data from the study has been collected. All data will be presented based on your analysis; individuals will not be singled out or identifiable. Individual data will not be disclosed to anyone outside the research team. There is always a chance, although remote, that you could be identified as donating a sample. However, a new Federal law, called the Genetic Information Nondiscrimination Act (GINA), generally makes it illegal for health insurance companies, group health plans, and most employers to discriminate against you based on your genetic information. This law will generally protect you in the following ways:

- Health insurance companies and group health plans may not request your genetic information that we get from this research
- Health insurance companies and group health plans may not use your genetic information when making decisions regarding your eligibility or premiums
- Employers with 15 or more employees may not use your genetic information that we get from this research when making a decision to hire, promote, or fire you or when setting the terms of your employment

Confidentiality & Privacy Act.

Work and rest patterns - Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. All data from this study will be kept on a secure server and/or in a locked facility and only the researchers will have access to the data. This data will not be disseminated to you or to any outside parties.

Note: Up to six data collection periods

NPS IRB
Approved: 02/12/2019
Expires: 01/30/2020

Saliva Collection for Telomeres/Stress Assessment - Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. All data from this study will be kept on a secure server and/or in a locked facility and only the researchers will have access to the data. This data will not be disseminated to you or to any outside parties. The saliva samples will be labelled with a study code and your personal information will be kept separate from the saliva samples. There is always a chance, although remote, that you could be identified as donating a sample.

Points of Contact. If you have any questions or comments about the research, or you experience an injury or have questions about any discomforts that you experience while taking part in this study please contact the Principal Investigator, Dr. Nita Lewis Shattuck, 831-656-2281, nlshattu@nps.edu. Questions about your rights as a research subject or any other concerns may be addressed to the Naval Postgraduate School IRB, Dr. Bryan Hudgens, bryan.hudgens@nps.edu.

Statement of Consent.

Work and rest patterns

I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

_____ _____

Participant's Signature Date

Saliva Collection for Telomeres/Stress Assessment

I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Check all that apply:

☐ I agree to provide saliva samples, which will be analyzed for stress hormones.

☐ I agree to provide saliva DNA samples, which will be analyzed for telomere length.

☐ I agree to having my saliva DNA samples retained by the study investigators to be analyzed in the future for research purposes that have not yet been determined, including genotyping (analyzing the genes in your DNA).

_____ _____

Participant's Signature Date

Note: Up to six data collection periods

B. COMMANDING OFFICER PERMISSION TO CONDUCT STUDY

DEPARTMENT OF THE NAVY
[redacted]

1000
[redacted]
07 Mar 18

From: Commanding Officer [redacted]
To: Dr. Nita L. Shattuck, Naval Postgraduate School (Operations Research Department)

Subj: PERMISSION TO STUDY SAILOR WORK AND REST PATTERNS IN [redacted]

1. Per the Comprehensive Review recommendations [redacted] has been enrolled in a study of Sailor workload during Basic, Intermediate and Advanced Phases during 2018. The purpose of this study is to examine the effect of varying manning levels on individual Sailor and ship-wide performance.

2. We are interested in learning how the change in manning levels affects Sailor fatigue and performance levels. We request the assistance of Dr. Nita Shattuck of the Naval Postgraduate School to assess the impact of shipboard manning levels on the work, rest and performance patterns of Sailors on [redacted]

3. The point of contact for [redacted] for this effort is [redacted] USN who can be reached at [redacted].

[redacted]

Copy to:
COMDESRON 21
COMNAVSURFPAC (N1)

DEPARTMENT OF THE NAVY
[redacted]

6500
[redacted]
8 Mar 18

From: Commanding Officer, [redacted]
To: Dr. Nita Lewis Shattuck, Naval Postgraduate School (Operations Research Department)

Subj: PERMISSION TO STUDY SAILOR WORK AND REST PATTERNS IN [redacted]

1. Per the Comprehensive Review recommendations, [redacted] has been enrolled in a study of Sailor workload during Basic, Intermediate and Advanced Phases. The purpose of this study is to examine the effect of varying manning levels on individual Sailor and ship-wide performance.

2. We are interested in learning how the change in manning levels affects Sailor fatigue and performance levels. We request the assistance of Dr. Nita Shattuck of the Naval Postgraduate School to assess the impact of shipboard manning levels on the work, rest and performance patterns of Sailors on [redacted]

3. The point of contact for [redacted] for this effort is [redacted] who can be reached at [redacted]

[redacted]

Copy to:
COMDESRON 23
COMNAVSURFPAC (N1)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX F. SHIP A PARTICIPANT SUMMARY

The following table represents continuity of individual participants across data collection periods on Ship A. Participant ID corresponds to a unique Sailor volunteering to take part in the CR53 study. Cells annotated with an "X" denote that the participant was included in final data analysis.

Table 27. Ship A Participant Summary

Participant ID	DATA COLLECTION				
	1			2	3
	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
R001				X	X
R002					
R003	X	X	X		
R004	X	X	X		
R005	X	X	X	X	
R006	X	X	X	X	X
R007					
R008					
R009	X	X	X	X	X
R010					
R011	X	X	X		
R012	X	X	X		
R013	X	X	X		
R014	X	X	X		
R015	X				
R016	X	X	X	X	
R017	X	X	X		
R018					X
R019					
R020					
R021	X	X	X		X
R022					
R023				X	
R024	X				
R025					
R026					
R027					

Participant ID	DATA COLLECTION				
	1			2	3
	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
R028					
R029					
R030					
R031	X	X	X		
R032					
R033	X	X			
R034					
R035					
R036					
R037					
R038					
R039					
R040					
R041					
R042	X	X	X	X	X
R043	X		X		
R044					
R045	X	X			X
R046					
R047					
R048					
R049					
R050	X	X	X		
R051					
R052	X	X	X		
R053	X				
R054					
R055			X		X
R056	X	X	X	X	
R057				X	
R058					
R059					
R060					
R061					
R062	X	X	X		
R063					
R064					
R065					
R066					

Participant ID	DATA COLLECTION				
	1			2	3
	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
R067	X	X	X		
R068	X	X	X	X	X
R069					X
R070					
R071	X	X	X		
R072					
R073					
R074					
R075	X	X	X		
R076	X	X	X		
R077					
R078					
R079					
R080					
R081					
R082					
R083					
R084					
R085					
R086	X	X	X		
R087					
R088					
R089	X	X	X		
R090	X	X	X		
R091					
R092					
R093					
R094	X	X			
R095	X	X	X		
R096	X	X	X	X	X
R097				X	X
R098				X	X
R099					
R100					
R101					X
R102					
R103					X
R104					X
R105					

Participant ID	DATA COLLECTION				
	1			2	3
	R1_W1	R1_W2	R1_W3	R2_W1	R3_W1
R106					X
R107					X
R108					
R109					X
Total	**35**	**31**	**30**	**13**	**19**

APPENDIX G. SHIP B PARTICIPANT SUMMARY

The following table represents continuity of individual participants across data collection periods for Ship B. Participant ID corresponds to a unique Sailor volunteering to take part in the CR53 study. Cells annotated with an "X" denote that the participant was included in final data analysis.

Table 28. Ship B Participant Summary

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P001						
P002						
P003			X			
P004			X	X		
P005						
P006	X	X				
P007						
P008	X					
P009						
P010						
P011						
P012	X		X			
P013				X		
P014	X	X	X	X		
P015				X		
P016						
P017						
P018						
P019						
P020				X		
P021	X	X	X			
P022	X	X	X		X	X
P023	X	X	X		X	X
P024						
P025						
P026						
P027	X	X	X			

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P028						
P029						
P030						
P031						
P032				X		
P033	X	X	X			
P034						
P035						
P036						
P037						
P038						
P039						
P040						
P041	X	X	X	X		
P042						
P043						
P044						
P045	X	X	X	X	X	X
P046						
P047						
P048	X			X		
P049						
P050	X		X		X	
P051					X	X
P052	X	X	X	X		
P053	X	X	X			
P054	X	X	X	X	X	X
P055						
P056						
P057	X	X	X	X		
P058	X	X	X	X	X	X
P059						
P060	X	X	X		X	X
P061						
P062	X	X	X	X	X	X
P063	X	X	X	X	X	X
P064						
P065		X		X		
P066	X	X	X	X		

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P067	X	X	X	X		
P068	X	X	X	X		
P069	X	X	X	X		
P070	X	X	X	X		
P071	X	X	X	X	X	X
P072						
P073	X	X	X	X	X	X
P074						
P075						
P076	X	X	X	X		
P077						
P078						
P079	X	X	X	X		
P080						
P081						
P082						
P083						
P084			X			
P085						
P086						
P087	X					
P088		X				
P089		X	X		X	X
P090	X			X		
P091	X	X	X			
P092	X	X	X			
P093	X	X	X	X		
P094	X					
P095	X	X	X	X		
P096						
P097			X	X		X
P098						
P099		X				
P100	X	X			X	X
P101	X	X	X	X	X	X
P102	X	X	X			
P103	X	X	X	X		
P104						
P105						

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P106						
P107						
P108	X	X	X			
P109						
P110	X		X	X		
P111						
P112						
P113						
P114						
P115						
P116						
P117						
P118	X	X	X			
P119	X	X	X	X		
P120						
P121						
P122						
P123						
P124	X	X	X		X	X
P125			X			
P126	X		X	X	X	X
P127	X	X				
P128						
P129				X		
P130	X	X	X	X	X	X
P131						
P132				X		
P133			X		X	
P134						
P135						
P136						
P137						
P138						
P139	X	X	X			
P140						
P141				X		
P142						
P143				X		
P144				X		

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P145				X		
P146				X		
P147						
P148						
P149						
P150				X		
P151				X	X	X
P152						
P153						
P154						
P155				X		
P156				X		
P157				X		
P158				X		
P159				X		
P160				X		
P161						
P162				X		
P163				X		
P164					X	X
P165					X	X
P166						
P167					X	X
P168						
P169					X	X
P170						
P171						
P172					X	X
P173					X	X
P174					X	X
P175						
P176						
P177					X	X
P178						
P179					X	X
P180						
P181					X	X
P182					X	X
P183						

Participant ID	DATA COLLECTION					
	1			2	3	
	P1_W1	P1_W2	P1_W3	P2_W1	P3_W1	P3_W2
P184						
P185					X	X
P186						X
P187						
Total	**50**	**45**	**49**	**52**	**32**	**32**

APPENDIX H. NPS EQUIPMENT AND INSTRUCTIONS

Naval Postgraduate School

Date: _____ Participant ID: _____

Pre-Study Questionnaire

Instructions: *Please answer ALL questions as accurately as possible. ALL information is confidential and will be used only for research purposes.*

1. What is your age: _____ years
2. Gender (Check one ☑) ☐ Male ☐ Female
3. What is your rate: (for example, FC, HT, OS, IT, GSE) _____
4. What is your rank: (for example, E4, O2) _____
5. Department: (for example, Engineering, Operations, etc.) _____
6. Years on active duty: _____
7. How many times have you deployed: _____ Total number of months deployed: _____
8. In your previous experiences, what watch schedules did you stand when the ship was underway (e.g., 4/8, 12/12, 5/10, 5/15, etc.)? _____
9. Which of the following nicotine products do you use? (Check ALL that apply ☑) and indicate how often)
   - ☐ Cigarettes (If YES, how often? _____)
   - ☐ Chewing tobacco/snuff (If YES, how often? _____)
   - ☐ Nicorette gum or patches (If YES, how often? _____)
   - ☐ Electronic smoke (If YES, how often? _____)
   - ☐ Other (specify): _____ (How often? _____)
10. Have you ever been diagnosed by a physician with any of the following? (Check ALL that apply ☑)
    - ☐ Insomnia
    - ☐ Obstructive Sleep Apnea (OSA)
11. Do you take any prescribed or over-the-counter medications? (Check one ☑) ☐ Yes ☐ No
    If **YES**, please list all medications you take:

    _____

    _____

ESS instructions: *How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in the **last week**. Even if you have not done some of these things recently try to work out how they would have affected you. Check ☑ the most appropriate number for each situation.*

	CHANCE OF DOZING			
	None (0)	Slight (1)	Moderate (2)	High (3)
Sitting and reading	O	O	O	O
Watching TV	O	O	O	O
Sitting inactive in a public place (e.g. a theater or a meeting)	O	O	O	O
As a passenger in a car for an hour without a break	O	O	O	O
Lying down to rest in the afternoon when circumstances permit	O	O	O	O
Sitting and talking to someone	O	O	O	O
Sitting quietly after a lunch without alcohol	O	O	O	O
In a car, while stopped for a few minutes in traffic	O	O	O	O

NAVAL
POSTGRADUATE
SCHOOL

1 UNIVERSITY CIRCLE
MONTEREY, CALIFORNIA 93943
WWW.NPS.EDU

Work and Rest Patterns

Activity Log

Naval Postgraduate School

Study Phase: _____

Participant ID: _____

Beginning Date: _____

Actigraph #: _____

If this booklet is found, please return to the NPS Crew Endurance Team

Activities

E – Eating/Messing
R – Removed Actigraph
S – Sleeping/Napping
P – Personal/Free Time – Includes working out, grooming, hygiene, haircuts, smoke breaks.
C – Commuting

M – Maintenance/Work – Time allocated for gathering tools, conducting maintenance, ESOMMS for equipment tagout, traveling to maintenance area i.e. going aloft or from CCS to shaft alley (Total Maintenance time)

G – GMT – includes training such as Safety Standown, GMT's, Navy-wide trainings.

T – Shipboard level training – including duty section training, equipment walkthrough for certification/assessment preps or equipment light-off, training team administration, safety walkthroughs and equipment stowage post-training. This also will account for any warfare related drills pre/post briefs, trainings required for CSTT/ITT/DCTT/ETT/MTT etc. as well as classroom training from certifying authorities in preparation for certification.

W – Watch – Duty Day/Underway watch standing – to include EDO (inport)/EOOW(underway), CSMC (inport)/CSOOW (underway), OOD I/P, POOW, Duty-GM being in armory during pre/post-watch arming of watches.

PD – Professional Development – conducting advancement exams, CPO365 Phase I/Phase II Activities, PO Leadership Courses, PQS completion, OJT, writing and debriefing, mentoring, board participation, DRB's etc.

A – Administrative Requirements – Time associated with working on SKED, OMMS-NG for JSN writing or equipment validations, RADM for watchbill writing and PQS inputs, 8 o'clock updates, CASREP writing. Work related email included here, berthing or messdeck inspection/ walkthrough. This also includes personal records management such as DEERS verification, PG2 updates (not to include YN/PS personnel records management) etc.

D – Meetings – Divisional/Departmental/All Hands Call, Awards ceremonies, Quarters, PB4T, PO Association meetings, MWR, Safety Council, daily/weekly maintenance meetings (either internal or with ship supervisor).

Study Activities

1. Read, sign and return consent form to the NPS Research Team.
2. Complete the Pre-Study questionnaire and return to the NPS Research Team.
3. Receive your actigraph from the NPS Research Team. You will be given an ID number which will be the number located on the back of your sleep watch. Print, Sign and Date the Check-out sheet for your actigraph. Take your actigraph and Activity Log with you.
4. Wear the actigraph at all times unless:
   a. Showering, or engaged in an activity in which you think it may become damaged (e.g., diving, swimming, etc.)
   b. Directed to remove it by the chain of command.
5. Place the actigraph on your non-dominant wrist. The local time should be displayed on the watch face.
6. Notify a member of the NPS Research Team ASAP if you think the actigraph is not working properly.
7. Each day, record your activities in the next section of this Activity Log (see example in next page).

Reminder

The completed questionnaires and actigraph will be used for research purposes only. All results will be kept confidential.

Thank you for participating in this study!

Activities

E – Eating/Messing
R – Removed Actigraph
S – Sleeping/Napping
P – Personal/Free Time – Includes working out, grooming, hygiene, haircuts, smoke breaks.
C – Commuting

M – Maintenance/Work – Time allocated for gathering tools, conducting maintenance, ESOMMS for equipment tagout, traveling to maintenance area i.e. going aloft or from CCS to shaft alley (Total Maintenance time)

G – GMT – includes training such as Safety Standown, GMT's, Navy-wide trainings.

T – Shipboard level training – including duty section training, equipment walkthrough for certification/assessment preps or equipment light-off, training team administration, safety walkthroughs and equipment stowage post-training. This also will account for any warfare related drills pre/post briefs, trainings required for CSTT/ITT/DCTT/ETT/MTT etc. as well as classroom training from certifying authorities in preparation for certification.

W – Watch – Duty Day/Underway watch standing – to include EDO (inport)/EOOW(underway), CSMC (inport)/CSOOW (underway), OOD I/P, POOW, Duty-GM being in armory during pre/post-watch arming of watches.

PD – Professional Development – conducting advancement exams, CPO365 Phase I/Phase II Activities, PO Leadership Courses, PQS completion, OJT, writing and debriefing, mentoring, board participation, DRB's etc.

A – Administrative Requirements – Time associated with working on SKED, OMMS-NG for JSN writing or equipment validations, RADM for watchbill writing and PQS inputs, 8 o'clock updates, CASREP writing. Work related email included here, berthing or messdeck inspection/ walkthrough. This also includes personal records management such as DEERS verification, PG2 updates (not to include YN/PS personnel records management) etc.

D – Meetings – Divisional/Departmental/All Hands Call, Awards ceremonies, Quarters, PB4T, PO Association meetings, MWR, Safety Council, daily/weekly maintenance meetings (either internal or with ship supervisor).

Date: _____

Midnight 0000	0015	0030	0045	0100	0115	0130	0145	0200	0215	0230	0245	0300	0315	0330	0345
0400	0415	0430	0445	0500	0515	0530	0545	0600	0615	0630	0645	0700	0715	0730	0745
0800	0815	0830	0845	0900	0915	0930	0945	1000	1015	1030	1045	1100	1115	1130	1145
Noon 1200	1215	1230	1245	1300	1315	1330	1345	1400	1415	1430	1445	1500	1515	1530	1545
1600	1615	1630	1645	1700	1715	1730	1745	1800	1815	1830	1845	1900	1915	1930	1945
2000	2015	2030	2045	2100	2115	2130	2145	2200	2215	2230	2245	2300	2315	2330	2345

M Maintenance	**PD** Prof. Dev.	**E** Eating/messing
W Watch	**D** Meetings	**R** Removed sleep watch
G GMT Training	**A** Admin	**S** Sleeping/napping
T Shipboard Training		**P** Personal Time/Free time
		L Leave/POM/24-96 Lib
		C Commuting

How many hours of have off-ship training did you have today? _____

# of Caffeinated Beverage _____ When? _____

# of Energy Drinks: _____ When? _____

Did you work out? Yes No

If YES, when? _____

If YES, type of workout (running, weight lifting, etc.) _____

Additional Notes:

Activities

E – Eating/Messing
R – Removed Actigraph
S – Sleeping/Napping
P – Personal/Free Time – Includes working out, grooming, hygiene, haircuts, smoke breaks.
C – Commuting

M – Maintenance/Work – Time allocated for gathering tools, conducting maintenance, ESOMMS for equipment tagout, traveling to maintenance area i.e. going aloft or from CCS to shaft alley (Total Maintenance time)

G – GMT – includes training such as Safety Standown, GMT's, Navy-wide trainings.

T – Shipboard level training – including duty section training, equipment walkthrough for certification/assessment preps or equipment light-off, training team administration, safety walkthroughs and equipment stowage post-training. This also will account for any warfare related drills pre/post briefs, trainings required for CSTT/ITT/DCTT/ETT/MTT etc. as well as classroom training from certifying authorities in preparation for certification.

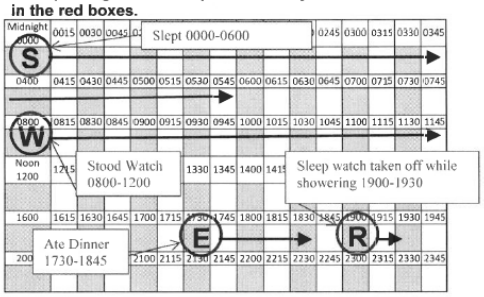
W – Watch – Duty Day/Underway watch standing – to include EDO (inport)/EOOW(underway), CSMC (inport)/CSOOW (underway), OOD I/P, POOW, Duty-GM being in armory during pre/post-watch arming of watches.

PD – Professional Development – conducting advancement exams, CPO365 Phase I/Phase II Activities, PO Leadership Courses, PQS completion, OJT, writing and debriefing, mentoring, board participation, DRB's etc.

A – Administrative Requirements – Time associated with working on SKED, OMMS-NG for JSN writing or equipment validations, RADM for watchbill writing and PQS inputs, 8 o'clock updates, CASREP writing. Work related email included here, berthing or messdeck inspection/ walkthrough. This also includes personal records management such as DEERS verification, PG2 updates (not to include YN/PS personnel records management) etc.

D – Meetings – Divisional/Departmental/All Hands Call, Awards ceremonies, Quarters, PB4T, PO Association meetings, MWR, Safety Council, daily/weekly maintenance meetings (either internal or with ship supervisor).

Example Log: The descriptions of daily activities are shown in the red boxes.



M Maintenance	**PD** Prof. Dev.	**E** Eating/messing
W Watch	**D** Meetings	**R** Removed sleep watch
G GMT Training	**A** Admin	**S** Sleeping/napping
T Shipboard Training		**P** Personal Time/Free time
		L Leave/POM/24-96 Lib
		C Commuting

How many hours of have off-ship training did you have today? ____6___

# of Caffeinated Beverages: ___0___ When? _____

# of Energy Drinks: ___1___ When? ___1500___

Did you work out? Yes **X** No

If YES, when? _____

If YES, type of workout (running, weight lifting, etc.) _____

Naval Postgraduate School

Date: _____ Participant ID: _____

Post-Study Questionnaire

Instructions:

*If data collection occurred during **inport days**, answer questions 1 to 5 and do not answer questions 6 to 10, then answer the remaining questions included in the questionnaire.*

*If data collection occurred during **underway days**, do not answer questions 1 to 5, answer questions 6 to 10,then answer the remaining questions included in the questionnaire.*

If data collection occurred during a period that covers both inport and underway days, please answer questions 1 to 5 regarding inport days and questions 6 to 10 regarding underways days. After completing questions 1 to 10, please answer the remaining questions.

ALL information is confidential and will be used only for research purposes. If you did not have any inport skip to the next page.

Inport questions

Instructions: *Please answer questions 1 to 5* ***corresponding to days inport*** *during the last data collection period. ALL information is confidential and will be used only for research purposes. If you did not have any inport days during the last data collection period skip to the next page.*

Inport

1. How many days were spent inport during the **last data collection period**? _____

2. Did you have duty or stand watch inport during the **last data collection period**? **(**Check one ☑) ☐ Yes ☐ No

   2.a What was your assigned watch station and when did you stand watch, if applicable? (For example: EDO (0630-1800), OOD I/P (2200-0200))

   _____

   2.b Where did you stand watch? (for example: CIC, Quarterdeck, CCS, CSMC, Roving watch)

   _____

3. The sleep I received during the **last data collection period** while inport was: **(**Check one ☑)

Much less than I needed	Less than I needed	About right	More than I needed	Much more than I needed
○	○	○	○	○

4. The sleep received **by other Sailors** during the **last data collection period** while inport was: **(**Check one ☑)

Much less than needed	Less than needed	About right	More than needed	Much more than needed
○	○	○	○	○

5. How did your workload for the **last data collection period** while inport compare to your normal workload while inport? **(**Check one ☑)

Much less than usual	Less than usual	About the same	More than usual	Much more than usual
○	○	○	○	○

Underway questions

Instructions: *Please answer questions 6 to 12* ***corresponding to days underway*** *during the last data collection period. ALL information is confidential and will be used only for research purposes. If you did not have any underway during the last data collection period skip to the next page. If you did not have any underway days during the last data collection period skip to the next page.*

Underway

6. How many days were spent underway during the **last data collection period**? _____

7. Did you stand watch while underway during the **last data collection period**? (Check one ☑)
   ☐ Yes ☐ No
   a. **If you stood watch**, which watchstanding schedule were you on? (hours on/ hours off)
   Check ALL that apply ☑

☐ 4hrs on/8hrs off	☐ 6hrs on/12hrs off
☐ 3hrs on/9hrs off	☐ 6hrs on/18hrs off
☐ 5hrs on/10hrs off (3-section)	☐ 6hrs on/12hrs off
☐ 5hrs on/15hrs off (4-section)	☐ 12hrs on/12hrs off
☐ 6hrs on/6hrs off	☐ Other, describe _____
☐ 7 on/5 off/5 on/5 off	_____

7.a When did you stand watch? (For example, 0000-0400 and 1200-1600)

_____

7.b Where did you stand watch? (for example, CIC, Bridge, Roving watch)

_____

8. The sleep I received during the **last data collection period** was: (Check one ☑)

Much less than I needed	Less than I needed	About right	More than I needed	Much more than I needed
○	○	○	○	○

9. The sleep received **by other Sailors** during the **last data collection period** was: (Check one ☑)

Much less than needed	Less than needed	About right	More than needed	Much more than needed
○	○	○	○	○

10. How did your workload for the **last data collection period** compare to your normal workload while underway? (Check one ☑)

Much less than usual	Less than usual	About the same	More than usual	Much more than usual
○	○	○	○	○

ESS instructions: *How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in the **last data collection period**. Even if you have not done some of these things recently try to work out how they would have affected you. Check ☑ the most appropriate number for each situation.*

	CHANCE OF DOZING			
	None (0)	Slight (1)	Moderate (2)	High (3)
Sitting and reading	○	○	○	○
Watching TV	○	○	○	○
Sitting inactive in a public place (e.g. a theater or a meeting)	○	○	○	○
As a passenger in a car for an hour without a break	○	○	○	○
Lying down to rest in the afternoon when circumstances permit	○	○	○	○
Sitting and talking to someone	○	○	○	○
Sitting quietly after a lunch without alcohol	○	○	○	○
In a car, while stopped for a few minutes in traffic	○	○	○	○

ISI instructions: *Please rate the severity of your insomnia symptoms during the **last data collection period**. Check ☑ the most appropriate for each situation.*

	None (0)	Mild (1)	Moderate (2)	Severe (3)	Very Severe (4)
Difficulty falling asleep	○	○	○	○	○
Difficulty staying asleep	○	○	○	○	○
Problems waking up too early	○	○	○	○	○
How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?	Very Satisfied ○	Satisfied ○	Moderately Satisfied ○	Dissatisfied ○	Very Dissatisfied ○
How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?	Not at all Noticeable ○	A Little ○	Somewhat ○	Much ○	Very Much Noticeable ○
How WORRIED/DISTRESSED are you about your current sleep problem?	Not at all Worried ○	A Little ○	Somewhat ○	Much ○	Very Much Worried ○
To what extent do you consider your sleep problem to INTERFERE with your daily functioning CURRENTLY? (i.e. daytime fatigue, mood, ability to function at work, concentration, memory, mood, etc.)	Not at all Interfering ○	A Little ○	Somewhat ○	Much ○	Very Much Interfering ○

PSQI instructions: *The following questions relate to your usual sleep habits during the **last data collection period only**. Your answers should indicate the most accurate reply for the majority of days/nights in the **last data collection period**. Please answer all questions.*

1. In the last data collection period, what time have you usually gone to bed at night?	Bed Time: _____
1. During the last data collection period, how long (in minutes) has it usually taken you to fall asleep each night	Number of Minutes:_____
2. In the last data collection period, what time have you usually gotten up in the morning?	Getting up time:_____
3. During the last data collection period, how many hours of actual sleep did you get at night? (this may be different than the number of hours you spent in bed.)	Hours of Sleep per Night:__

Instructions: *For each of the questions, check the one best response.*

4. During the last data collection period, how often have you had trouble sleeping because you...	Not during the last week	Less than once a week	Once or twice during the last week	3 or more times during the last week
a) Cannot get to sleep within 30 mins	O	O	O	O
b) Wake up in the middle of the night or early morning	O	O	O	O
c) Have to get up to use the bathroom	O	O	O	O
d) Cannot breathe comfortably	O	O	O	O
e) Cough or snore loudly	O	O	O	O
f) Feel too cold	O	O	O	O
g) Feel too hot	O	O	O	O
h) Had bad dreams	O	O	O	O
i) Have pain	O	O	O	O
j) Other reason(s), please describe: _____ How often during the last data collection period have you had trouble sleeping because of this other reason?	O	O	O	O
5. During the last data collection period, how would you rate your sleep quality overall?	Very Good O	Fairly Good O	Fairly Bad O	Very Bad O
6. During the last data collection period, how often have you taken medicine to help you sleep (prescribed or "over the counter"?	Not during the last week O	Less than once a week O	Once or twice a week O	Three or more times a week O
7. During the last data collection period, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	O	O	O	O
8. During the last data collection period, how much of a problem has it been for you to keep up enough enthusiasm to get things done?	Not a problem at all O	Only a very slight problem O	Somewhat of a problem O	A very big problem O

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX I. CNSP DATA

The following table reflects manning actions that were realized onboard Ship B, with corresponding date of arrival onboard the ship. These manning actions can be seen in COB numbers corresponding to the final data collection period.

Table 29. Ship B Manning Actions During Data Collection Period 2 and 3

Month	Rating	Pay Grade	Losing Command CRUDES?	Manning Action	Estimated Date of Arrival
MAR	SH	E5	YES	120 DAY TAD	03/04/19
MAR	FCA	E5	YES	120 DAY TAD	03/04/19
MAR	OS	E4	NO	120 DAY TAD	03/04/19
MAR	OS	E4	NO	120 DAY TAD	03/04/19
MAR	SH	E3	NO	120 DAY TAD	03/04/19
MAR	OS	E5	NO	120 DAY TAD	03/04/19
MAR	OS	E5	NO	120 DAY TAD	03/04/19
MAR	OS	E5	NO	120 DAY TAD	03/04/19
MAR	OS	E3	YES	120 DAY TAD	03/04/19
MAR	MM	E4	NO	120 DAY TAD	03/04/19
MAR	MM	E4	NO	120 DAY TAD	03/04/19
MAR	MM	E6	NO	120 DAY TAD	03/04/19
MAR	GSM	E3	YES	120 DAY TAD	03/04/19
MAR	DC	E4	NO	120 DAY TAD	03/04/19
MAR	DC	E3	NO	120 DAY TAD	03/04/19
MAR	DC	E3	YES	120 DAY TAD	03/04/19
MAR	DC	E4	YES	120 DAY TAD	03/04/19
MAR	IT	E5	YES	179 DAY TAD	03/04/19
MAR	CS	E3	NO	120 DAY TAD	03/04/19
MAR	ET	E6	YES	XFER	03/15/19
MAR	LS	E5	YES	120 DAY TAD	03/15/19
MAR	FCA	E7	YES	179 DAY TAD	03/18/19
APR	CS	E5	NO	XFER	04/01/19
APR	OS	E6	NO	XFER	04/01/19
APR	LS	E5	NO	XFER	04/01/19
APR	OS	E6	NO	XFER	04/01/19
APR	FCA	E4	YES	120 DAY TAD	04/01/19
APR	FCA	E4	YES	120 DAY TAD	04/01/19
APR	QM	E6	YES	120 DAY TAD	04/08/19
APR	CS	E6	NO	XFER	04/15/19
APR	HT	E5	YES	XFER	04/26/19

Table 30. CNSP Data Collected during the Basic Phase

CR TEST SHIP AND CONTROL SHIP METRICS								
1	E	Number of CASREPs open	MFOM Message Traffic	CNSP N47, LT Billy Abbott	Number of CASREPs by CAT	Monthly (C2, C3, C4)		No
2	E	Average duration of open CASREPs	MFOM Message Traffic	CNSP N47, LT Billy Abbott	Time CASREPs remain open (average by CAT of how long CASREPs stayed open)	Once per training cycle (C2, C3, C4)		No
3	E	Number of CASREPs requiring Tech Assist	MFOM Message Traffic	CNSP N47, LT Billy Abbott	Percentage of CASREPs (by CAT) requiring Onboard Tech Assist (OBTA) or Distance Support	Monthly (C2, C3, C4)		No
4	E	PMS RAR (Recorded Accomplishment Rate)	SKED	Ship 3MC / CNSP N4 3M (Jerry Brugger)	PMS RAR (accomplishment rate of scheduled maintenance)	Weekly (as generated by SKED)	give as %.	No
5	E	PMS SAR (Situational Accomplishment Rate) for R-Checks	SKED	Ship 3MC / CNSP N4 3M (Jerry Brugger)	PMS SAR (accomplishment rate of scheduled maintenance)	Weekly (as generated by SKED)	give as %.	No
6	E	PMS Spot-Check Completion Rate	Ship 3MC Files	Ship 3MC	Number of spot-checks done per 3M instructions	Weekly	give as number and %.	
7	E	3M Equipment Validations	SKED	Ship 3MC / CNSP N4 3M (Jerry Brugger)	Number of equipment validations done	Weekly (as generated by SKED)	give as number and %.	No
8	E	Ship CSMP job average completion time	OMMS	Port Engineer	Number of jobs assigned and completed, for all scopes of work, to include tech assist and ship force	Every 2 weeks, or as SF uploads offship to Port Engineer.	Tech assist job completion will, normally, require Sailor escort. With increase # SF personnel, more TA4 jobs can be completed.	No
9	H	WESS (mishaps)	Number of MISHAPS and HAZREPS	LT Danielle Gray, (619)437-3070 danielle.gray@navy.mil	Safety data	Monthly	30 day delay in reporting	No
10	H	Sick call visits	IDCs on board each ship	Rob Gerardi, NCCOSC, robert.d.gerardi3.ctr@mail.mil (619) 532-7474	Number of sick call visits	Monthly		No
11	H	Suicide related behaviors	OPNAV N17	Eric Randolph, eric.randolph@navy.mil	Number of suicide related behaviors	Monthly	FORCE CHAPS	No
12	H	Number of alcohol related incidents	Force ADCO / LegalO	CNSP N1C	Number of alcohol related incidents	Monthly		No
13	H	NJP (COs mast)	Ship's records	XO, Legal Officer or MA	Number of CO's Mast	Monthly		Yes
14	H	Sleep	Sleep watches, logs	Nita Shattuck	Duration, efficiency	subset of crew	Decide on department or rates on which to	No
15	H	Sleep quality history	Pittsburg Sleep Quality Index	Nita Shattuck	Score on PSQI	all crewmembers (if possible)	3 minutes	No
16	H	Insomnia	Insomnia Severity Index	Nita Shattuck	Score on ISI	all crewmembers (if possible)	1 minute	No
17	H	Daytime sleepiness	Epworth Sleepiness Scale	Nita Shattuck	Score on ESS	all crewmembers (if possible)	1 minute	No
18	H	Psychological mood	Profile of Mood State	Nita Shattuck	Score on POMS	all crewmembers (if possible)	5 minutes	No
19	H	Resilience/Organizational climate	Questions from SET	Nita Shattuck	Responses on Resilience questions	all crewmembers (if possible)	2 minutes	No
20	O	Time to Accomplish Ammo Onload	Ship Logs (Deck Log, Smooth Log)	Ship WEPS	Time to conduct Ammo Onload	Once per training cycle		Yes
21	P	Fit and Fill	COGNOS	CNSP N13 (PSC Perez)	Fit and Fill Percentages	Monthly	Test ship should have 100% Fit to DSMD reqmts throughout BP	No
22	P	Number of unplanned losses	BBD / ARIS Comms with Ship	Ship PERSO	Number of unplanned losses by type (medical, legal, etc.)	Monthly		Yes
23	P	Internal TADs (FSAs, ER09 DCPOs)	Ship-Reported	Ship PERSO	Which personnel are being utilized in	Monthly	See if Test Ship utilizes increased manning	Yes
24	P	Elapsed time to process transfers	Ship-Reported	Ship PERSO	Time (days) gains and losses are submitted to PSD (average)	Monthly	Data may be able to be accessed remotely by CNSP N1 / PRAT	Yes
25	P	Turnover rate (in % of Department)	Ship-Reported	Ship PERSO	Turnover rate	Monthly	Total turnover / total dept.	Yes
26	p	Number of days underway each month	Ship-Reported	Ops Officer	Number of days underway each month	Monthly		Yes
27	P	Sailors working >12 hour days underway	Ship-Reported	Department Head	Sailors working >12 hour days u/w	Monthly		Yes
28	P	Sailors working >10 hour days inport	Ship-Reported	Department Head	Sailors working >10 hour days inport	Monthly		Yes
29	P	Number of Tiger Team hours outside of Department	Ship-Reported	Department Head	Number of Tiger Team hours outside of Department	Monthly		Yes
30	P	% COB Sailors not mustering for work	Muster Report	Ship PERSO	Number of assigned Sailors absent from ship on routine basis	Weekly	Total not mustered (average M-F) / COB.	Yes
31	P	Number of Leave days taken	Muster Report	Ship PERSO	Number of days of leave taken by Sailors	Monthly		Yes
32	S	Actual vs. posted hours that ship's store is open	Ship-Reported	Ship SUPPO	Number of hours ship store is open	Weekly	Metric to evaluate tasking of SHs outside of S3 division.	Yes
33	S	Supply Management Score (SMC)	ATG/CNSP N41	CDR Sheffield CNSP N41 CDR James Newton ATG	SMC Score	Once per cycle		No
34	S	Material Outstanding File (MOF) Percentage	R-SUPPLY	LCDR Henley CNSP N41 jarred.henley	Do all outstanding requisitions older than 5 days, have valid and current, supply status.	Weekly		No
35	T	Did Sailors Qualify for Basic Quals in required time	R-ADM	Ship TRAINO	- 3M 301 Maintenance Man - Basic DC (DC 301-306) - Advanced DC (DC 307-308) - QA Craftsman (301) - SRF Basic	Once per training cycle	total # qualified in time / total number eligible to be qualified give answer as a %	Yes
36	T	Number of ESWS Pins Earned	FLTMPS	CNSP N13 (PSC Perez)	Number of Sailors qualify ESWS	Monthly		No
37	T	Divisional Training Time	R-ADM	Ship TRAINO	Hours spent on Divisional training	Monthly		Yes
38	T	ASA Checksheet Discrepancies	ASA Checksheets	Ship TRAINO	Number of discrepancies on warfare area and Engineering management program Afloat Self-Assessment checksheets	Quarterly	# of discrepencies / total number Give number as a %	Yes
39	T	Time to set Material Condition of Readiness / EMCON / HERO	Ship Logs (Deck Log, Engineering Log, Smooth Log)	Ship TRAINO	Best time to set various readiness conditions - ZEBRA setting at GQ - HERO - EMCON	Monthly		Yes
40	T	Number of Sailors in port/stbd watch-rotation	Condition III watchbill	Senior Watch Officer	Number of Sailors in port/stbd watch-rotation	Monthly		Yes
41	T	Number of days in schools for CIN, NEC or other shipboard requirement	CANTRAC / Ship Muster (possibly ship PB4T weekly presentation?)	SURFOR N7 &/or FLTMPS	Lost 'work days' from ship for a Sailor, based on availability of seats and location of schoolhouse	Bi-Weekly		No
42	T	Total number of hours allocated to All-Hands Call, DV visits.	Ship Internal documentation - POD/POW	Ops Officer	Number of hours not-available for individual work for maintenance, personal time.	Monthly		Yes

APPENDIX J. PARTICIPATION BY DATA COLLECTION PERIOD BY RANK GROUP AND DEPARTMENT

A. SHIP A

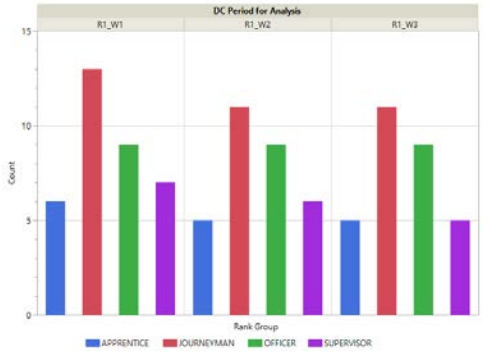


Figure 21. Ship A Data Collection 1 Participant Summary, by Rank Group

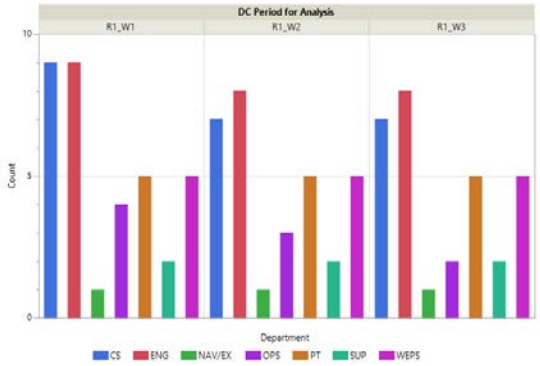


Figure 22. Ship A Data Collection 1 Participant Summary, by Department

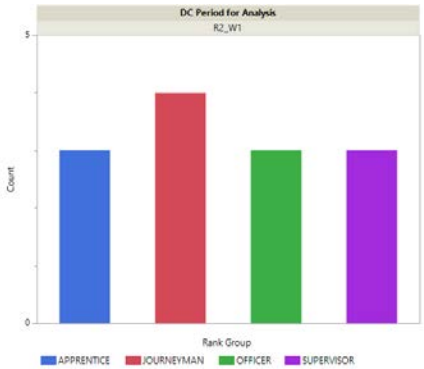


Figure 23. Ship A Data Collection 2 Participant Summary, by Rank Group

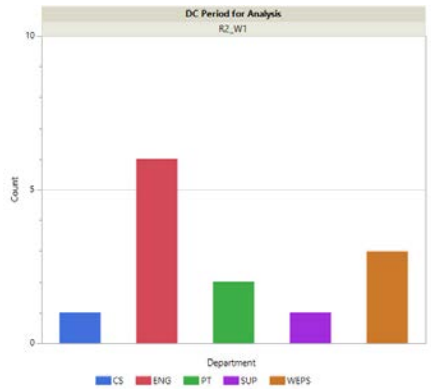


Figure 24. Ship A Data Collection 2 Participant Summary, by Department

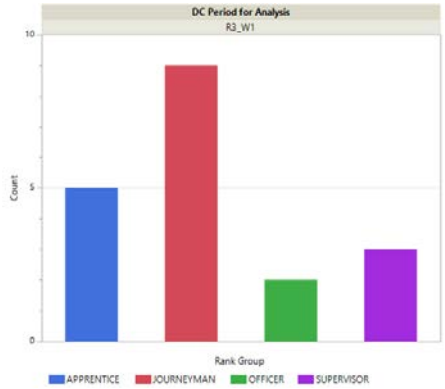


Figure 25. Ship A Data Collection 3 Participant Summary, by Rank Group

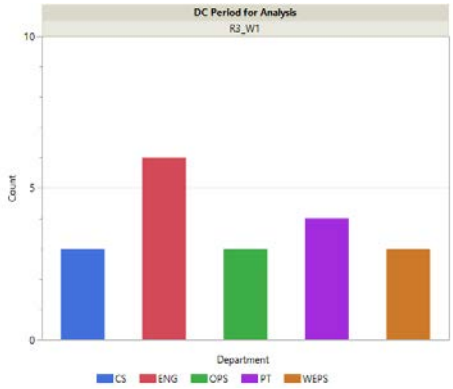


Figure 26. Ship A Data Collection 3 Participant Summary, by Department

B. SHIP B

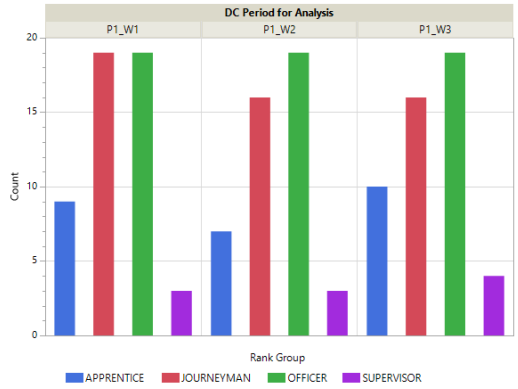


Figure 27. Ship B Data Collection 1 Participant Summary, by Rank Group

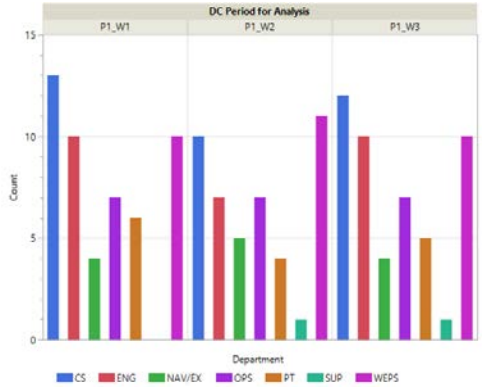


Figure 28. Ship B Data Collection 1 Participant Summary, by Department

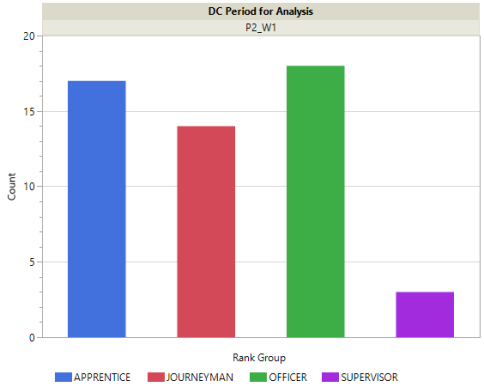


Figure 29. Ship B Data Collection 2 Participant Summary, by Rank Group

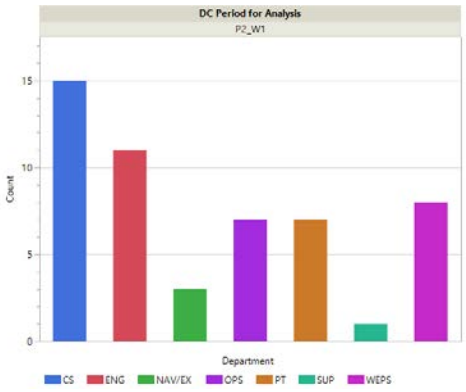


Figure 30. Ship B Data Collection 2 Participant Summary, by Department

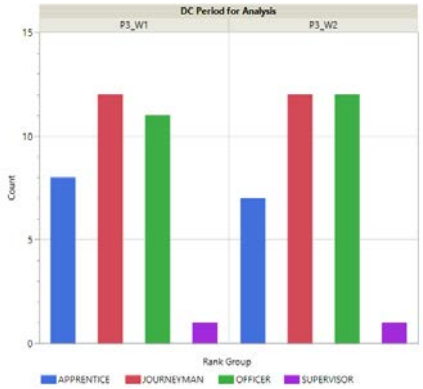


Figure 31. Ship B Data Collection 3 Participant Summary, by Rank Group

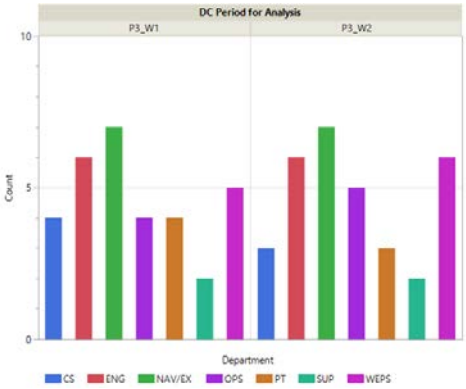


Figure 32. Ship B Data Collection 3 Participant Summary, by Department

LIST OF REFERENCES

Bastien, C. (2001). Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Medicine, 2*(4), 297–307. https://doi.org/10.1016/S1389-9457(00)00065-4

Boschert, A. (2018). *An analysis of manpower, personnel, and financial policy decisions on DDG 51 Flight I class ships* (Naval Postgraduate School Master's thesis). Retrieved from Calhoun.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Commander, Naval Surface Force, U.S. Pacific Fleet. (2018a). *Comprehensive Review item 38: Inspections, certifications, assessments, and assist visits reductions out brief* [Final Out Brief]. San Diego, CA: Commander, Naval Surface Force, U.S. Pacific Fleet.

Commander, Naval Surface Force, U.S. Pacific Fleet. (2018b). *Comprehensive Review item 38: Inspections, certifications, assessments, and assist visits reductions out brief* [Working Out Brief]. San Diego, CA: Commander, Naval Surface Force, U.S. Pacific Fleet.

Department of Defense. (2005). *Guidance for manpower management* (DoD Directive 1100.4). Washington, DC: Department of Defense.

Department of the Navy. (2014). *Optimized fleet response plan* (OPNAVINST 3000.15a). Washington, DC: Department of the Navy.

Department of the Navy. (2017a). *Comprehensive review of recent surface force incidents* [Memorandum]. Norfolk, VA: U.S. Fleet Forces Command.

Department of the Navy. (2017b). *Fleet manpower requirements determination (FMRD): Aviation criteria status report*. Millington, TN: Navy Manpower Analysis Center.

Department of the Navy. (2017c). *Inport workload assessment model beta test Jan-Jul 2017* [Action Memorandum, Ser 00/260]. Millington, TN: Department of the Navy.

Department of the Navy. (2017d). *Required operational capabilities and projected operational environment for (Arleigh Burke) class guided missile destroyers* (OPNAV INSTRUCTION F3501.311C). Washington, DC: Department of the Navy.

Department of the Navy. (2019a). *Navy total force manpower policies and procedures* (OPNAVINST 1000.16L CH-2). Washington, DC: Department of the Navy.

Department of the Navy. (2019b). *Readiness Reform Oversight Committee (RROC)* [Memorandum]. Retrieved from Department of the Navy website: https://assets.documentcloud.org/documents/5751002/RROC1YR.pdf

Department of the Navy, & Commander, Naval Surface Force Atlantic/Pacific. (2016). *Surface force readiness manual* (COMNAVSURFPAC/COMNAVSURFLANT INSTRUCTION 3502.3A). San Diego, CA: Department of the Navy, & Commander, Naval Surface Force Atlantic/Pacific.

Fletcher, C. L. (2018). *The unresourced burden on United States Navy sailors at sea* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/58294

Government Accountability Office. (2010). *Military readiness: Navy needs to reassess its metrics and assumptions for ship crewing requirements and training* (GAO-10-592). Washington, DC: U.S. Government Printing Office.

Government Accountability Office. (2016). *Military readiness: Progress and challenges in implementing the Navy's optimized fleet response plan* (GAO-16-466R). Washington, DC: U.S. Government Printing Office.

Government Accountability Office. (2017a). *Navy force structure: Actions needed to ensure proper size and composition of ship crews* (GAO-17-413). Washington, DC: U.S. Government Printing Office.

Government Accountability Office. (2017b). *Navy readiness: Actions needed to address persistent maintenance, training, and other challenges facing the fleet* (GAO-17-798T). Washington, DC: U.S. Government Printing Office.

Green, K. Y. (2009). *A comparative analysis between the Navy standard workweek and the actual work/rest patterns of sailors aboard U.S. Navy frigates* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/4434

Haynes, L. E. (2007). *A comparison between the Navy standard workweek and the actual work and rest patterns of U.S. Navy sailors* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/3298

Holzbach, J., & Williams, H. L. (1976). *Enlisted manning levels and ship performance* (No. NPRDC-TN-76-9). Retrieved From Navy Personnel Research and Development Center San Diego CA website: http://www.dtic.mil/docs/citations/ADA141452

Insomnia severity index (ISI). (n.d.). Retrieved January 7, 2019, from http://mapi-trust.org/questionnaires/isi/

Johns, M. (1991). A new method for measure daytime sleepiness the Epworth sleepiness scale. *Sleep*, *14*(6), 540–545. Retrieved from http://epworthsleepinessscale.com/wp-content/uploads/2016/06/a_new_method_for_measure_daytime_sleepiness_the_epworth_sleepiness_scale1.pdf

Johns, M. (1992). Reliability and factor analysis of the Epworth sleepiness scale. *Sleep*, *15*(4), 376–381. https://doi.org/10.1093/sleep/15.4.376

Kerno, K. M. (2014). *An analysis of warfighter sleep, fatigue, and performance on the USS Nimitz* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/43937

Mason, D. R. (2009). *A comparative analysis between the Navy standard workweek and the work/rest patterns of sailors aboard U.S. Navy cruisers* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/4541

McNair, D. M., Heuchert, J. P., & Lorr, M. (2005). *Profile of mood states: Technical update*. North Tonawanda, NY: Multi-Health Systems Inc.

NAVMAC. (2017, October 12). *Final report—Inport workload assessment*.

Quester, A. O., & Marcus, A. J. (1989). *How OPTEMPO, crew turnover, and material condition affect the training readiness of surface combatants* (Research Memorandum No. CRM 88–246; p. 30). Alexandria, VA: Center for Naval Analyses.

Shattuck, N. L., Matsangas, P., & Brown, S. (2015). *A comparison between the 3/9 and the 5/10 watchbills* [Technical Report]. Retrieved from Monterey, California, Naval Postgraduate School website: https://calhoun.nps.edu/handle/10945/45008

Surface Warfare Enterprise. (2018). *2018 comprehensive review item 38: Inspections, certifications, assessments, and assist visits reductions* [Memorandum]. San Diego, CA: Surface Warfare Enterprise.

Young, R. L. (2013). *A comparison of sleep and performance of sailors on an operationally deployed U.S. Navy warship* (Naval Postgraduate School Master's thesis). Retrieved from https://calhoun.nps.edu/handle/10945/37748

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California