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Comparison of the Watchstanding, Training, and Maintenance Processes Between the U.S. Navy Fleet and the U.S. Merchant Marine

June 2022

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Prepared for the Naval Postgraduate School, Monterey, CA 93943

ACQUISITION RESEARCH PROGRAM
DEPARTMENT OF DEFENSE MANAGEMENT
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ABSTRACT

Recent GAO reports indicate that Navy watchstanding, training, and maintenance systems need improvement. This thesis compares (a) watchstanding regulations in the Merchant Marine to the standard watch rotation used in a Navy warship, (b) training processes and requirements for Merchant Marine Officers to those of a SWO, and (c) maintenance processes used in the Merchant Marine to offer alternative processes to those present in the U.S. Navy. Review of literature and interviews with Navy Officers and Merchant Marine Officers provide insight into the processes used in both industries. Results indicate that the Navy implements inconsistent watchstanding practices; struggles to provide adequate training through a "jack-of-all-trades" training style of officers in order to qualify them in navigation, engineering, and combat departments; and uses aging maintenance tracking systems to maintain readiness. The Merchant Marine follows the strict Standards of Training, Certification, and Watchstanding (STCW) regulations; has separate career ladders and licensing for deck and engineering officers; and uses different maintenance tracking methods. Results of the study led to several recommendations, among them to leverage licensed Merchant Mariners in the Navy's Strategic Sealift Officer (SSO) program to augment Navy vessels and encourage cross-pollination of talents.

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First and foremost, I would like to thank God. I can wholeheartedly say that I have felt Your guidance in my life, providing me challenges to test my strength but never leaving my side. Thank You for patiently waiting for me to find You again.

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Finally, a shout-out to the U.S. Merchant Marine Academy, the original institution that tried to teach me how to properly manage my time. Acta, non verba.

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LIST OF ACRONYMS AND ABBREVIATIONS

3 A/E	Third Assistant Engineer
ADOC	Advanced Division Officer Course
AIS	Automatic Identification System
AQD	Additional Qualification Designation
BDOC	Basic Division Officer Course
CFR	Code of Federal Regulations
CIC	Combat Information Center
CO	Commanding Officer
CPR	Cardiopulmonary resuscitation
GAO	Government Accountability Office
GPA	Grade Point Average
HSI	Human System Integration
IMO	International Maritime Organization
ISEA	In-Service Engineering Agent
LCS	Littoral Combat Ship
MARAD	Maritime Administration
MMC	Merchant Marine Credential
MSC	Military Sealift Command
NAVDORM	Navigation Department Organization and Regulations Manual
NAVEDTRA	Naval Education & Training
NAVMAC	Navy Manpower Analysis Center
NAVSEA	Naval Sea Systems
NOBC	Navy Officer Billet Classifications
NSWCPD	Naval Surface Warfare Center Philadelphia Division
OCS	Officer Candidate School
OOD	Officer-Of-the-Deck
PIC	Person-In Charge
RCM	Reliability Centered Maintenance
RMC	Regional Maintenance Center
SMD	Ship Manpower Document

SSOP	Strategic Sealift Officer Program
SSP	Subspecialty
STBD	Starboard
STCW	Standards of Training, Certification, and Watchkeeping
SWO	Surface Warfare Officer
SWOS	Surface Warfare Officer School
TAO	Tactical Action Officer
UN	United Nations
USCG	United States Coast Guard
USCGA	United States Coast Guard Academy
USMMA	United States Merchant Marine Academy
USNA	United States Naval Academy

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I. INTRODUCTION

> It follows then as certain as that night succeeds the day, that with out a Decisive Naval force we can do nothing definitive. and with it every thing honourable and glorious.[1]
>
> — President George Washington

June 17 2017, the USS Fitzgerald (DDG 62) collided with the *ACX Crystal* on its Port side, tearing open a hole on the starboard (STBD) side of the *Fitzgerald*. The Officer Of the Deck (OOD) started watch shortly before the incident. The *USS* Fitzgerald was navigating south of the Japanese coast. There were no ships tracked on the Automatic Identification System (AIS), but the Tactical Action Officer (TAO) in Combat Information Center (CIC) was tracking 5 targets on the SPS-67 radar. This radar had a known issue and had to be refreshed to update the position of the radar return. In addition, the return contained a large amount of clutter. According to Connor & Powley, "The CO's [Commanding Officer] standing order was for him to be called if there were any contacts within ten thousand yards" (Connor & Powley, 2020, p. 3)

The conditions were clear, and visibility was unrestricted. At 0120, the lookout saw a ship approaching on the starboard side, but the OOD was not concerned. CIC provided no information on this target to the pilot house. At 0130, it became obvious that the vessel was on a collision course, but by then it was too late. The OOD had "started her day 22 hours earlier and had caught about an hour of rest" (Connor & Powley, 2020, p. 3). Why did these officers receive so little rest? On the surface, it appears that there were no rules or regulations in place to protect these officers and insure they were rested enough for the job.

Two months later, the USS John S. McCain (DDG 56) experienced a loss of steering while maneuvering in the crowded Strait of Malacca. Although both collisions happened in rapid succession, the cause was different. When the ship entered the straits,

[1] Quote from Founders Online, https://founders.archives.gov/documents/Washington/99-01-02-07408.

the sailors assigned to the helm were temporarily assigned from the USS Antietam (CG 54) *and* were not familiar with the steering system on the USS John S. McCain (DDG 56). When the CO noticed that the helmsman was struggling, he ordered the helm be split between the two stations: a helm responsible for steering control, and a lee-helm responsible for throttle control. Due to the lack of experience, the helmsman transferred both steering and throttle control to the other station, causing the rudder to move from 1–4 degrees right rudder to amidships. The helmsman interpreted this as a loss of steering control.

In response to the perceived loss of steering, the CO ordered the lee-helm to reduce speed from 20 to 10 knots. The vessel has two throttle levers for the two shafts. The lee-helmsman lowered the port throttle thinking that it would control both shafts. This lowered the speed of the port shaft while the STBD shaft continued at the previously ordered speed. The combination of a rudder stuck amidships and the STBD shaft moving while the port slowed down caused the ship to turn to port onto a collision course with the vessel Alnic MC. "'The commanding officer and others on the ship's bridge lost situational awareness,' the report states. 'Personnel assigned to ensure these watchstanders were trained had an insufficient level of knowledge to effectively maintain appropriate rigor in the qualification program. The senior most officer responsible for these training standards lacked a general understanding of the procedure for transferring steering control between consoles'" (LaGrone & Werner, 2017). The government investigation of this incident admits to training downfalls that were part of the cause of this incident. What kind of training would be necessary to ensure sailors are better prepared in hectic situations?

All the proposed solutions to the Navy Surface Fleet to prevent accidents like this revolved around three major areas: training, watch standing, and Human Systems Integration (HSI). But unfortunately, the Navy has not properly addressed the underlying issues. "'I'm concerned that this reveals an underlying problem still facing the Navy—that it simply is not putting enough sailors on the ships to cover the workload,' Pendleton said at a Dec. 12 congressional hearing" (Doornbos, 2019). The Navy is struggling to find enough trained sailors to fill the required billets. Due to the lack of personnel, the existing personnel are required to work long hours. "GAO (Government Accountability Officer)

Defense Capabilities and Management director John Pendleton said many sailors on two Yokosuka-based ships he visited on a research trip last fall reported heavy workloads and 100-hour workweeks" (Doornbos, 2019). In addition, due to long deployments, the Navy struggles to keep up with maintenance and dry-docking requirements of ships. "In 2018, just 29% of ships came out of their maintenance availabilities on time, former head of the surface navy Vice Adm. Rich Brown said at the 2020 Surface Navy Association annual conference" (Eckstein, 2022). The Navy must better address training, watchstanding procedures, and ship readiness concerns brought up prior to the two collisions in 2017 if it wishes to maintain a strong fleet to continue its operations overseas.

A. PROBLEM STATEMENT

Although the Navy has taken steps to address the issues identified by working groups and the GAO, many parties are not convinced the Navy has done enough.

> One officer said Navy leaders are misrepresenting how well-trained their crews are by temporarily loaning specialists from his destroyer to other ships just before their crews undergo testing. Ships that cannot meet new training and staffing goals are nonetheless granted special permission and sent to sea. Another officer said higher-ups had raided his destroyer for parts to ensure that other warships were ready to deploy. (Miller & Faturechi, 2019)

This thesis compares the Navy surface community's watchstanding, training, and engineering processes as a whole with parallel processes in the commercial maritime industry. Because the civilian world does not operate weapons, it will focus on the navigation and maintenance of Navy vessels. The reasoning behind why the Merchant Marine was chosen for this analysis is to provide a new perspective. The Navy has a rich history rooted in tradition, but not adapting to changing environments has led to the downfall of many organizations. Other government sectors, such as software development, have looked to the commercial world to better improve the aging government processes. By taking a similar approach, this thesis aims to show how commercial practices can be leveraged on individual Navy vessels to improve watchstanding processes, increase the quantity and quality of training, and reduce vessel downtime due to maintenance related causes.

B. MOTIVATION

I attended United States Merchant Marine Academy (USMMA) and graduated on June 17th, 2017, the day of the *USS Fitzgerald* collision. My experience during undergraduate studies included sea time onboard two commercial ships, one Military Sealift Command (MSC) ship, and a tugboat, where I went overseas and learned about Merchant Marine plant management, ship maintenance, and the overall culture of the shipping industry. Course work at USMMA also included lessons by Naval officers to prepare midshipmen for their careers as Ensigns, either active duty or in the Naval Reserve. Some of my classmates sailed on Surface Warfare ships as part of their sea years to gain experience in the active-duty field. They would compare how differently the U.S. Navy operated compared to the Merchant Marine. After graduation, I received a bachelor's degree in Marine Engineering Systems, a commission in the United States Naval Reserve as a Strategic Sealift Officer (SSO), and a license as a Third Assistant Engineer.

To fulfill their service obligations, graduates must work in the commercial industry as Maritime officers for five years and remain in the Naval Reserve for eight years. If the graduates choose to pursue a career in the active-duty military, they must serve for six years. Unfortunately, the available jobs in the American shipping industry are decreasing. As a result, Maritime Administration (MARAD) has authorized waivers to working in the commercial industry as government employees in an agency that relates to the maritime field. Upon graduation, I applied for a waiver and took a job at Naval Surface Warfare Center, Philadelphia Division (NSWCPD) as a mechanical engineer supporting steering and navigation systems for the Littoral Combat Ship (LCS) class platform. By working as a government employee, I have received experience in the Navy surface fleet through many ship visits and underways to supplement my experience in the Merchant Marine Fleet.

One of the findings of the two collisions was that poor design of the steering system led to a perceived loss of steering. As a result, Naval Sea Systems (NAVSEA) headquarters tasked NSWCPD to analyze all the Navy ship classes for all potential causes of actual and perceived losses of steering. This was my primary job upon starting work at NSWCPD. I analyzed the steering system of the LCS Freedom class and identified all possible ways the system could fail, ways the system could be perceived to fail, ways that a loss of rudder

indication can occur, and analyzed training and technical documentation. I have been very involved with the collisions and have worked with many parties concerned with the accidents. Unfortunately, the solution of analyzing the steering system only solves part of the issue.

I am currently working on implementing the solutions identified in my report. These issues will address the engineering defects of the ships. In addition, NSWCPD is attempting to find ways to make the ship steering systems more uniform across the different platforms.

Finally, I have many classmates who are officers in the active-duty surface and submarine fleets. Talking with them about their experiences is a major inspiration for writing this thesis. Many of their complaints are not listened to, and this thesis aims to voice their concerns. Many great officers have aimed to solve the problems that lead to the collisions, but the goal of this paper is to offer a perspective of someone with experience in multiple fields who has been deeply involved since the beginning.

C. RESEARCH QUESTIONS AND OBJECTIVES

This thesis will analyze Navy shipboard manning through three different questions:

- How do U.S. Navy watchstanding processes contrast with the regulations used in the commercial industry?
- How does Navy officer training compare to Merchant Marine officer training?
- How does the Navy manage maintenance requirements compared to the Merchant Marine?

The objective is to look at these three problem areas in the Navy and show how they are impacting the Navy's readiness. This thesis will then look to the commercial industry to compare how similar issues are tackled. The goal is not to offer radical solutions to these problems, but rather small changes to try and make incremental improvements to the Navy's effectiveness.

D. SCOPE OF THESIS

This thesis will focus on the manning and management of individual Navy ships. It will examine how watchstanding is handled in the bridge and engine room; it will not examine management beyond the level of an individual ship, such as how groups of ships are managed by the squadrons and commodores. This thesis will focus on training for junior officers (JO), and not focus on training for enlisted sailors or more senior officers. This thesis will not analyze specific engineering issues found on Naval ships, since NAVSEA has already performed similar analyses.

E. SUBJECT MATTER EXPERT DISCUSSIONS

This thesis will supplement prior research with discussions with subject matter experts (SME). Lieutenant Junior Grade (LTJG) David Harland, Lieutenant (LT) Alejandro Mata, and 2nd Assistant Engineer (2 A/E) Vincent Breglia participated. LTJG Harland and LT Mata were both graduates of USMMA. LTJG Harland has experience sailing as a deck cadet on a Roll-on Roll-off cargo ship, two container ships, the USMMA training vessel, and as a Midshipman on the USS John S. McCain (DDG 56). He graduated with a degree in marine transportation and a third mate's license and began his career as a Surface Warfare Officer (SWO). He began his career on the USS Russell (DDG 59) where he sailed as the auxiliary officer (AUXO) and earned his SWO qualification. He is currently Navigator on the USS Preble (DDG 88). Harland was chosen due to his experience and licensure as a third mate in the merchant marine. He has experience as both a deck and engineering officer in the U.S. Navy. His perspective will be informed with experience in multiple departments and industries.

LT Mata graduated from USMMA with a degree in marine engineering and a license as a third assistant engineer. He began his tour as a SWO on the USS John Paul Jones (DDG 53) where he earned his SWO qualification. He began as a navigation officer before being assigned to a position in the engineering department. He is currently stationed on the USS Chief, a minesweeper. Much like LTJG Harland, he was chosen due to having experienced both industries and both departments but licensed as an engineer instead of a navigator.

Finally, the third SME is 2 A/E Vincent Breglia, who graduated from the State University of New York (SUNY) Maritime college with a degree in marine engineering and a Third Assistant Engineer license. He has experience as a cadet on the T/S Empire State, and experience as an assistant engineer on several Merchant Marine ships. He requested to not disclose the company he is working for. He has experience as a more senior engineering in the Merchant Marine to supplement what the other SMEs have to say, due to them not being in the industry for as long. The goal of these interactions is to provide new perspectives from subject matter experts that may not have been considered by career Naval officers.

F. THESIS ORGANIZATION

Chapter II provides an overview of the concepts, organizations, and systems addressed in this thesis. Chapter III contains a literature review of previously submitted research on the three areas being examined. Chapter IV presents the data to be analyzed. Chapter V analyses the problem description and examines the data. Chapter VI provides thesis conclusions and recommendations for future manning structures.

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II. BACKGROUND

> Human experience shows that people, not organizations or management systems, get things done. For this reason, subordinates must be given authority and responsibility early in their careers. In this way they develop quickly and can help the manager do his work. The manager, of course, remains ultimately responsible and must accept the blame if subordinates make mistakes.[2]
>
> — ADM Hyman Rickover

A. THE MAKING OF A US NAVY SURFACE WARFARE OFFICER

A naval officer's career in the surface navy fleet starts after graduation from college, or as an enlisted member of the Navy going through an enlisted-to-officer program. College graduates must have attended the Naval Academy, a qualified Reserve Officers' Training Cops (ROTC) program, or attend Officer Candidate School (OCS) to earn a commission as an Ensign in the Navy. The specific requirements are: a student must graduate from a university with a grade point average (GPA) of at least 2.75, be a born or naturalized citizen, be at least 19 but not older than 29 years old, and pass the physical requirements (Kingston, 2022).

The next step starts with Basic Division Officer Course (BDOC) at Surface Warfare Officer School (SWOS). BDOC serves to create a foundation for new officers to ensure they're ready for their first tour. It offers training on engineering, leadership, damage control, navigation, seamanship, and ship handling. Upon graduation from BDOC, officers are sent on their first deployment on a Navy ship. While onboard the ship, Navy officers are assigned to a job on the vessel and given a Personnel Qualification Standard (PQS) book to complete. During their first sea tour, an officer may also attend Advanced Division Officer Class (ADOC), which reinforces the concepts in BDOC while leveraging the experience an officer gained while shipboard. ADOC focusses on advanced qualifications required for their Surface Warfare Officer (SWO) qualification. Upon successful

[2] Quote from govleaders https://govleaders.org/rickover.htm

completion of the required PQS and demonstration of adequate knowledge of shipboard knowledge and leadership, the final step is an oral examination. The officer must attend an oral examination chaired by the commanding officer and comprised of other qualified SWOs. The officer must complete the entire process at any time prior to their second deployment (Winston & Brown, 2018). Shown in Table 1 are the required PQSs that an officer must accomplish to earn their SWO qualification.

Table 1. Required PQS

Course Number	Training Title
NAVEDTRA 43119	Basic Damage Control
NAVEDTRA 43241	Maintenance and Material Management System
NAVEDTRA 43463-1	Division Officer Afloat
NAVEDTRA 43397	Inport Officer of the Deck
NAVEDTRA 43152	Small Boat Officer
NAVEDTRA 43101-3	SWO Engineering
NAVEDTRA 43101	Combat Information Center Watch Officer
NAVEDTRA 43385-9	Anti-Terrorism Watch Officer
NAVEDTRA 43101	Qualify and serve successfully as an underway officer of the deck

Table constructed using DOD Memorandum COMNAVSURFPAC/COMNAVSURFLANT INSTRUCTION 1412.1A

When a SWO first gets on a vessel, they begin with on-the-job training (OJT). They are not fully prepared for ship handling, engineering, or combat systems after completing SWOS. They are given a PQS book and are required to get signatures for all the above items stating that they are competent and qualified in that aspect. Looking at the chart, it becomes clear that an officer is not specialized in the U.S. Navy. They are required to receive qualifications in engineering, navigation, and combat billets alongside more general qualifications, such as damage control. A Navy officer, in fact, never follows a specialized career field and is expected to have experienced all departments prior to a tour as a Commanding Officer, with the exception of Limited Duty Officers, who start their careers as enlisted sailors. This is in stark contrast to the Merchant Marine.

B. THE MAKING OF A MERCHANT MARINE OFFICER

The licensing, certification, and training of a Merchant Marine officer is handled by the United States Coast Guard (USCG). The primary way that a Merchant Marine officer is trained is through the state funded maritime academies, and USMMA. The entire deck and engine applications are referenced in appendix A and B respectively. The general requirements are that the applicant must be a U.S. citizen, at least 19 years of age, hold a USCG medical certificate, pass a drug test, and paid the fees. The sea service requirements are where getting a Coast Guard license becomes difficult. If the applicant is an unlicensed sailor, they need 1080 days of sea service, with 720 of those days as an able-bodied (AB) seamn for a third mate's license, or as a qualified member of the engine department (QMED) for a third assistant engineer's license. The sea service is waived if the applicant is a graduate of USMMA, USCGA, United States Naval Academy (USNA), or a state maritime academy. Applicants with Accreditation Board for Engineering and Technology (ABET) accredited degrees can apply with 180 days of sea service. Depending on what the tonnage of vessel the applicant is applying for, there are requirements that the sea service be on vessels of that tonnage or horsepower. The applicants must take cardiopulmonary resuscitation (CPR), first aid, basic firefighting, and advanced firefighting courses within 5 years of applying. Then finally, the applicant must take the coast guard exams and pass with a 70% or higher for most exams, or a 90% or higher on select deck officer exams.

C. STANDARDS OF TRAINING, CERTIFICATION, AND WATCHKEEPING

In the commercial sector, Standards of Training, Certification, and Watchkeeping (STCW) is the primary guidance for how long sailors are allowed to work in a day, and how much rest they must receive. The International Maritime Organization (IMO) enforces the STCW requirements, which were adopted in 1978. Prior to STCW, watchstanding requirements were the responsibility of the countries that flagged the vessels. Naturally, this led to different requirements depending on the nationality of the vessel. In addition, this caused issues when crewmembers from countries different from the country the ship is registered were not familiar with the different standards. STCW was formed to create a standard that applied to ships and crews of all nationalities. The requirements apply to

officers and unlicensed crewmembers and has requirements in fire prevention, first aid, launch and recovery of survival craft, ETC (Maritime Skills Academy, 2022). The STCW regulations are amended if necessary to ensure they apply as technology changes. STCW also outlines rest requirements for the sailors. In STCW 2010:

A. Sailors must have a minimum of 10 hours of rest in any 24 hour period
B. Sailors cannot work more than 77 hours in a 7 day period
C. The rest hours cannot be divided into more than two periods
    a. One of which must be at least six hours in length
    b. Interval between periods shall not exceed 14 hours (MI News Network, 2021)

D. APPLICABLE CODE OF FEDERAL REGULATIONS

There are two Code of Federal Regulations (CFRs) that apply to the United States Merchant Marine: Title 33 and 46. Title 33 outlines requirements for navigation and navigable waters. This chapter starts by describing the organization of the Coast Guard, but then goes into details on requirements for navigation in U.S. waters. An example is Chapter I, which includes information on Aides to Navigation. This then gets further broken down in who participates, how to mark items of interest, such as buoys, and gives information on who is responsible for maintaining them. As an engineer, the most important CFR is 33 CFR § 164.25-Tests before entering or getting underway. This CFR details all the steering checks that must be completed prior to going underway and ensures that the steering system and all its back-ups are functioning prior to committing to a maneuver (Code of Federal Regulations, Title 33)

Title 46 goes into detail on the shipping industry. Things of note that are included are training requirements, ship design requirements, and cargo handling. In Chapter I, subchapter B, it details how to obtain the Merchant Mariner Credential (MMC), how to obtain an officer endorsement, and requirements for specific credentials, like the Tankerman-Person In Charge (PIC). Subchapter F contains information on vessel design. There are multiple subchapters that detail requirements for different types of cargo vessels. Chapter II outlines the requirements for MARAD (Code of Federal Regulations, Title 46).

E. INTERNATIONAL MARITIME ORGANIZATION

The United Nations (UN) formed the IMO "to create a level playing field so that ship operators cannot address their financial issues by simply cutting corners and compromising on safety, security and environmental performance. This approach also encourages innovation and efficiency" (International Maritime Organization, n.d.). The IMO covers ship design, manning, operation, and disposal to attempt to standardize the industry and ensure many practices are addressed by different nations. The first task the IMO performed was the creation of the Survival of Life at Sea (SOLAS) regulations. This standardized the shipboard requirements for safety equipment. The IMO then moved on to create the Maritime Pollution (MARPOL) regulations to address oil pollution, as well as other forms such as trash and sewage. The commercial maritime industry must follow these laws, and much of the ship's design and daily operation is influenced by these requirements. The U.S. Navy, on the other hand, is not held to these laws the same way the Merchant Marine is.

1. Survival of Life at Sea (SOLAS)

SOLAS is an IMO treaty that establishes the safety measures in construction, equipment, and operation of Merchant Marine ships. It is divided into fourteen chapters. Chapters of note are II, which outlines fire protection, detection, and extinction, Chapter III which outlines the lifesaving equipment required, Chapter IV which outlines requirements for communications, and Chapter V which outlines safety of navigation. The Maritime industry is concerned with these regulations because they contain requirements for running drills, and inspections of life-saving equipment. The Navy has its own requirements for drills and safety equipment that exceed the requirements in SOLAS (Wankhede, 2022).

2. Maritime Pollution (MARPOL)

MARPOL is an IMO treaty that establishes regulations to protect the environment against ship pollution. It is divided into 6 annexes; I-Regulations for the prevention of pollution by oil; II-regulations for the control of pollution by noxious liquid substances; III-prevention of pollution by harmful substances carried by sea in packaged form; IV-

prevention of pollution by sewage; V-prevention of pollution by garbage; and VI-prevention of air pollution from ships. Annex I outlines the requirements to have an oily-water separator if the ship is designed to discharge oily waste over the side. This piece of equipment is designed to separate the water from oil, and the waste can be discharged once it reads less than 15 parts per million (PPM) oil. Annex IV details how grey and black water must be handled. It specifies how far away from shore you must be to discharge grey water, and the requirements for treating black water before it can be discharged over the side. Annex V mainly details when food and paper waste can be thrown over the side. The rest must be contained onboard and discharged ashore (Kantharia, 2021).

F. MILITARY SEALIFT COMMAND

Sealift of supplies for the military is provided by Military Sealift Command (MSC) and the commercial maritime sector. MSC is made up of government owned vessels operated by government employees called civilian mariners (CIVMAR). The Military Sea Transportation Service (MSTS) was founded after WWII to create a single managing agency for the nation's sealift needs. The MSTS was renamed to MSC during the Vietnam war. MSC has several different ship types that perform different missions for the Navy. The Fleet Oiler (PM1) fleet is comprised of the Henry J. Kaiser (T-AO) class which provides Underway Replenishment (UNREP) support, sending supplies while underway, to Navy ships. The Special Mission (PM2) fleet provides unique capabilities to the Navy, such as oceanography vessels or cable layers. The Prepositioning Force (PM3) is made of container ships and vessels that can carry rolling stock. The Service Support (PM4) fleet includes command vessels like the USS Mount Whitney (LCC 20) and hospital ships like the USNS Comfort (T-AH 20). The Sealift Program (PM5) is made up of many different types of ships that can deliver military cargo. Fleet Ordnance and Dry Cargo (PM6) fleet is primarily made up of the Lewis and Clark (T-AKE) class, which provides UNREP services for dry cargo to Navy warships, such as ammo and food. Finally, the Expeditionary Fast Transport (PM8) made up of the Spearhead Class (T-EPF) can support a wide range of missions but are primarily used as fast troop transports (Military Sealift Command, n.d.).

G. READY RESERVE FLEET

The Ready Reserve fleet is a small fleet of MARAD owned vessels that exist to support the deployment of the U.S. military in times of conflict. These vessels are pre-positioned in areas around the country and are crewed 24/7 to ensure the Navy can quickly deploy these vessels to meet sealift demands if necessary. These vessels must reach full readiness status within five to ten days (MARAD, 2022).

H. STRATEGIC SEALIFT OFFICER PROGRAM

The Strategic Sealift Officer Program (SSOP) is an arm in the U.S. Naval Reserve that supports the military's sealift requirements and capabilities during peace and war. The SSOP was founded to ensure the Navy had qualified and licensed merchant marines at its disposal to provide the Navy with manpower for MSC and Ready Reserve Fleet ships in times of conflict. To join the SSOP, one must first possess an MMC with a mate's or assistant engineer's license. The most common method is to attend one of the maritime academies and opt to participate in the program to receive tuition assistance. Upon completion of their college program, they must complete 8 years in the SSOP and must maintain their U.S. Coast Guard MMC. In the case of USMMA, all graduates must either participate in this program, or join the military in an active-duty capacity. The most common way to participate is as an Individual Ready Reserve (IRR) member. This means that the sailor performs one two-week Active-Duty Training (ADT), sails on a vessel as their civilian career, and maintains their readiness status while they are in the program. For sailors that have transitioned shoreside, they are given the option to join the Selected Reserve (SELRES), where you do a traditional program with one drill weekend every month, and one two-week Annual Training (AT) per fiscal year (United States Merchant Marine Academy, 2014).

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III. LITERATURE REVIEW

> A Captain of the Navy ought to be a man of Strong and well connected Sense with a tolerable Education, a Gentleman as well as a Seaman both in Theory and Practice, for, want of leaning and rude Ungentle Manners are by no means the Characteristick of an Officer.[3]
>
> —John Paul Jones

A. WATCHSTANDING

Watchstanding is the practice of assigning sailors to jobs at scheduled times to ensure a vessel can operate continuously. These jobs can involve driving the ship or maintaining the propulsion plant. For both the U.S. Navy and the U.S. Merchant Marine, watchstanding is a crucial part of the daily operations for a vessel. Watches are divided into time spent on watch, and time spent resting or performing regular work duties. An example is a 4 hours on/ 8 hours off rotation (4/8), where a sailor will spend 4 hours in the morning on watch, and 8 hours resting or performing day work duties such as maintenance. They will then stand another 4 hours of watch in the afternoon and get another 8 hours of rest. As example of this could be standing watch from 0400–0800. The sailor will then have breakfast, and work until lunch time: 0800–1200. They may then get four hours of rest time, 1200–1600, before returning to watch 1600–2000. They will then rest until they begin watch at 0400 the next morning. Duty sections are what the watch teams are referred to. In the example of a 4/8 schedule, you need three duty sections to ensure there is someone on watch during all 4 hours blocks of a day. Table 2 visualizes this type of watch rotation.

[3] Quote from *The Long Road to Annapolis: The Founding of the Naval Academy and the Emerging American Republic.*

Table 2. 4/8 Three Section Duty Watch Rotation

Time	Duty Section One	Duty Section Two	Duty Section Three
0000-0400	Watch	Rest	Rest
0400-0800	Rest	Watch	Rest
0800-1200	Day Work	Rest	Watch
1200-1600	Watch	Day Work	Daywork
1600-2000	Rest	Watch	Rest
2000-0000	Rest	Rest	Watch

In the U.S. Navy, there are few references that outline watch schedule requirements. The *Watch Officers Guide* outlines best practices for Navy watchkeeping but does not recommend or outline any specific type of watch rotation (Stavridis, 2020). OPNAVINST 3120.32C outlines standard watches but does not mandate COs follow or implement these guidelines. In the U.S. Merchant Marine, there are no regulations that specify what watch rotation must be used, but rather how much rest each crew member must receive. STCW 2010 outlines the requirements and watch rotations are up to the discretion of the Master and the vessel owners so long as the crew maintains their rest hours. In addition, in the U.S., 46 CFR CFR § 15.1111 provides regulations on work hours and rest periods:

1. Every person assigned duty as officer in charge of a navigational or engineering watch, or duty as ratings forming part of a navigational or engineering watch, or designated safety, prevention of pollution, and security duties onboard any vessel that operates beyond the boundary line, as described in part 7 of this chapter, must receive -
    a. A minimum of 10 hours of rest in any 24-hour period; and
    b. 77 hours of rest in any 7-day period (Work Hours and Rest Periods, 2022)

No studies were found during this literature review that examined watch rotation effectiveness in the U.S. Merchant Marine, and a few studies analyzed impacts to the circadian rhythm, which will be discussed in the following section. Regarding the U.S.

Navy, Roberts (2012) compared different watch rotations on the USS Jacinto. They found that with the minimal manning being implemented on U.S. Navy ships under something called "Optimal Manning," 3/9 watch rotations performed best with four sections of duty, 4/8 worked best for three sections, and 12/12 worked best for two sections.

B. CIRCADIAN RHYTHM

Our bodies operate on a 24-hour cycle called the Circadian Rhythm. The most apparent aspect of this rhythm is the sleep-wake cycle. This rhythm operates on cues from nature, such as the sunlight. This impacts aspects of the entire body such as protein production in the digestive system in preparation for meals. When this rhythm is thrown off, it can create problems such as insomnia, and affect alertness and coordination (Suni, 2022).

The Circadian Rhythm is important to examine with respects to watchstanding due to the irregularity of watch rotations. No matter which rotation a sailor is on, they will have to be awake at unnatural hours. Regarding the Navy, as previously mentioned, there are no specific regulations outlining which watch rotation to utilize. The watch officer will choose a rotation that will help them accomplish the mission, but the most common is 5 hours on, 15 hours off rotation (5/15). Kerno (2014) examined the impact of crew restfulness aboard the USS Nimitz (CVN 68) on their performance based on Navy watchstanding requirements. He found that officers on a 4 hours on/20 hours off watch schedule demonstrated more consistent sleep when compared to the 5/15 schedule. Yokeley (2012) compared the typical 5/15 watch rotation to the 3/9 on the USS Jason Dunham (DDG 109). He found that the crew had a measurable increase in performance while following a watch rotation that followed the natural circadian rhythm.

In the Merchant Marine, the most common watch rotation is a 4/8, where watch standers will stand two 4 hours watches, one in the morning and another in the afternoon. Sanquist, Raby, Forsyth, & Carbalhais (1997) studied the Merchant Marine and their 4/8 watch schedule. They found that on average, mariners received 6.6 hours of sleep in fragmented periods of less than 5 hours. The watchstanders on the 0400–0800 rotation were found to be most impacted by lack of sleep.

C. TRAINING

This background section details the process to becoming a SWO and becoming a Merchant Marine Officer. The major difference is that a freshly graduated third mate or third assistant engineer is expected to be fully proficient in their duties fresh out of the gate; little OJT needs to be provided by the crew and no formal training needs to be offered by the vessel owner. Licensed mates and engineers keep up on refresher courses through their union throughout their career and get licensed for higher positions through the U.S. Coast Guard. The U.S. Navy, on the other hand, must train all their officers from scratch. A freshly commissioned Ensign is not a professionally licensed mariner, so the Navy and the vessel the sailor is assigned to must provide all training and certification.

Since the Navy must provide all training for new recruits, they begin by sending new officers to BDOC and putting them on a first tour to receive OJT and earn their qualification. Wilson and Olsen's (2018) interviewed former BDOC staff and students to identify weaknesses in the SWOS model and provided recommendations on ways to improve SWO training. Their recommendations included increased BDOC staff, including officers with Additional Qualification Designations (AQDs) billeted to BDOC to offer advanced training and knowledge, and to implement a Yard Patrol (YP) training craft program similar to that at the USNA.

A SWO is expected to earn their qualification within two years, which is contrasted by the maritime academies that take three years of classroom education and one entire year at sea as a cadet to be allowed to sit and take an exam to earn their professional license. A comparison of classroom-based training with more on-the-job training showed that the Navy invests a similar amount in both programs, but a heavier OJT curriculum increases the burden on ships to perform training for JOs, and produces less confident officers (Macaluso, 2011).

One major note is that even when a SWO earns their SWO pin, they are not licensed as a third mate or third engineer. The Navy qualifies them to navigate and maintain a vessel, but according to Coast Guard regulations, are not licensed to be officers on a commercial or MSC ship. CAPT Nygaard (USN, Retired) (2015) compares the SWO credentialling to

that of the aviation and diving communities. He states that SWOs leave active duty with no credentials and must spend significant time and money to develop civilian skills because their military skills and accomplishments are not valued or accepted. In other words, a qualified SWO cannot become a Merchant Mariner without investing in licensure and training.

D. MANPOWER

In the U.S. Navy, the Navy Manpower Analyses Center (NAVMAC) performs studies for all the Navy's ship classes and develops a Ship Manpower Document (SMD) to outline manning requirements. Sometimes, these manning requirements cannot be reached due to the levels of sailors available. When the Navy cannot meet the SMD requirements, this is called "Standard manning." Garbacz (2013) compared two Destroyers' manning levels, one which receives a standard level of manning, and another that receives additional sailors to meet the full SMD requirements. The study showed that crew members on the vessel with increased manning worked an average of .8 hours less a day.

In contrast, the rules that outline how a Merchant Marine Ship should be manned are found in IMO resolution A.1047(27). This resolution states that minimum safe manning is the number of sailors needed to navigate the vessel, transport the cargo, and protect the environment safely and securely. It is the responsibility of the owner to develop a minimum manning document and have it approved by IMO. This means that crew compliment varies by ship, but still must be approved by an authority.

One ship class to note is the Littoral Combat Ship (LCS) platform, which has the most limited manning for a surface combatant. An LCS uses a 3:2:1 rotation, where three crews are assigned to two ships, with one ship on deployment. This is like the Merchant Marine, where a ship will have two crews that rotate (30 days on-30 days off for example) to ensure the vessel can remain operational throughout the year. Pantaleo (2013) compared the minimal LCS manning structure to similar smaller surface combatants, such as the old Frigate class and minesweeper. Unfortunately, Pantaleo's finding was that officers on these ships were understaffed and overworked while trying to work around a 5/15 watch rotation.

One other issue in the Navy to note is retention issues for high-ranking officers.

> If you do pick up, you'll be offered to sign the department head retention bonus of $155 thousand dollars for your first look, decreasing as it goes through as an incentive to try and stay in. Navy obviously has a manning problem to support the number of department heads, and then the number of XO's and CO's they need (LTJG Harland, 2022).

Cassels (2016) examined the retention bonus structure to offer alternatives. They distributed surveys to SWOs to gather data on officer retention. It showed that the Navy could save money by changing the way the Navy offers retention bonuses. This research paper did not consider the possibility of changing the training pipeline or making specialized career routes. Supplementing Navy crews with CIVMARs is another alternative that has been explored. Ewing (2010) wrote about a study that U.S. Navy fleet officials were performing to analyze the impacts of fielding hybrid crews aboard amphibious ships. The reasoning for performing this study was because the Navy has seen good results when they transitioned the fleet oilers (T-AO) to be fully staffed by CIVMARs. They found that CIVMARs cost less than active-duty sailors, keep equipment in better shape, and free up active-duty sailors for destroyer and cruiser platforms.

E. ENGINEERING PRACTICES

Vessel navigation is the primary focus of the navigation department. The Engineering department is primarily concerned with plant management and maintenance management. The three types of maintenance are preventative, predictive, and corrective maintenance. Preventative maintenance is what engineers spend most of their time doing. This is maintenance that is done to "predict" problems in the future, such as an oil change for your car. Predictive maintenance is the use of tools to analyze the performance of a piece of equipment. An example would be a vibration test of an engine or motor. A sensor can be attached to the equipment to gather vibration data. A history of this data can be used to determine if a failure is likely to occur in the future. Finally, corrective maintenance is what is done after a piece of equipment has broken. You are "correcting" the discrepancy, such as replacing a flat tire.

The Navy uses the Planned Maintenance System (PMS) to schedule maintenance based on time. The Merchant Marine will use software, such as the American Bureau of Shipping's (ABS) Nautical Systems (NS) Enterprise (Discussion with 2 A/E Breglia). Engineers will input the run time of all equipment, and this software will bring up all maintenance that the manufacturer recommends be done at that interval. There are very limited studies done on maintenance processes in the U.S. Navy. Duncan & Hartl (2015) examined the contract vehicles that the government use to procure labor related to vessel maintenance. They found that Multiple Aware Contract-Multiple Order (MAC-MO) contracts were effective in increasing competition and improved the quality of work packages. Alexander (2020) examined the planned depot maintenance of the U.S. Coast Guard's shipboard davit system. They recommended gathering the davit failure and maintenance data for each ship and to use this to determine what factors are causing the davits to fail.

Although maintenance in the Navy or Merchant Marine has not been analyzed, Busch (2007) examined maintenance processes in the aviation industry, which follows similar processes of planned maintenance with the occasional overhaul. He found that taking a Reliability-Centered Approach to maintenance could ease maintenance responsibilities and improve equipment reliability.

F. SUMMARY

Regarding watchstanding, the Navy does not have regulations on how COs must implement watch rotations and it is largely dependent on mission requirements. Some watch rotations that are more effective than others for accomplishing mission requirements and crew size must be considered. The watch rotation can have a huge impact on a sailor's circadian rhythm, which in turn can have detrimental effects on a sailor's ability to complete mission tasks. When training sailors, the Navy relies heavily on OJT to bring new sailors up-to-speed, which impacts the quality of training received. On top of this, the Navy is having trouble retaining sailors, causing a drought of more senior officers.

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IV. DATA

> They have delivered the goods when and where needed in every theater of operations and across every ocean in the biggest, the most difficult and dangerous transportation job ever undertaken. As time goes on, there will be greater public understanding of our merchant fleet's record during this war.[4]
>
> —President Franklin D. Roosevelt

A. WATCHSTANDING IN THE U.S. NAVY

1. Manpower

Manning requirements in the Navy are handled by the Navy Manpower Analysis Center (NAVMAC). Manpower Requirements are defined as the minimum number of billets needed so that 100% of scenario-based missions can be accomplished. The requirements in the Ship Manpower Document (SMD) are written to the minimum skill, pay grade, and quantity. Every ship in the Navy has an SMD tailored specifically for its needs. A good SMD to examine and compare to the Merchant Marine is for the LCS class, due to the smaller manning requirements. To create an SMD, NAVMAC determines which officers are needed using the Navy Officer Occupational Classification System (NOOCS). There are four categories within this system. The first is the Designator, which is the code given to a specific job an officer has. The Navy Officer Billet Classifications (NOBC) describes general occupational duties. The Subspecialty (SSP) is used to identify postgraduate degrees or equivalent experience. Finally, the Additional Qualification Designations (AQD) are any qualifications not captured in any of the other codes (Military Personnel Plans and Policy Division, 2011).

Table 3 shows the preliminary SMD created by the Program Executive Office for the LCS 2 class.

[4] Quote from American Merchant Marine. http://www.usmm.org/quotes.html

Table 3. LCS Officer Manpower Requirements (PEO, 2012)

Billet Title	**Rank**	**Designator**	**NOBC**
CO	CDR	1110	9235
XO	LCDR	1110	9228
OPS	LT	1110	9275
CSO	LT	1110	9261
CICO	LTJG	1110	9217
EMO	LTJG	1110	9283
CHENG	LT	6130	9364
MPA	LTJG	1110	9336

The Commanding Officer (CO) is responsible for the entire ship and is similar in duties to the master of a Merchant Marine ship, with the added responsibility of combat knowledge. The Executive Officer (XO) is the second in command and ensures that the CO's orders are carried out. The equivalent Merchant Marine rank is a chief mate. The Operations Officer (OPS) is responsible for coordinating the ship's operations, training, and tactical planning. These job duties also mirror what a chief mate is responsible for on a merchant ship. The Combat Systems Officer (CSO) is responsible for the ship's combat department. This could be comparable to the chief mate's duties as they are responsible for all cargo operations on a commercial ship. The Combat Information Center Officer (CICO) is responsible for all CIC equipment handling. There is not a Merchant Marine position that mirrors this. The Electronic Materials Officer (EMO) is responsible for shipboard electronic equipment maintenance. In the Merchant Marine, there is typically not an officer responsible for electronic equipment, but Merchant Marine electronics are considerably simpler compared to a Navy warship. The Chief Engineer (CHENG) is responsible for managing the operation and maintenance of the engine department, which is like a Chief Engineer on a Merchant Marine vessel. Finally, the Main Propulsion Assistant (MPA)

assists the CHENG, similarly to the First Assistant Engineer in the Merchant Marine (NAVPERS 1589I, 2022).

2. Watch Rotation Requirements

a. Deck Department

In the Navy, the bridge team composition is defined by the *Navigation Department Organization and Regulations Manual* (NAVDORM). This document specifies how many watch standers you need and exactly what level of qualification is required for each watch position. This changes depending on what kind of maneuvers are being performed. To begin, the primary crewmember responsible for the safety of navigation of the ship is the CO. The NAVDORM lists more detailed requirements for the CO with respect to navigation. During all restricted water transits, the XO is expected to be readily available to assist the CO and Navigator as necessary. The NAVDORM specifies that the XO must review the navigation brief, supervise the Navigator and navigation team, and perform any other roles assigned to them by the CO (*NAVDORM,* 2010*)*.

The CO will designate a Navigator to be responsible, under their delegation, for safe navigation of the ship. They must receive all orders from the CO. They must utilize all navigation tools at their disposable, maintain communication with the CIC, notify the CO, OOD, and Conning Officers if the vessel is approaching a danger, ensure that the Electronic Charting Display and Information System (ECDIS) has the latest electronic charts available, and organize the navigation bill. In some cases, an Assistant Navigation (ANAV) can be assigned to assist the Navigator in all aspects of Navigation. The ANAV will also be formally designated by the CO (*NAVDORM,* 2010).

The NAVDORM describes additional positions that must be filled. A Navigation Evaluator verifies the accuracy of the ship's position through electronic or visual means. A Navigation Plotter maintains the navigation plot by plotting and labelling in fix on the chart in use. A Bearing Recorder relays information via the internal telephone circuit from the navigator to the Navigation Plotter. Bearing Takers obtain accurate bearings to navigation aids that the Navigator designates. A fathometer (a piece of equipment that measures the depth below the ship's keel, the lowest centermost part of the ship) operator,

who reports soundings to the Bearing Recorder. The Quartermaster of the Watch (QMOW) is an enlisted sailor who works directly with the Navigator in navigating the ship. The Piloting Officer communicates with the Navigation Evaluator and Shipping Officer and ensures the accuracy of the ship's position via the ECDIS. A Navigation Radar Operator keeps the Navigation Plotter aware of all radar ranges. A Navigation Plotter is responsible for the CIC's navigation plot. The Navigation Recorder monitors the Bridge Bearing Recorder and the Fathometer Operator via the phone system. The Bridge CIC Phone Talker can be made responsible for providing a smooth flow of information to the Navigator. Finally, a shipping officer communicates with the Piloting Officer and Bridge Phone Talker and provides reports to the conning officer. Table 4 is from the NAVDORM that lists the qualifications required for the Navigator, senior Quartermaster, and QMOW (*NAVDORM,* 2010):

Table 4. Qualification Requirements for Navigator, Assistant Navigator, Senior Quartermaster, and Quartermaster of the Watch

Requirement	**Navigator**	**Carrier Navigator/ ANAV**	**Senior Quartermaster**	**Quartermaster of the Watch**
Bupers Assigned	No	Both	No	No
Qualified OOD Underway	Yes	OOD qualified within six months of reporting	No	No
Successful Completion of the Following:				
SWOS Advanced Shiphandling	No	Completed for carrier Navigators	No	No

Requirement	Navigator	Carrier Navigator/ ANAV	Senior Quartermaster	Quartermaster of the Watch
Navigator/senior QM refresher course	Yes	Both	Yes	No
VMS Operator Course	Yes	Both	Yes	Yes
Radar Operator PQS	Yes	Yes	Yes	Yes
Navigator/ANAV PQS	Yes	Yes	Yes	No

Table copied from the NAVDORM.

There are many sailors involved in the watch team. During normal underway maneuvers, there are three major officers in charge: The Officer of the Deck (OOD), Junior Officer of the Deck (JOOD), and the conning officer. The OOD oversees the watch team overall. The JOOD is their assistant. The conning officer in the primary looking and gives orders to the helmsman. A PORT, STBD, aft, and forward lookout assist in providing visual fixes of other vessels or hazards that the OOD must be aware of. A helmsman is responsible for driving the vessel. The QMOW mans the ECDIS and serves as the Navigator's representative on the bridge (conversation with LTJG Hardland).

Restricted maneuvering is anytime the vessel is performing complex maneuvers, primarily entering port and getting underway. While performing restricted maneuvering, the bridge can have up to fifteen people, including the CO, just focused on Navigation of the ship. While performing regular underway operations, there will be three officers and six to seven enlisted in the bridge. "All in all, to be in 4 watch rotations, you're talking 40 plus people involved in navigating the ship throughout a 24-hour day" (LTJG Harland, 2022).

Additionally, there is no Navy regulation on how many hours you can stand at a time. An Officer can stand a watch rotation which could be five hours on watch, with ten hours off, or five hours on watch and fifteen hours off. You can expect to work a typical workday in addition to the watch standing, and there is no one keeping track of how many hours you work to ensure you are getting adequate rest (conversation with LTJG Harland).

b. Engineering Department

Similarly to the Deck department, the engineering department has an *Engineering Department Organization and Regulations Manual* (EDORM) that specifies what the major roles are that must be filled on a vessel. It also specifies additional positions required during restricted maneuvering and makes special considerations for different types of propulsion plants. The EDORM specifies that the CO is responsible for the operation of the engineering plant. The XO is designated as the integrated training team leader. The Chief Engineer (CHENG) is appointed by the CO and is responsible for ensuring the department properly maintains and manages the propulsion plant (*EDORM,* 2010).

Directly below the CHENG is the Main Propulsion Assistant (MPA), who handles tasks as delegated by the CHENG. The Damage Control Assistant (DCA) is responsible for limiting the impact of battle damage, such as controlling the stability, list, and trim of the vessel when taking on water. The Auxiliary Officer (AUXO) is responsible for auxiliary machinery equipment. The Electrical Officer (EO) is responsible for the electrical plant. These are the main engineering officers, but there are other roles that can be added as necessary (*EDORM*, 2010).

The engine plant can be in one of four states: cold iron, auxiliary steaming when you are running the auxiliary generators for power in port, full underway operations, and restricted maneuvering. At any given time, the engine plant has an Engineering Officer of the Watch (EOW), a propulsion auxiliaries control console operator, an electrical plant control console operator, engine room operators in each of the main engine rooms, the propulsion systems monitor, the auxiliary systems monitor, and the sound and security. This totals to around 13 to 15 people on watch at all times to operate the engineering plant. Unlike the Merchant Marine, the U.S. Navy never has an unmanned engine room, which

will be explained in the following section. The plant is manned 24/7 when underway (conversation with LTJG Harland).

3. Navy Watch Rotations

The most common watch rotation in the Navy is a rotating five hours on/15 hours off (5/15) schedule. The biggest problem with this type of rotation, is that a sailor on this watch rotation does not follow a 24-hour day schedule, but instead an 18- or 20-hour day. In a three-section (three different teams that rotate when they are on watch) watch rotation, watches begin at 0200, 0700, 1200, 1700, and 2200, which the final 2200 watch lasting four hours. Due to this odd number of hours, this results in starting watch at a different time every week.

According to research done by Shattuck and Matsangas (2015), crew members on a 5/15 schedule reported elevated levels of fatigue. "Over an entire 3-day rotation cycle, a crewmember on the 5/15 watch standing schedule sleeps at three distinctly different times on subsequent days. Our findings suggest that the 5/15 schedule yields poor quality sleep that has less recuperative value." (Shattuck & Matsangas, 2015) They reported a significant decrease in mood by the end of the two-week period. More importantly, the study found that they had worse psychomotor vigilance performance than crews that used 6 hours on, 18 hours off or 3 hours on, 9 hours off watch rotation. The report suggests that the likely cause was poor sleep hygiene due to disrupting the internal circadian rhythm. Their results suggest that 5/15 watch rotations should be avoided (Shattuck & Matsangas, 2015).

B. WATCHSTANDING IN THE MERCHANT MARINE

1. Manpower

In a typical Merchant Marine ship, such as a container ship, the crew may be comprised of little more than 20 members. This is typically up to the discretion of the vessel owner. In the United States, the deck department will have five officers: the master, chief mate, second mate, and two third mates. This is supplemented by an unlicensed Bosun, and around three Able-Bodied (AB) Seamen. The Engine Department typically has four officers: a Chief Engineer, First Assistant Engineer, Second Assistant Engineer, and Third

Assistant Engineer. This is supplemented by three to five unlicensed crewmembers depending on the demands of the vessel, such as a refrigeration engineer for vessels carrying refrigerated cargo containers. Finally, the steward's department, responsible for the hospitality of the crew, will have a Chief Steward in charge of the department, a Chief Cook who prepares meals, and a Steward's Assistant who assists the chief steward and cook in the kitchen, and cares for the living quarters of the vessel.

2. Watch Rotation Requirements

a. Deck Department

During underway operations, a deck watch rotation will be comprised of the mate on watch, which is either one of the Third Mates or the Second Mate, along with an AB. The AB serves as the lookout, while the mate handles navigation. While performing docking and getting underway, the number of people in the bridge does not increase by much. One of the junior mates is sent ahead on the bow, and another is sent astern. Both are responsible for managing the line handlers. The pilot house will then have a helmsman responsible for steering the vessel, a few lookouts, and the mate on watch. They are supplemented by the Master and Chief Mate. The vessel will pick up a Harbor Pilot, a licensed sailor who has extensive knowledge of the port, to help guide the vessel in. The Pilot, under the watch of the Master, makes recommendations to the helm for a proper approach to port.

During these maneuvers, the Merchant Marine uses the smallest amount of manpower possible to achieve objectives. This is where STCW comes into play. When using a small crew, it is important that they be well trained. STCW details the amount of training required for all the officers and unlicensed members to ensure they are competent in their positions. Then, on top of this, STCW regulates the number of hours each member is allowed to work. The Chief Mate is responsible for managing every crew members' hours through a computer system provided by the vessel owner. This will track how many hours a crew member worked, how many hours they stood watch, and how many hours of rest they received. As mentioned previously, every sailor must have at least 10 hours of rest in any 24-hour period, cannot work more than 77 hours in a 7-day period, and the time

spent resting cannot be divided into more than two periods (MI News Network, 2010). This is done for safety, to ensure the crews are not being overworked.

b. Engineering Department

An internal combustion diesel engine is the most common type of propulsion plant in the Merchant Marine. These types of plants operate in an "unmanned" status, meaning there is not an engineering watch 24/7. The engineers begin their day around 0800 and spend the day working on planned maintenance. They will work around 8 hours, with a long lunch break, and clock out unless there is a demand for overtime work. Once all the engineers are clocked out, the engine room is the responsibility of the duty engineer. The third, second, and first assistant engineers rotate being on duty. The alarm system is routed to their stateroom, and they are on-call for the whole day in the event of an alarm. Since diesel plants have a high amount of automation, there is no need to have the engine room manned while underway.

> We have our logbooks that will keep track of attendance status and its attendance status to the engineering department, and then we also have a program "WATCHKEEPER" which will log their hours and make sure that we're within regulation of OPA [Oil Pollution Act] and, you know, OSHA [Occupational Safety and Health Administration] and things like that to make sure that we're compliant with all those. So, if you do get an alarm in the middle of the night, you check your hours, you stay down for "x" hours, again, as much rest as needed to put you back into compliance (2 A/E Breglia, 2022)

While performing maneuvers, the engine room is manned 24/7, typically by the first assistant engineer and a senior unlicensed crewmember. They will stay in the engine control room to manage the plant while underway. Some vessels will have an officer standby in the steering gear room, to be on deck in the event of a steering failure. The rest of the engineers will do non-invasive work, while the vessel docks. It is the first assistant engineer's responsibility to ensure the engineers are following the same STCW regulations.

3. Merchant Marine Watch Rotations

The most common type of watch rotation in the Merchant Marine is four hours on, eight hours off (4/12). With this type of watch rotation, a crew member will stand watch

twice a day, for four hours each time, and with eight hours off watch. The first eight-hour block during the day is partially spent doing regular day work, with the second eight-hour block used for rest. According to the *Crew Endurance Handbook* published by the Naval Postgraduate School Crew Endurance Team, this type of watch follows the natural circadian rhythm. It states that this type of watch rotation also allows sailors to get into a routine since the watches land on the same time every day. The downside of this type of rotation is that one of the watch rotations, 0000 to 0400 has awkward rest hours and will have to split their sleep between the two rest periods (Naval Postgraduate School, n.d.).

C. U.S. NAVY TRAINING

1. Career Path

The officers in the United States Navy (USN) are more general in their approach to management and are expected to be experts in all three departments on a warship: deck, engine, and combat. Additionally, there are several different ship classes that they can be assigned to and vary extensively in the ship handling characteristics, propulsion plants, and weapons suites. The Navy has adopted a more general career path for SWOs since 1899 when Congress combined the departments (GAO, 2021). Prior to becoming a qualified officer, they are expected to learn about aspects of all three departments. During their career, they could be assigned to any department, only to work in a different department later in their careers. Below is a figure that shows the three phases a SWOs career from entry level to Commanding Officer.

Figure 1. Career Progression and Key Duties U.S. Navy Surface Warfare Officers (SWOs) Perform aboard Ships. Source: U.S. Government Accountability Office (2021).

In addition to being trained in multiple departments, a SWO is also expected to adapt to any ship class. The Navy has stated that the goal of their career path is to create competent COs who have had experience in the four areas of seamanship, combat, engineering, and command and leadership. The methodology is that a CO should be well rounded because understanding how the entire ship works is pivotal in combat roles.

The GAO compared the U.S. Navy Officer career ladder to five foreign Navy's, the USCG, and the USN Submarine Officer career path. Most of these programs start an officer's career path more generally, and then assign them to a specific department as they advance in rank and experience. Most of them separated engineering from the deck and weapons departments and made them a separate career path. One thing to note is that for the navies that separate out departments, only officers in the deck departments are eligible for command of a vessel.

> Unlike some foreign navies, where officers trained in engineer [ing] will only ever be in engineering and not command ships, officers on the bridge will only ever stand bridge watch [and go] into command, and not stand watch [in] combat or engineering, and officers in combat only stand combat watches. The advantage of this is producing well rounded officers and COs who know all aspects of their ship. The downside is you end up with the "Jack-of-all-Trades, master of none," and your average merchant

> mariner with the same number of years as any Surface Warfare Officer is going to be far more adept their specific job, be it engineering or bridge watch. Obviously, there's no merchant marine correlation to combat. (LTJG Harland, 2022)

Interestingly, the GAO investigated the Navy's requirements for new SWOs and found that the Navy commissioned more Ensigns (entry level officers) than it needed:

> We found that the U.S. Navy commissions nearly twice as many SWOs needed to fill junior SWO billets, which can limit training opportunities aboard ships. For example, from fiscal years 2017 through 2021, our analysis shows that the personnel requirement for SWO Ensign—the rank which represents entry-level SWOs—aboard ships averaged 946.42\ During the same time period, our analysis found that the U.S. Navy exceeded its Ensign requirement—referred to as over execution—by an average of 800 Ensigns, or about 85 percent (see fig. 8).43 According to the U.S. Navy's Strategic Readiness Review, for over 20 years, the U.S. Navy has consistently commissioned more SWOs than needed to meet annual personnel needs. (GAO, 2021)

The Navy states that it does this to compensate for low retention of officers at the 8-year mark of their careers, the Department Head level. There is a large retention bonus for officers that get selected for their department head tour while explaining the career ladder in the SWO program. The Navy is working to improve SWO retention by looking at potential incentives. The Navy makes a large investment in training, and when that talent leaves, people need to be trained to make up for that capability. Unfortunately, this means the Navy has a large number of JOs and few senior officers to fill the more specialized billets (conversation with LTJG Harland).

Ziezulewicz (2021) mentions that one of the reasons sailors leave the Navy so early is the reliance on OJT. When a mission needs to be accomplished, "it's often easier for more seasoned SWOs to just do jobs themselves than take the time to teach a junior officer how to do it" (Ziezulewicz, 2021). SWOs complain about having little to do but feeling too awkward to ask for more work. Additionally, moving young officers around different departments doesn't allow them to become specialized and master one aspect of sailing. "'I felt really dumb,' the SWO said. 'I kept getting popped from job to job. You spend so much time trying to cultivate value in yourself'" (Ziezulewicz, 2021).

2. SWO Qualification

Since there are no specific prerequisites to becoming a Surface Warfare Officer, besides general requirements for all officers, the Navy must provide all the training they will need at the start of their careers. SWOs attend SWOS to receive their initial training (BDOC) which offers general training on engineering, leadership, damage control, navigation, seamanship, and ship handling. Each ship has specific requirements on the number of JOs they need, and typically have limited opportunities for training due to mission requirements. Due to the large number of JOs, most ships have more unqualified officers than the manning document requires (GAO, 2021).

> As the U.S. Navy has over-commissioned SWOs to account for periods of low SWO retention to Department Head, it has had to assign SWOs to surface ships above the number requirement for junior SWOs. For example, U.S. Navy officials stated that almost all ships have more SWO trainees than the ship's personnel requirement, particularly if the ship is operational. (GAO 2021)

The large number of young officers competing for limited training makes finding training opportunities to get signoffs for the PQS difficult and competitive. One requirement is to get time driving the vessel, but if there are a lot of Ensigns competing to drive the ship, this limits the amount of time available to each officer. The Navy has a large emphasis on On-the-Job training and expects the vast majority of the qualification process to be completed while performing other duties (GAO, 2021).

3. Surface Warfare Officer Requirements Document

The Surface Warfare Officer Requirements Document (SWORD) outlines the requirements for a SWO at the five major career milestones: Division Officer, Department Head, Executive Officer, Commanding Officer, and Major Commander. It provides a broad guide for a SWO's career progression in their mastery of the four core competencies of fight the ship, drive the ship, manage the ship, and command the ship. A SWO is expected to master all four of these throughout their career progression (Commander, Naval Surface Forces, 2018). LTJG Harland mentions that this is the reasoning of why the Navy trains SWOs in all aspects of the ship. This approach helps produce well rounded officers and COs that know all aspects of their ship, but may not be adept at a specific job.

D. MERCHANT MARINE TRAINING

1. Licensure

As mentioned in the background, Merchant Marine officers are trained through the state funded maritime academies, and USMMA. There is an additional career path for unlicensed mariners to become officers called "Hawse Pipers."

> So, I've noticed just the difference in, in technical ability [of a Hawse Piper], you may have a little more technical and a little bit more theoretical knowledge coming out of the academies, but the hawse pipers have definitely more experience. While we went to school for, you know, took classes those four years, you know, at the age of 18, some of these guys came right out to sea. So, they have four years of actually working with their hands and little bit more of that experience, that you can't get when you just go through an Academy. Granted, yes, there's cadet sailing and there is training ships, but it's just not the same (2 A/E Breglia, 2022).

A program at a maritime academy takes typically four years to complete, and graduates receive a Bachelor of Science degree and a license as a Third Mate or Third Assistant Engineer.

When a Merchant Marine officer graduates from one of the academies (or earns their license) and begins their first job on a vessel, they are expected to hit the ground running immediately. A Third Assistant Engineer or Third Mate is an officer, and there is a level of responsibility and expectation associated with that. Although it is technically an entry level position, these jobs do not have entry level expectations. A Third Mate is expected to stand watch on a vessel 8 hours a day, assist in navigation, perform maintenance duties on the deck of the ship, assist in docking/undocking maneuvers, and be a competent ship handler. The engine department of a merchant vessel is typically composed of less than ten personnel: four officers and around four unlicensed engineers (depending on the ship's needs). Due to the low manpower, a Third Assistant Engineer is typically solely responsible for the Marine Sanitation Device, the auxiliary diesel generators, and the water generation system. These lower-level officers have to step up and handle a large level of responsibility with few other officers to fall back on.

2. Career Path

The entry level positions for the deck and engine departments are the Third Mate and Third Assistant Engineer respectively. The next highest position is the Second Mate and Second Assistant Engineer respectively. To earn these licenses, you need 360 days of sea service while sailing as a Third mate/Assistant Engineer. For engineers, this can get more complex as you require individual licenses for steam, diesel, and gas turbine propulsion plants. Next is the Chief Mate/First Assistant Engineer. For these positions, you need to hold a Second Mate/Assistant Engineer license, and sail for 360 days as Third or Second Mate/Assistant Engineer. The major difference is you also need to sit for an exam to earn this license. The final positions are Master and Chief engineer for the Deck and Engineering departments respectively. To earn these licenses, you need 360 days of service as a Chief Mate or First Assistant Engineer. One thing to note, is that an engineer will never progress through the deck career path and a mate will never be an engineer. The career paths are independent and designed for their respective departments.

3. Advantages of Commercial Crewing Model

There have been several U.S. Navy ships that were previously manned by Navy personnel that transitioned to using fully civilian crews in MSC. Studies have been done on transferring the navigation and engineering responsibilities of the amphibious ships to lower costs.

> Manning a ship with a small number of highly experienced professional mariners would cost less than active-duty sailors, the thinking goes; they would keep equipment in better shape and make sure it lasted longer, and they would free up sailors to take jobs on the cruisers and destroyers that have been suffering from the effects of lean manning (Ewing, 2010).

The Navy transferred the crews of the USS Mount Whitney (LCC 20) from 600 navy personnel to 325 hybrid crew members: 170 active duty and 155 CIVMARs. They retain a Navy CO, but the daily functions are performed by the civilian crew. This shows that with the civilian credentialling model, fewer sailors are needed to accomplish similar tasks. A potential drawback with using a civilian crew on a military ship is that the crew

would have to go into warzones, which comes with issues with the Geneva Convention (Ewing, 2010).

E. U.S. NAVY MAINTENANCE PROCESSES

1. Ship Maintenance Overview

a. Organizational-Level Maintenance

The Navy classifies all maintenance performed by ship's force as Organizational-Level Maintenance. This is the primary responsibility of the ship's engineering department and consists of all maintenance actions that are within the capabilities of the crew and the resources they have available. This includes actions such as facilities maintenance, preventative maintenance, corrective maintenance, and documentation of deferred maintenance actions. Maintenance of the ship is the responsibility of the CO and is typically delegated to the CHENG. Organizational-Level Maintenance is performed through the Planned Maintenance System (PMS), which will be touched on in a later section (OPNAVINST 4700.7M, 2019*)*.

b. Intermediate-Level Maintenance

Intermediate-level maintenance is any maintenance that cannot be accomplished via organizational-level maintenance. Instead of being performed by ship's force, they are performed by a centralized repair facility, primarily the Regional Maintenance Centers (RMC). Government waterfront modernization and maintenance activities are referred to as fleet maintenance activities and they include maintenance functions that are beyond the capability of ship's force. In more severe cases, a Non-Chief of Naval Operations (CNO) Availability can be scheduled. An availability is a period set aside to perform maintenance and modernization. The ship is typically docked pier-side and can vary in length (*OPNAVINST 4700.7M*).

c. Depot Level Maintenance

Depot-level maintenance is comprised of the most invasive maintenance activities which focus on repair, overhaul, rebuilding, upgrading, and modernization activities that are beyond the scope of Intermediate Maintenance Actions. This maintenance can be

performed during CNO-scheduled availabilities, Continuous Maintenance Availabilities (CMAV), and Private Sector Availability if the vessel will not be undertaking maintenance in a public yard. These are scheduled ahead of time and can involve dry-docking the vessel to complete high level maintenance (*OPNAVINST 4700.7M)*.

2. Planned Maintenance System

The Navy performs Operational Level Maintenance, preventative, and corrective, through the Planned Maintenance System (PMS). This is a computer system that identifies maintenance required for a ship and schedules the actions. The PMS is divided into Maintenance Index Pages (MIPs) for specific pieces of equipment. The MIPs are then farther divided into specific Maintenance Requirement Cards (MRCs) that walk the sailor through specific maintenance tasks. The MRCs have a specific Periodicity code to determine when the card is done as outlined in Table 5.

Table 5. MRC Periodicity Codes (NAVEDTRA 14310, 2001)

Code	**Periodicity**
D	Daily
2D	Every 2nd day
3D	Every 3rd Day
W	Weekly
2W	Every 2nd week
3W	Every 3rd week
M	Monthly
2M	Every 2nd Month
Q	Quarterly
4M	Every Fourth Month
S	Semiannually
8M	Every 8th Month
A	Annually
18M	Every 18months

Code	Periodicity
24M	Every 24 Months
30M	Every 30 Months
48M	Every 48 Months
54M	Every 54 Months
60M	Every 60 Months
R	Situational Requirement
U	Unscheduled Maintenance
LU	Lay-Up
PM	Periodic Maintenance
SU	Start-Up
OT	Operational Test

One very important thing to note about the MRC periodicity codes is that they are all time based, except for the "R" cards. This means that even if a piece of equipment was never run, it will have maintenance associated with it based on how much time has elapsed. R cards will have a note that states at how many runtime hours that maintenance must be performed.

3. Condition Based Maintenance

Due to the weaknesses in PMS, the Navy has begun to move towards a Condition Based Maintenance System (CMS). Most equipment does not require repairs based on time, but rather the condition it is in. The goal of the CMS is to reduce operating and support costs, reduce maintenance manhours, and increase readiness. This will require NAVSEA to utilize Reliability Centered Maintenance to determine the correct maintenance intervals for equipment. Although I have found little information on the progress of this new system, OPNAVINST 4790.16B (2015) outlines the Navy's goals to implement this system in the fleet.

4. Regional Maintenance Centers

The Navy's RMCs are the second line of defense when ship's force is not capable of repairing a system with the resources they have available. In the United States, there are three RMCs, the Mid-Atlantic Regional Maintenance Center in Norfolk, Virginia, Southeast Regional Maintenance Center in Mayport, Florida, and the Southwest Regional Maintenance Center in San Diego, California. There are also overseas RMCs that can assist vessels that are forward deployed. They comprise government employees who are experts in different types of systems.

5. Navy Readiness Figures

The Government Accountability Office (GAO) analyzed the maintenance period completions and found that Navy ships spent over 33,700 more days in maintenance than expected. The Navy scheduled 75% of the maintenance periods on time. When a ship does not complete maintenance on time, it is unable to perform mission requirements and cannot begin training prior to deployments. The GAO has found that decreased crew levels, extended deployments, and deferred maintenance were the leading causes of the delays. This report mentions that the Navy has difficult adhering to its maintenance planning process. The crews are having trouble adhering to their own maintenance schedules, causing little issues to become bigger (GAO-20-257T)

F. MERCHANT MARINE MAINTENANCE PROCESSES

The way maintenance is performed in the Merchant Marine is not standardized by any regulations. The vessel owner will implement a system to perform all the maintenance recommended by the OEMs of all the equipment on board. A common software that a shipping company may utilize is "NS Enterprise" to manage all maintenance requirements (discussion with 2 A/E Breglia). All the maintenance required for a piece of equipment is put into this software, whether it is hour based, or time based. Once a week, the engineers inspect all equipment and write down the number of hours it has been running. Every major piece of equipment will have a time on it that tracks how long it has been running. This is put into the software, where it brings up maintenance that is going to be due. When the

maintenance is completed, the engineers input the number of hours the equipment has at the time the maintenance is completed into the software.

G. RELIABILITY CENTERED MAINTENANCE

A different way of approaching equipment maintenance is called Reliability Centered Maintenance (RCM). The DOD commissioned a report on RCM techniques to be used for the aviation industry. Traditional aircraft maintenance defined specific overhaul requirements to ensure equipment reliability. This study found that for complex items, scheduled overhaul had little effect on reliability unless there is a single, dominant, failure mode (Nowlan & Heap, 1978). This study compared the Douglas DC-8 aircraft, which required 4 million man-hours of inspections during the first 20,000 hours of operation, while the Boeing 747 that utilized RCM required only 66,000 man-hours in its first 20,000 hours of operation (Nowlan & Heap, 1978).

Using the RCM approach, components in a complex system are examined. If a component being replaced on a schedule is considered technically feasible (reduces consequences of a failure) or worth doing (the cost is justified), then schedule-based maintenance should be utilized. For all other equipment, it should be dealt with by reactive maintenance, in other words, replace it when it fails, create processes to detect hidden failures, or redesign the system to reduce the consequences of a failure (Busch, 2007).

The typical interpretation of how a piece of equipment fails is that as time passes, the likelihood of failure steadily increases, until it hits a point where the likelihood of failure dramatically increases. The maintenance will then be optimised to replace the component before it reaches this point to prevent future failure from occurring. Figure 2 shows a visualization of this interpretation.

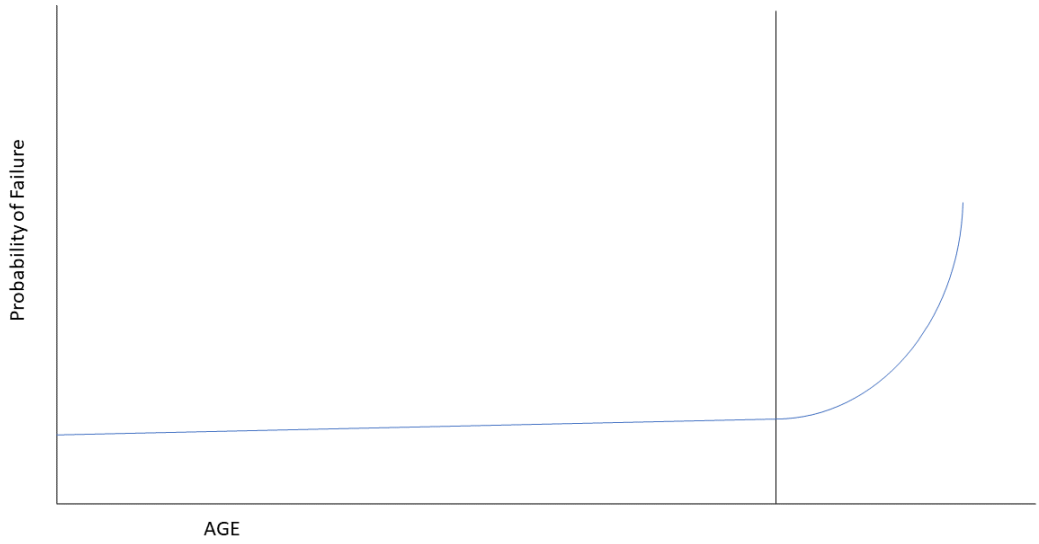

Figure 2. Traditional Failure Plot. Constructed Based on Information in Busch's Research (2007).

The study found that 68% of items followed a high-risk infant-mortality period, with no point where the useful life peaked (Nowlan & Heap, 1978). Figure 3 shows what this type of failure plot looks like. Busch goes on to examine all the components in a piston engine and explains their associated failure plots. Most components displayed this type of failure plot. This meant that by replacing these components often, you are introducing a possibility of failure due to the high probability of infant failure with the new parts.

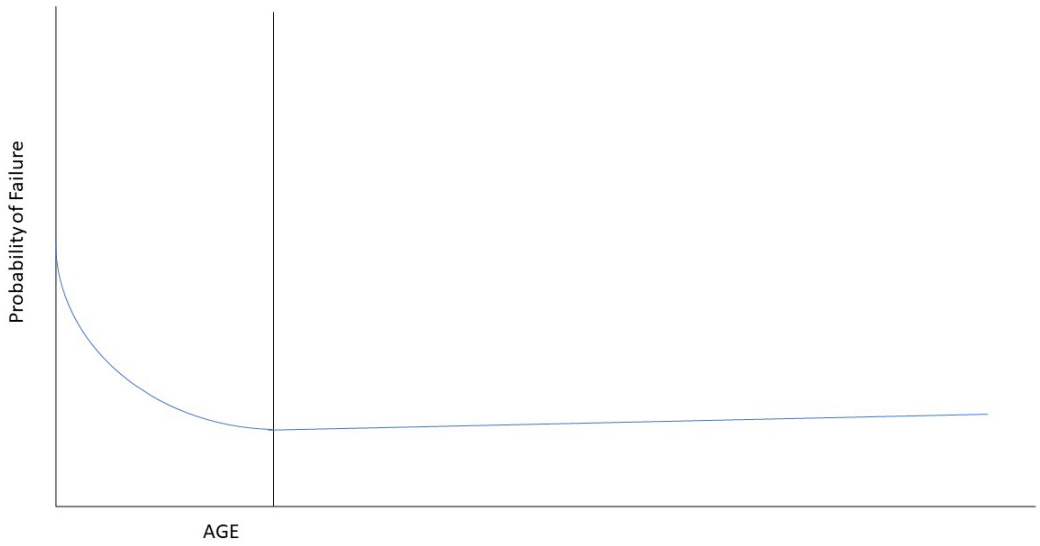

Figure 3. High-Probability Infant Mortality Plot. Constructed Based on Information in Busch's Research (2007).

V. ANALYSIS

> But Goethe tells us in his greatest poem that Faust lost the liberty of his soul when he said to the passing moment: "Stay, thou art so fair." And our liberty, too, is endangered if we pause for the passing moment, if we rest on our achievements, if we resist the pace of progress. For time and the world do not stand still. Change is the law of life. And those who look only to the past or the present are certain to miss the future.[5]
>
> —President John F. Kennedy

A. WATCHSTANDING

1. Deck Department

Since most Merchant Marine vessels are privately owned, their primary concern is making money. Using this mind set, the Merchant Marine can be analyzed to see the minimum number of personnel that are needed to perform a task. Table 6 compares the deck department manpower during regular underway and maneuvers.

Table 6. Comparison of Deck Department Manning between the U.S. Navy and U.S. Merchant Marine

	US Navy	**US Merchant Marine**
Underway	8 crew members	2 Crew members
Docking/getting underway	13-15 Crew Members	5-7 crew members

US Navy information taken from the *NAVDORM.*

According to the Merchant Marine, the bare minimum required for a ship to transit open ocean is two crew members. The Navy quadruples this number just in the bridge, and this does not account for the crew members in CIC watching combat radars during a transit.

[5] Quote from John F. Kennedy: Presidential Library and Museum. https://www.jfklibrary.org/learn/about-jfk/life-of-john-f-kennedy/john-f-kennedy-quotations

To add perspective, according to Naval Technology, an Arleigh Burke Class Destroyer has a crew compliment of 303, compared to around 24 in a typical Merchant Marine Ship (Naval Technology, 2022). The Merchant Marine would not have a combat department, so the number of sailors in combat cannot be compared, and fewer than the total number of 303 sailors is required for navigation and engineering. Although a case can be made that more crew members make sense for a warship, where you need redundancies and more situational awareness, the problem is the manning issues the Navy. For example, the GAO report GAO-21-168 mentions that "US Navy SWOs separate from their community earlier and at higher rates compared with officers in similar U.S. Navy communities…," and that the Navy hires more JOs than required due to the low retention of department level officers (GAO, 2021).

2. Engineering Department

Table 7 is a second table comparing the engineering departments.

Table 7. Comparison of Engineering Department Manning between the U.S. Navy and U.S. Merchant Marine

	US Navy	**US Merchant Marine**
Underway	7	1*
Docking/Getting Underway	13-15	2-3

*While underway, the engine room is unmanned, and one engineer is on duty to answer alarms.

Just like the deck department, the Navy has a much higher crew compliment. In the engineering department, some of this difference in crew size is due to combat demands, requiring a Navy warship to man the engine room 24/7. This comparison is not as direct, since average Merchant Marine vessel has a diesel propulsion plant, and most Navy ships use gas turbine propulsion plants. Gas turbine plants typically require less maintenance and

less oversite than a diesel plant but can be coupled with more complex systems as a result of the demands placed on a warship.

3. Watchkeeping

The Navy does not have anything comparable to the STCW regulations found in the Merchant Marine. The most common type of watch rotation in the U.S. Navy is the 5/15 rotation. The number of hours spent on watch, working, or resting are not tracked by department heads in the Navy, and there are no rules specifying what the limits are, compared to the Merchant Marine which follows the STCW (MI News Network, 2021). The First Assistant Engineer and Chief Mate are both required to track their respective departments' work hours and must ensure every member received adequate rest. Additionally, sailors on the 5/15 watch rotation report elevated levels of fatigue, increased hostility, and deteriorating performance when compared to 3/9 or 6/18 watch rotations (Shattuck & Panagiotis, 2015). There is no standardization on what kind of watch rotations should be utilized, such as three four-hour watch rotations that follow circadian rhythms vs. three five-hour watch rotations that slowly move the start time of each rotation as time passes.

B. TRAINING

The biggest difference between the Merchant Marine and the U.S. Navy is the skill set of incoming officers. The Navy does not have the luxury of requiring credentials such as a third mate's license prior to applying for a job. Before one can become a junior officer in the Merchant Marine, they must gain a Coast Guard license in the department of their choosing, requiring either attending a four-year academy to gain the necessary coursework, sea time, and examinations, or sailing as an unlicensed crew member for approximately the same amount of time and passing the examinations. The Navy's PQS system is designed to function the same way as the requirements to becoming a licensed Merchant Mariner.

The Navy's PQS system does not have the same strict requirements as the Coast Guard does for its license. This may explain why a SWO cannot get a job in the Merchant Marine, even though they've driven and maintained ships as part of their job. Nygaard (2015) compares the SWO community to the aviation community, noting that part of the

process for a Naval Aviator to earn their wings is to earn a pilot's license. This is not a requirement for the SWO, and in the current system, it is not possible. A SWO cannot earn a third mate license and a third assistant engineer license as part of their initial training; the Navy does not have the training pipeline in place to support providing the necessary training to be compliant with Coast Guard requirements (conversation with LTJG Harland).

If the Navy wished to pursue licensure, they would have to examine the requirements from GAO report GAO-21-168, *Navy Readiness: Actions Needed to Evaluate and Improve Surface Warfare Officer Career Path.* They mention foreign navies that have specialized career field for deck, weapons, and engineering officers which advance through their own separate jobs. The benefit of this approach would be the streamlining of training for officers. Instead of giving navigation training to all officers, only officers pursuing the deck career path would take those courses. Then these officers would not have to take the same engineering or weapons courses, allowing them to receive additional navigation training. Along the way, the Navy could work on satisfying Coast Guard requirements, including the sea time. By the time deck and engine officers fulfill their PQS, they should be able to pass the Coast Guard exam and earn their license. The Navy could offer different incentives for weapons officers.

By pursuing this type of training, the Navy could use fewer, but better trained officers on their vessels, hopefully reducing the number of sailors required to accomplish mission requirements. As Ewing (2010) mentioned, when the Navy implemented a hybrid crew on the USS Mount Whitney (LCC 20), they proved that with the civilian credentialling model, fewer sailors are needed to accomplish similar tasks. On the flip side, the issues with using a civilian crew on a military ship are that the crew would have to go into warzones, which comes with issues with the Geneva Convention and pay. If the Navy can credential its officers the same way Merchant Mariners are, they would solve both issues.

C. MAINTENANCE PROCESSES

Most of the maintenance performed on a Navy surface ship is based on a counter through PMS (conversations with LT Mata and LTJG Harland). Large numbers of overhauls are performed with the intent to maintain equipment so regularly that it never fails. This runs contrary to the recommendations found in the RCM study. Compared to the processes in the Merchant Marine, the NS Enterprise software used on most merchant ships is a small improvement, but still lacking. They operate in a similar fashion, where there is a large reliance on preventative maintenance. The Merchant Marine has an advantage in how this maintenance is tracked. The NS Enterprise software appears to be a more streamlined maintenance tool than the MRC system used in the Navy. It does maintenance based on the condition of the equipment rather than time intervals. Thankfully, the Navy sees the weakness in PMS and is already implementing CMS practices and is performing studies on how to improve maintenance to ensure vessels can maintain their readiness.

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VI. CONCLUSIONS AND RECOMMENDATIONS

> All that is valuable in human society depends upon the opportunity for development accorded the individual.[6]
>
> —Albert Einstein

A. CONCLUSION

In conclusion, this study compares three aspects of Navy vessel management using data from previous research and information from subject matter experts. In regard to watchstanding, there are strict STCW rules in the commercial sector which are not enforced in the Navy. The Navy leaves most of the watchstanding requirements up to the discretion of individual ship COs, as long as they can accomplish mission requirements. Unfortunately, the most common 5/15 watch rotation has documented issues regarding the sleep sailors receive and their performance. By looking to the practices in the commercial sector, the Navy can leverage what works well there, but tailor it to meet the Navy's requirements.

The watch rotations are a symptom of a larger problem: manpower. The Navy struggles to train and retain enough sailors to perform its mission. Part of the issue is inescapable; new officers need to be trained from the ground up on ship handling, which the Merchant Marine can avoid through the licensing system. The Navy can attempt to emulate some of this system to help reduce the amount of training required for new SWOs by developing individual career paths for each discipline. This would then allow the Navy to license its officers, similar to the aviation programs.

Finally, the Navy can improve the processes used to maintain vessels by looking at processes used in the Merchant Marine, and even further by looking into RCM models already implemented in the aviation industry. By improving how maintenance is done at

[6] Quote from Gov Leaders. https://govleaders.org/quotes.htm

sea, it can limit the amount of maintenance that must be done during shipyard availabilities. This can ensure the Navy can meet mission requirements.

B. RECOMMENDATION ONE

The first recommendation is for the Navy to adopt an STCW style regulation to outline how many hours a crew member can work and how many hours of rest are required. This would require the CNO to release a requirement outlining the minimum number of hours of rest each sailor must receive in a 24-hour period. This does not have to follow the Merchant Marine 4/8 schedule, and in fact, the *Crew Endurance Handbook* published by the Crew Endurance Team at Naval Postgraduate School recommends watch rotations that use four sections instead of the three required for a 4/8 schedule. The most highly recommended watch rotation in the Handbook is a 3/9 watch rotation with four sections. The handbook outlines when each section is working, is on watch, and when they must have protected sleep. The CNO can offer templates for different types of rotations so CO's can choose the rotation that works best for them. This requirement must be enforced to ensure sailors get adequate rest (Naval Postgraduate School, n.d.).

The second part of this recommendation is to release a tool that department heads can use to track crew rest hours. Software in the commercial sector that tracks STCW rest hours could be customized for the Navy requirements. One of the chief causes of the USS Fitzgerald (DDG 62) incident was lack of sleep. This recommendation aims to find a middle ground to address this problem. The Navy must make a standardized regulation in writing to ensure all vessels are complying. If this is left up to the discretion of each CO, then different rules may be implemented across different ships and this issue will remain unsolved.

C. RECOMMENDATION TWO

My second recommendation is to set two or three career ladders for SWOs. By allowing officers to specialize in one department, it will ease training requirements for new officers and allow them to receive more training on individual fields at the same time. To increase incentives, the Navy can standardize the training by requiring new officers to pass the Coast Guard exams and earn licenses before they can earn their pin. This cannot be

accomplished without major investment in the training pipeline. The burden on ships will have to be shifted to SWOs, potentially implementing a training vessel that gives officers OJT with instructors, instead of expecting vessels to train new officers. Additionally, granting licenses will increase incentives for people to participate in the surface fleet. They could serve on Navy ships and earn relevant credentials for transitioning to the commercial sector. This will also help standardize Navy training with the Merchant Marine industry that shares the seas with the Navy.

Further analysis is needed to determine the best way to implement this recommendation. Individual ladders can be made for the navigation, weapons, and engineering departments. But due to how similar some of the weapons and navigations duties are, such as tracking targets, the Navy could potentially keep weapons and navigations as part of the same career path. GAO-21-168 mentions that foreign navies that implement separate career ladders often struggle to retain engineers due to lack of a command level engineering officer opportunities. The highest-ranking navigation officer would naturally be the CO, but there would be no equivalent position in the engineering or weapons departments. The Navy might look at developing different career routes for engineers, such as allowing them to move into the Engineering Duty Officer (EDO) program after they sail as CHENG.

D. RECOMMENDATION THREE

I recommend that the Navy explore RCM practices and ways to implement them on vessels. By doing better maintenance practices, the Navy can reduce the workload on the engineering department and ease their manpower issues. This goes together with recommendation two, since more skilled engineering officers will be needed if the Navy wishes to reduce manning. This recommendation may take a few years to implement; studies will have to be performed on all Navy ship classes to analyze all equipment to find the correct maintenance to perform. The Navy can leverage some of what is available in the industry to develop a program similar to *NS Enterprise* to more clearly track vessel maintenance requirements.

E. RECOMMENDATION FOUR

My final recommendation is meant to be the simplest to implement so that the Navy can see immediate results. In the background, I mentioned the SSO program, a branch of the Navy Reserve that is made up entirely of licensed Merchant Mariners. Currently, the program serves to provide mariners in time of war and Tactical Advisors (TACAD) to act as a go-between with a civilian captain and the U.S. Navy during joint operations. Typical reserve units meet one weekend per month, do an annual two-week training, and can expect to do a year-long deployment every five to seven years. The SSO program only requires its members to do two weeks per year, with no requirements for weekend drills or deployments. What I recommend is to utilize this force to supplement Navy surface ships.

Currently, the SSOs are very good at being mariners, but lack Navy specific experience. On the other hand, the Navy struggles with seamanship, but understands surface warfare. I recommend that the Navy offer mobilization opportunities to assign SSOs to Navy warships for one-year deployments. SSOs with engineering licenses can serve as the Auxiliary Officer (AUXO) for more junior engineers, or the MPA for more senior engineers. SSOs with navigation licenses can serve as the 1st Lieutenant for junior mates, and the Navigator for more senior mates. This will allow the SSOs to offer their professional mariner experience to the Navy and cross train their sailors, while also making the SSO program more versatile in how they can support the Navy.

F. CLOSING REMARKS

This project looked at multiple aspects of Navy training, watchstanding, and engineering, then compared them with the commercial sector. It did not look past an individual ship, so these recommendations would have to be analyzed to see how they might impact the fleet overall. The first three recommendations would require time and money to implement, but recommendation four would introduce alternative skill sets and processes to the Navy at minimal cost or risk. The officers already exist in the Navy and are being utilized for TACAD missions, which don't play into the skills they possess. The Navy can leverage them to teach their sailors new ways to think and to offer training, without the need for creating a new program, or changing any processes. Many government

programs, such as Kessel Run, obtained great success by implementing commercial sector practices in the government despite the rigidity of government processes. The proposed compromise between the security of government regulations and the efficiency of the commercial sector could provide the most effectiveness in accomplishing Navy missions.

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APPENDIX A. APPLICATION FOR THIRD MATE LICENSE

NATIONAL 3rd MATE OF SELF-PROPELLED VESSELS OF UNLIMITED TONNAGE UPON OCEANS OR NEAR COASTAL WATERS § 11.407

NAME:_____ **REFERENCE #:**_____ **DATE:** _____

General Requirements	Reference: 46 CFR	✓
Must have U.S. Citizenship.	10.221	
Must be at least Age 19.	11.201	
Medical Certificate Requirements: • Original - Must hold a valid Medical Certificate or **be approved** for Medical Certificate. • Renewal, ROG, New Endorsement - Must hold an unexpired Medical Certificate or submit a Medical Certificate application.	10.301/10.302	
Must be Drug Testing Compliant		
Mariner Fees must be paid.	10.219	
Sea Service Requirements	**Reference: 46 CFR**	
Recency – 90 days in the past 3 years on vessels of appropriate tonnage	11.201	
3rd MATE	**46 CFR**	
1080 days of service in the deck department on Ocean/NC or Great Lakes self-propelled vessels, **OF WHICH** 1. 180 days of bridge watchkeeping duties under the supervision of the master or a qualified officer.	11.407	
Experience gained in the engine department on vessels of appropriate tonnage may be creditable for up to 90 days of the service requirements **OR**	11.407	
Graduation from a maritime academy: USMMA (deck curriculum), USCGA / USNA (with qualification as DWO or OOD), Deck class of: California Maritime Academy, Maine Maritime Academy, State University of NY Maritime College, Texas Maritime Academy of Texas A&M University of Galveston, Massachusetts Maritime Academy or GLMA w/ocean option program (GLMA w/o ocean service will be allowed to test for NC); **OR**	11.407	
Satisfactory completion of a comprehensive apprentice mate training program approved by the Coast Guard, **OR**	11.407	
360 days as master on vessels of more than 200 GRT upon Ocean/NC waters while holding an Officer endorsement as Master less than 1600 GRT Ocean/NC (tonnage limitation WILL apply)	11.407	
NOTE: Service towards an Oceans, NC endorsement will be credited as follows: 1. Service on GL will be credited day for day. 2. Service on inland waters, other than GL, may substitute for up to 50% of the total required service. 3. Service on vessels to which STCW applies (inland or NC) will be credited day for day.	11.401	
A Master or Mate of GL &/or Inland of AGT, may obtain this endorsement by completing the prescribed examination.	11.407	

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Unlimited Tonnage	**46 CFR**	
All required service is on vessels of 100 GRT or more **AND**	11.402	
50% of the required service is on vessels 1600 GRT or more or a tonnage limitation may apply (see below).		
A **Tonnage Limitation** may be issued if 50% of the required service is not on vessels 1600 GRT or more; however, ALL required service MUST still be on vessels 100 GRT or more.	**46 CFR**	
Limited to max tonnage on which 25% of experience is obtained, rounded up to the next 1,000 GRT, **OR**	11.402	
Limited to 150% max tonnage which at least 50% of service was obtained rounded up to the next 1,000 GRT, **WHICHEVER IS GREATER.** Minimum tonnage calculated will be 2,000 GRT, when calculated total is 10,000 GRT or more, no tonnage limitations apply.		
Sail or Auxiliary Sail	**46 CFR**	
360 days of deck service on sail or auxiliary sail vessels. **(Note: Tonnage for Sail or Auxiliary Sail endorsements must be calculated separately)**	11.401	
Unlimited Tonnage - 360 days of deck service on sail or auxiliary sail vessels of 100 GRT or more, AND – 180 days on sail or auxiliary sail vessels of 1600 GRT or more, or – A tonnage limitation may be issued if 50% of the required service is not on vessels of 1600 GRT or more), **AND**,		
Complete CG exam module for Auxiliary Sail or approved Auxiliary Sail course	11.201	
Other Requirements	**Reference:**	
First Aid (completed within 1 year) (original only)	11.201	
CPR (must be valid) (original only)	11.201	
Approved Basic Fire Fighting Course within 5 years of application date (unless previously met) Valid STCW BT is acceptable.	11.201	
Advanced Fire Fighting Course within 5 years of application date (unless previously met) Valid STCW Advanced Firefighting is acceptable	11.201	
EXAMS See Exam Guide	**Reference:**	
Examination	11.903	
A person holding this endorsement may qualify for an STCW endorsement, according to § 11.309.		

Comments:

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APPENDIX B. APPLICATION FOR THIRD ASSISTANT ENGINEER LICENSE

NATIONAL 3rd ASSISTANT ENGINEER OF STEAM / MOTOR / GAS TURBINE
§ 11.516

NAME: _____ **REFERENCE #:**_____ **DATE:** _____

General Requirements	Reference: 46 CFR	✓
Must hold U.S. Citizenship.	10.221	
Must be at least age 19.	11.201	
Medical Certificate Requirements: • Original - Must hold a valid Medical Certificate or **be approved** for Medical Certificate. • Renewal, ROG, New Endorsement - Must hold an unexpired Medical Certificate or submit a Medical Certificate application.		
Must be Drug Testing Compliant.		
Mariner Fees must be paid.	10.219	
Sea Service Requirements	**Reference: 46 CFR**	
Recency – 90 days in the past 3 years with at least 45 days on vessels of 4,000 HP or more (deck service on vessels of 100 GRT or more may be applied towards recency).	11.201	
3RD ASSISTANT ENGINEER	**46 CFR**	
1080 days of service in the engine room **WITH** 1. 720 days as QMED or equivalent position; 2. 90 days of deck service on vessels of 100 GRT or more is creditable (may be applied towards recency), **OR**	11.516	
1080 days of service as an apprentice to the machinist trade engaged in the construction or repair of marine, locomotive, or stationary engines **WITH** 1. 360 days service in the engine room as Oiler, Fireman/Watertender or Junior Engineer **OR**	11.516	
Graduation from a maritime academy: USMMA (engineer curriculum), USCGA / USNA (with qualification as EWO or EO), Engineer class of: California Maritime Academy, Maine Maritime Academy, State University of NY Maritime College, Texas Maritime College of Texas A&M University of Galveston, Massachusetts Maritime Academy or GLMA **OR**	11.516	
Graduate of an ABET accredited school in marine engineering course **WITH** 1. 90 days of service in the engine room of steam, motor, or gas turbine vessels **OR**	11.516	
Graduate of mechanical or electrical engineering course of an ABET accredited school of technology, **WITH** 180 days service in the engine room of steam, motor, or gas turbine vessels, **OR**	11.516	
Completion of an comprehensive apprentice engineer training program, approved by the Coast Guard, **OR**	11.516	
360 days service as assistant engineer (limited) and completion of the appropriate examination	11.516	
Propulsion **Holds: Steam / Motor / Gas Turbine** **Requesting: Steam / Motor / Gas Turbine**	**46 CFR 11.502**	
At least 1/3 of the minimum service requirements must have been on the particular mode of propulsion (steam, motor and/or gas turbine) for which applied; **OR**	STM MTR GT	
Completion of Coast Guard approved training course which meets sea service: Steam or Motor or Gas Turbine (circle one)		

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Horsepower	46 CFR	
Unlimited Horsepower: At least 50% of the required service on vessels of 4000 HP/3000kW or more, **OR**	11.503	
Limited Horsepower: Max HP that 25% of the required service was obtained or 150% HP on which at least 50% of the required service was obtained, **WHICHEVER IS GREATER.**	11.503	
Other Requirements	**Reference:**	
First Aid (completed within 1 year) (original only)	11.201	
CPR (must be valid) (original only)	11.201	
Approved Basic Fire Fighting Course within 5 years of application date (unless previously met) Valid STCW BT is acceptable.	11.201	
Advanced Fire Fighting Course within 5 years of application date (unless previously met) Valid STCW Advanced Firefighting is acceptable.	11.201	
EXAMS see Exam Guide	**Reference:**	
Examination.	11.903	
Completion of a Coast Guard approved training course : Steam or Motor or Gas Turbine (circle one)		
Note: A person holding an endorsement as 3rd Assistant Engineer may qualify for an STCW endorsement, according to 11.327, 11.329, and 11.333.	11.516	

Comments:

October 11, 2019 MCP-FM-NMC5-40 (04)

APPENDIX C. QUESTIONS FOR NAVAL SEA SYSTEMS REPRESENTATIVE

1. Please describe your involvement with the Merchant Marine and the U.S. Navy.

2. How is watch standing handled in the bridge and Engine departments in the Navy? Where are these policies and procedures designated?

3. In what ways are these procedures implemented in the Merchant Marine compared to the Navy? How do those differences affect performance?

4. What are the potential impacts of implementing STCW watchstanding and manning protocols in the Navy?

5. What are the requirements to becoming a qualified SWO officer? (If interviewee does not know, interviewer will explain) How does that compare to the process to obtain a U.S. Coast Guard Deck and/or engineering license?

6. What is the Navy's reasoning of using the "Jack-of-All Trades" approach to SWO training?

7. How does the Navy currently address corrective, predictive, and preventative maintenance?

8. What is the Navy's current readiness according to NAVSEA (or other Navy) metrics?

9. Are COTS solutions for ship systems being discussed at NAVSEA? Please explain.

APPENDIX D. QUESTIONS FOR MERCHANT MARINE PORT ENGINEER

1. Please describe your current position in the U.S. Merchant Marine

2. How is watch standing performed and logged on the ships in your company's fleet?

3. How do individuals work their way up to becoming a port engineer and what are their options for advancing their license?

4. Can you compare the Maritime Academy and "Hawse Piper" approaches to becoming a Merchant Marine officer?

5. How does your company address corrective, predictive, and preventative maintenance?

6. Does your company measure vessel reliability on an annual basis? What processes does the company to reach this metric?

7. What kind of additional training is required for a Mariner to transition to becoming a Port Engineer?

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APPENDIX E. QUESTIONS FOR NAVAL SURFACE WARFARE OFFICER

1. Please describe your involvement with the Merchant Marine and the U.S. Navy

2. How is watch standing in the bridge and engine room handled in the Navy? How is watchstanding regulated in the Navy?

3. How does this compare with STCW requirements?

4. What are the potential impacts of implementing STCW watchstanding and manning protocols in the Navy?

5. What are the requirements to become a SWO officer and to advance through the SWO career?

6. What is the Navy's reasoning of using the "Jack-of-All Trades" approach to SWO training?

7. How does the Navy currently address corrective, predictive, and preventative maintenance?

8. Do you have readiness metrics for the ships that you've served on?

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APPENDIX F. TRANSCRIPT OF DISCUSSIONS WITH 2 A/E VINCENT BREGLIA[7]

Interview: Marjan Martinovic

Interviewee: 2 A/E Vincent Breglia

Interview setting: Interview was conducted via Teams at 06:50 EST May 19th, 2022

Affiliation with interviewee: Interviewee is a Second Assistant Engineer who agreed to be interviewed to additional insight into the Merchant Marine

(Start of Interview)

Interviewer: Ah, OK, so the questions I wrote were aimed towards a port engineer, so I'm going to edit them just a little bit to be more focused towards your career. But thank you, Mr. Vinny Breglia, thank you for participating in this interview. We'll go ahead and start with the first question. Please describe your current position in the United States Merchant Marine.

Interviewee: Right, so I'm currently sailing second assistant engineer. Yeah, basically that that position allows me to, you know be part of the merchant marine and do the responsibilities of both second and third assistant, or unlicensed officer, or able body seaman.

Interviewer: OK, cool. So, moving on to the next question. How's watch standing performed and logged on the ships in your company's fleet and the engine department?

Interviewee: Sure. So for, I can speak in the engineers, and I can also briefly discuss about the mates, the deck department. So, for the engineering system we have, we go unmanned operation, and in that case we'll, we have to go through a system of checks all through our automation system. We go to a page and it brings up checks that you know everything is clear. There are no active alarms while we go into unattended status.

Our system, we start work at 0600, then go to breakfast at 0730, then come back down and 0800. 0800 to 1200 were manned, then go to lunch from 12 to 1300, and then 1300 to 1700, we're manned again, unmanned for dinner, till 1730, and then we work till 1930 for the rest of the, and then the rest of the time, will be unmanned.

Umm, right and unmanned status, we have a rotating duty engineer. The duty engineer will come ahead, and they'll take the alarms and put them on to their room and we have a call

[7] Transcript included with the permission of the interviewee.

box. Any alarm that gets sent will go to their room, or if there's anything wrong with the ship that is not part of the engine room, there's something wrong in the house that is not covered by the alarm system, the mates will call down to the duty engineer for that night.

And then speaking about the mates, they have, they a, they work 4 hour watches, so you know if they have the 0800–1200, the 0400–0800, and what do we got, And 1200 to 0400. So, they'll rotate, you know, do 4 hours on 8 hours off, and four hours of overtime. So, they'll work 12 hours a day, and then have 12 hours off, and all of it's logged.
We have our logbooks that will keep track of attendance status and its attendance status to the engineering department, and then we also have a program "WATCHKEEPER" which will log their hours and make sure that we're within regulation of OPA and, you know, OSHA and things like that to make sure that we're compliant with all those. So, if you do get an alarm in the middle of the night, you check your hours, you stay down for hours, again, as much rest as needed to put you back into compliance.

Interviewer: OK. And just for some quick clarification for the engineers that stand duty, it's the 3rd, 2nd and 1st engineers. Or do you guys have a different compliment?

Interviewee: Right, right. We have a 2 3rd assistants, second assistant and 1st Assistant, and depending on ship-to-ship basis, sometimes the chief engineer will also stand wa- stand duty while we're out at sea?

Interviewer: OK, cool. And then you guys have two third mates and one second mate, One chief mate?

Interviewee: Correct. And then, captain.

Interviewer: OK, cool. Cool. Thank you for that. We'll move on to question #3. Just to, basically, just a quick summary of how do individuals work their way up to becoming a chief engineer and what are options for advancing their license?

Interviewee: Right, so prior company, we're all based on seniority, but also performance as well. So, you get hired, and then you'll have, you work your way up the list from third Assistant, second assistant, 1st, and then Chief.

And then yeah, so basically the requirements that you have to deal with in our company, we have proficiencies that allow you to sail to the next rank that are company made. So, you know you're proficient in the duties of the second assistant engineer, and then you're allowed to sail up and move up that rank so. You know, that as long, as well as Coast Guard requirements, so, Coast Guard requirements being, it's, become a second assistant, you need 365 days or 360. I forget what it is, channeling as third assistant. Then become the first, you have to take a test. Uh, and then you have to also have, again, 360 days sailing as sailing within the, while holding the second assistant license, you don't have to actually sailing in the second assistant position, and then first to chief, you need to sail six month

as first assistant, and then six months as either third assistant or second assistant. So, yea, get that through Coast Guard. So, movement is, you know, pretty, pretty rigid, there's not much other opportunities, other than you know meeting your requirements, and proficiencies. There's some there's no real way around any of that, especially in terms of the Coast Guard aspects.

Interviewer: OK. Thank you. So, sort of building off of this, if you've, have you worked with any hawse pipers in your career?

Interviewee: Correct. Oh yes, I totally forgot.

Interviewer: No, no problem. I was going to add if you can compare the Maritime Academy approach to the hawse piper approach to becoming a merchant marine officer?

Interviewee: Right, so I have sailed with a few hawse pipers, and actually some of the guys on ship right now are are hawse pipers, and some are actually going through the process of working their way up the ranks. And I mean, for me, it's difficult to say one way or the other. A lot of the, a lot of the hawse pipers have a better, a better hands on skills I've noticed, that they'll have a little bit more familiarity with the things, such as like you know, just your general welding and shop practices, and then also understanding of the, of how machines work in a more, I don't know how to put it, but in a… in a way that it's, you know, you being seen everything operate, and you understand the fundamentals because of operation, as opposed to theory. A lot of the guys coming out of school are better with understanding things in terms of theory and understanding principles of, you know, physics and whatnot because lot of the guys that go through a maritime Academy and was like, at least in the engineering side, have central engineering degree paired with it so, you know the fundamentals of head pressure, and things like that, that come common, that come through experience, that a lot of the Hawse pipers may see. You know, they may understand that there's still pressure behind some because of head, but they may not understand the calculations or anything like that to, to get that.

So, I've noticed just the difference in, in technical ability, you may have a little more technical and a little bit more theoretical knowledge coming out of the academies, but the hawse pipers have definitely more experience. While we went to school for, you know, took classes those four years, you know, at the age of 18, some of these guys came right out to sea. So, they have four years of actually working with their hands and little bit more of that experience, that you can't get when you just go through an Academy. Granted, yes, there's cadet sailing and there is training ships, but it's just not the same.

Interviewer: For sure. OK. Thanks. So we'll move on to more to, I guess, like the day-to-day. How does your company address corrective predictive and preventative maintenance on your ship?

Interviewee: Right, so onboard, we use NS enterprise, which is the ABS, ABS service basically that that we use and it'll take care of what we, we go ahead once we get a new piece of machinery or anything like that, all the maintenance schedule based on the manufacturer's recommendations, and whether it's hour based or month based or time based maintenance. All of that maintenance will be put in to an NSE, NS enterprise, and it'll go ahead and populate per week of what jobs are coming due. And then it's, it's the responsibility of the officers, the engine officers, to go ahead and look forward, to plan when this maintenance can be done, whether that's, you know, because some of the maintenance, you know, may be on a main engine, or something that's used while we're at sea, so, they have to plan for a port stay where they can get, you have the engine down, and be able to complete this maintenance. And then on top of that, if things start breaking, or as need basis, you know, there's something goes wrong with the with the system or something goes wrong with the piece of machinery, then that may take precedence depending on the level of vital, vitalness of that equipment for the ship.

Interviewer: OK. Thank you. So just to to clarify, so you mentioned that you that the system you input hours and time to do this maintenance, uh, how do you get the hours for this equipment?

Interviewee: Right. So, then all the equipment that's logged hours, we, it's the responsibility of the third assistant. They usually go around once a week usually on Sunday, usually a more relaxed day during the week and they'll go around Sunday, collect all the hours and put them into NS5, NSE, and that'll update the system. And then after you complete a job or a maintenance, it will request what the hour count is after you've completed a certain maintenance.

Interviewer: OK. Thank you. And then finally, I'm not sure if you have this information, but does your company measure vessel reliability? What are there any kind of processes that they use to reach this metric?

Interviewee: I'm not exactly sure what you mean by reliability. If you mean like, you know, fuel consumption or things like that, sure, we can talk about?

Interviewer: No, I think it's more like, Uh is, is. is the ship ready to depart and go underway? How much time is spent in port due to failures that render it unable to get underway?

Interviewee: Right. I wouldn't know that. That would probably be something more that they've kept track of in the office, as opposed to something that, that I would deal with or have the know how to get that.

Interviewer: Yep, no problem. And then the final question is sort of geared towards the port engineer so we will skip that one. Thank you very much for the information. Is there anything you'd like to add before we end?

Interviewee: No, I mean I ah, yeah I mean, if there's anything that you need a little more clarification on, I have, gladly give you a hand there. But, no, I think, I think that covers just about everything. I think I answered as best I could on all those questions there and yeah.

Interviewer: No problem. Thank you so much, Vinny Breglia. I'm gonna stop the recording here.

[End of Interview]

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APPENDIX G. TRANSCRIPT OF DISCUSSIONS WITH LTJG DAVID HARLAND, SURFACE WARFARE OFFICER[8]

Interview: Marjan Martinovic

Interviewee: LTJG David Harland, Surface Warfare Officer

Interview setting: Interview was conducted via Teams at 20:15 EST May 5th, 2022

Affiliation with interviewee: David Harland attended the Merchant Marine Academy with the interviewer. They met while participating in the Merchant Marine Academy Band.

(Start of Interview)

Interviewer: Good evening, Lieutenant JG Harland. Thank you for taking the time to participate in this interview. Here on the screen share, I have the interview questions that you can reference when needed, and we'll go ahead and start at the top.

Please describe your involvement with the merchant marine in the U.S. Navy.

Interviewee: Alright, so I attended the United States Merchant Marine Academy from 2014 until I graduated in 2018. During that time, I received a third mates license for unlimited tonnage and a radar observer certification to Stand Bridge Watch upon all vessels in the United States merchant Marine up to unlimited tonnage.

During that time, I sailed on a roll-on roll-off trailer carrier, a container ship, and two container ships as well as the Kings Point training ship, and I also spent three months as a midshipman assigned to the Navigation Department on board *USS John S McCain*.

Upon graduating, due to a, at the time, lack of jobs in the U.S. Merchant Marine I pursued and received a Commission as a surface Warfare Officer candidate in the United States Navy.

From there, I started my time as a surface warfare officer on board the *USS Russell,* DDG 59 out of San Diego, California. I served in the engineering department, which is not what I was taught at the United States Merchant Marine Academy. Received my qualification as a combat Information Center Watch Officer, Officer of the deck, and eventually Engineering Officer of the Watch as well as earning my service warfare qualification on board the *USS Russell*.

[8] Transcript included with the permission of the interviewee.

I then transferred, attended Advanced Division Officer School, where I was taught reinforced training on Bridge watch standing, maritime warfare and combat systems, as well as engineering. This training I did not actually consider that useful, as I did two deployments on board *USS Russell* and had received far better training on that ship. The Navy uses this training to baseline all officers coming from various ships to ensure everyone has the same baseline level of training before going on to their second tour, their next assignment. I then went and spent six weeks at Surface Navigator school training how to be a navigator for the U.S. Navy.

I've, once again, this mainly ended up being, other than being taught Navy specific navigation tasks, a refresher course on what I learned at the U.S. Merchant Marine Academy as a deck officer, and I now currently serve as the navigator on board *USS Preble*. However, that ship has not yet been underway as it is undergoing a long maintenance and repair period in San Diego, CA.

During my time on board *USS Russell*, I completed two deployments, and accrued well over 1300 hours of qualified officer of the deck time.

Interviewer: Thank you. We'll move on to question #2. How is watch standing in the bridge and engine room handled in the Navy and how is watch standing regulated in the Navy?

Interviewee: In the United States Navy, the Bridge watch standing is regulated by a document called the NAVDORM, the Navigation Department Organization and Regulations Manual for Bridge Watch, and the EDORM Engineering Department Organization and Regulations manual for the Engineering department. This specifies exactly what watch standers need exactly which PQS qualifications for their watch position and how many of them you need, and how many you need based on where you are. So we'll start with engineering.

For engineering, it's pretty much the same. You have three types of plant. You have cold iron, you have auxiliary steaming when you're up on your generators import but not up on your main engines, full underway operations, and then a boosted restricted maneuvering doctrine where you have additional watch standers manned to support extra requirements for coming in and out of port and any area where you would need maximum redundancy.

This requires many, many, many. watch standers, including the EOW, the Engineering Officer of the Watch, a propulsion auxiliaries control console operator, an electrical plant control console operator, engine room operators in each of the main engine rooms,
the propulsion systems monitor, the auxiliary systems monitor, and the sound and security, this watch Stander goes around and sound the voids. The Auxiliary systems monitor, and propulsion systems monitor monitor the recordings and readings on all their equipment. All of the equipment have readings taken on an hourly, and in general it takes about, depending on the type of ship, more for steamships, somewhat less for gas turbine, takes

about 13 to 15 people on watch at all times to operate the engineering plant. There is no such thing as an unmanned engine room. The plant is manned 24/7 when underway.

On the bridge, your average bridge team is broken down into three officers: the officer of the deck, the junior Officer of the Deck, and the conning officer. The Officer of the deck is overall in charge of the entire watch team. The junior officer, the deck is his or her assistant and is generally training to be the junior officer of the deck. The conning officer serves as your primary lookout, always looking forward as well as giving orders to the helmsman. Bridge watch, in addition contains a port and starboard lookout, an aft lookout, a helmsman, a Boatswain's Mate of the watch, whose job is to enforce order and regulation among the junior officers on the bridge, as well as a quartermaster of the watch whose job it is to man our ECDIS, our Electronic Charting Display and Information System, record the ship's position, and answer navigation questions. They serve as the Navigator's representative on the bridge.

This watch is further plussed up with getting underway and entering port. The navigator on the bridge as the navigation evaluator, bearing recorders, a specific person to record the deck log, as well as a Lee helm to operate the engines addition to your helmsmen, a helm safety officer to monitor the Helm and Lee Helman and Determine what they are doing, as well as in the Combat Information Center. Normally you have a Combat Information Center watch officer, combat radar operator, and a Surface Warfare Supervisor who are the normal underway watch requirements. And coming out, entering, and leaving port, this is further bolstered by a shipping officer, to provide backup for Combat for where vessels are, a piloting officer to provide navigation backup to the Navigator, and both of those actually have a Surface Warfare coordinator who, in addition to manning the Surface Warfare side, is a further backup to the bridge for navigation questions. So, all in all, coming out and leaving port, you have approximately 13 to 15 people focused on navigation at any one time, including the captain and the pilot. Full out at sea, you have three officers on the bridge at all time, along with six to seven enlisted.

All in all, to be in 4 watch rotations, you're talking 40 plus people involved in navigating the ship throughout a 24-hour day.

Interviewer: OK. Thank you. I'll move on to question #3. How does this compare with STCW requirements?

Interviewee: It's approximately, probably 10 times as many watch standers. And then the huge difference is the training. So Navy, we have PQS, Personal Qualification Standard. This is where the people on the ship train you up in On-the-Jon training for your watch position, often involving little to no formal schooling, whereas STCW, in addition to amounting the time you need for underway days, 330 + 30 in our Bridge Resource Management course for a deck license, of just underway time. And formal schooling before you get your license. For STCW, obviously you have your 330 days, your 30 days counted as BRM, so 360 total, along with a whole bunch of classes you need to take to get your

license. In the Navy, most of that is on-the-job training, and some of these PQSs require as few as five or six qualified watches before you start standing the watch.

Overall, I would say that STCW is far more stringent and difficult to get than PQS and produces far more reliable watch standers off the gate.

Interviewer: Ok. Thank you. Question #4-

Interviewee: I'd also actually like to add something on that.

Interviewer: Go for it

Interviewee: STCW also has a regulation for how many hours of watch you can stand at a time. The U.S. Navy is finally adopting this with the fallout from some of the unfortunate collisions in 2017. Used to be in the U.S. Navy, you would stand five hours on ten hours off, or five hours on, fifteen hours off. You'd always be standing watch at different times. You'd still expect to work a full workday, and there was no management of hours.

We are slowly changing that with adoptions of circadian rhythm watch bills and following a more set schedule, but there is still no formal method of tracking people are getting adequate rest in the U.S. Navy.

Interviewer: OK. Thank you. Question, #4, what are the potential impacts of implementing STCW watch standing and manning protocols in the Navy?

Interviewee: The Navy has the Manning in terms of number of people, I, in my opinion, to support STCW watch standing, but nowhere near the bandwidth and the training pipeline. It would kneecap our ability to produce enough people to man the number of people we need in all these watch stations. Training an officer for full STCW certification, along with issuing a license, is a process that, even expedited, only focusing on the license would take months, and the Navy simply does not have the bandwidth to fully enforce it.

They have recently stood up an extra course, Officer of the Deck phase one, a further six-week course on Bridgewater standing that was not available when I was in Ensign, to teach some of these STCW principals, including, critically, a radar observer course, that is Coast Guard approved. This is really helping, as officers used to show up to a ship and stand bridge, watch, without even ever knowing how a radar works. And I think this is a step in the right direction, but the Navy would require a dramatically longer, more expensive, and much more failure prone pipeline to fully implement any STCW require- full STCW requirements. The LCS program I believe is attempting to do this, with a much, much longer pipeline to train a bridge that consists of far fewer officers, but I have not gone through that pipeline and don't have any personal experience with it.

Interviewer: OK, thank you. Question, #5, what are the requirements to become a SWO officer and to advance through the SWO career?

Interviewee: So, your requirements to initially become a Surface Warfare Officer, is to receive a Commission through an ROTC program or the Naval Academy and apply for that job. The requirements, don't know the exact requirements, other than just having a bachelor's degree, but it is known to be not the most stringent program to enter in the U.S. Navy, especially compared to something like pilot or NFO. There is no aptitude selection battery or anything like that to become a surface warfare officer.

To advance through your Surface Warfare Officer career, this has changed somewhat recently, you will go to your Basic Division Officers Course, ten-week course of instruction teach you the basics of the Navy, along with the now, as I just talked about, Officer of the Deck phase one, to assess, to get some training on how to stand bridge watch, all and simulator. You will then complete a 30-month tour of duty on your first ship. You will leave, go to Advanced Division Officers course, for a more advanced level loading of everyone's different experience from your first tour, like I talked about earlier, proceed to OOD phase two, a three-week course of instruction which also includes your first "go, no-go" criteria, where if you do not pass, you will be processed for separation from the Navy. This is new and was not in effect when I went through this course of instruction. Following that, you will complete your second tour in a specific job of eighteen months, before being eligible to go on to either a short tour or an additional afloat tour at a staff, as those billets seem to be filled. During this time, you get three looks to screen for department head. Your first look at the end of your second year or your third year, your 4th year and your fifth year. If you do not screen Department head on any of these looks, you will probably not pick up the rank of O-4, Lieutenant Commander, and you will be processed out at your high year tenure as a Lieutenant at your eleven-year mark.

If you do pick up, you'll be offered to sign the department head retention bonus of one-hundred-and-five thousand dollars for your first look decreasing as it goes through as an incentive to try and stay in. Navy obviously has a manning problem to support the number of department heads, and then the number of XO's and CO's they need. From there you will, if you do select and want to pursue, you will do your shore tour. You will then go to department head school for approximately a year, before going to two, eighteen-month department head tours. At the halfway point of this, you will do your first command qual to attempt to qualify for command. This is a test of bridge watch standing, along with numerous knowledge and aptitude tests. If you are selected for command, you would complete your department head tours, serve several staff tours, as well as completing professional military education before going to a XO tour, and then a CO tour. You can also select for various special programs, depending on where you fall out on the scale. During this time, you will go through several boards for Lieutenant Commander. You do not necessarily need to screen for command to select Lieutenant Commander. After that, during your shore tours, you would pretty much need to screen for at least CO special mission to attempt to pick up Commander. Beyond that, I don't have any experience with that, as I am currently still a division officer. I have screened for department head, but I have not gotten anywhere near the command qual screenings.

Interviewer: Thank you. Uh question #6-

Interviewee: I should probably add how you get your SWO pin. To leave your first tour, you must qualify as a Surface Warfare Officer. You start as a designation 1160 Surface Warfare Officer Candidate, and then move on to become a Surface Warfare Officer. You need to complete a long list of PQS, Personal Qualification Standards that, most importantly include Combat Information Center Watch officer, the navigation and contact management officer in combat, and then Officer Of the Deck underway, where you are in-charge of the bridge watch. After that you, are eligible to receive your Surface Warfare Officer's qualification, which is required to leave your first tour and go on to your second tour. Failing to achieve that during your first thirty-month tour of duty will result in you being recommended for a different community or administratively separated.

Interviewer: Perfect. Thank you. Question, #6, what is the Navy's reasoning of using the Jack of all trades approach to Surface Warfare Officer training?

Interviewee: The Navy's reasoning for using Jack of all trades that Surface Warfare Officers, especially at the CO level, are supposed to know all about the trade, from sitting combat watch, fighting the ship, damage control, the engineering plant, to Standing Bridge watch. They believe that any officer should be able to step into any role and thrive. Unlike some foreign navies, where officers trained in engineers will only ever be in engineering and not command ships, officers on the bridge will only ever stand bridge watch into command, and not stand watching combat or engineering, and officers in combat only stand combat watches. The advantage of this is producing well rounded officers and COs who know all aspects of their ship. The downside is you end up with the Jack-of-all-Trades, master of none, and your average merchant mariner with the same number of years as any Surface Warfare Officer is going to be far more adept their specific job, be it engineering or bridge watch. Obviously, there's no merchant marine correlation to combat.

Interviewer: Question #7 how does the Navy currently address corrective, predictive, and preventative maintenance?

Interviewee: The Navy uses the 3M, Material Maintenance Management system, to do a massive amount of PMS on all pieces of equipment in attempt to prevent it from breaking. The idea here, is that if the equipment is well maintained, it will never break in the first place, and thus prolong its lifespan. I find that sometimes the Navy is a little more, a little too overzealous on this, and constantly taking apart equipment to the point where it becomes damaged just by how much it's been taken apart.

Corrective maintenance is handled when something breaks, you order the parts and fix it. Pretty standard compared to the merchant marine. Some parts in the Navy, just like the merchant marine, require the Original Equipment Manufacturer to do work on them, although the Navy tries to limit this, as the Original Equipment Manufacturer is not always available based on where they're deployed and, obviously, any kind of combat scenario. I do think we could do a better job in the Navy of really looking hard at what maintenance

needs to be accomplished, especially if you wish to reduce the size of our crews. Right now, every person could be expected to do, depending on your job, thirty to forty hours of maintenance a week, not even counting watch standing. That's a full work week right there.

Interviewer: Ok, and final question-

Interviewee: And I'll end that with the common quote of "we're gonna fix it till it breaks."

Interviewer: [Chuckles] Question #8, do you have readiness metrics for the ships that you've served on?

Interviewee: Specifically, no, I don't believe I can say exact readiness metrics. Can say that ships go through life cycles. They go through a maintenance phase, a basic training phase, an integrated phase, and then your advanced training deployment phase, where you complete various trainings from various different representative parties to ensure that the ship is combat, and deployment ready. Ship's readiness increases and decreases throughout his life cycle as it transitions from a maintenance period to an operational period. This is in stark contrast to the merchant marine, where obviously the ship is in theory ready to go and everyone's professionally licensed and ready to man it.

Interviewer: OK, well, Lieutenant Junior Grade Harland, thank you for your time. I appreciate you taking the time to participate in this interview. You've given us a lot of good information. I hope you have a good rest of your day.

Interviewee: Of course. Thank you.

[End of Interview]

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APPENDIX H. TRANSCRIPT OF DISCUSSIONS WITH LT ALEJANDRO MATA, SURFACE WARFARE OFFICER[9]

Interviewee: LT Alejandro Mata, Surface Warfare Officer

Interview setting: Interview was conducted via Teams at 06:50 EST May 19th, 2022

Affiliation with interviewee: Alejandro Mata attended the Merchant Marine Academy with the interviewer. They were both part of the 2017 graduating class.

(Start of Interview)

Interviewer: Good morning, Lieutenant Alejandro Mata. Thank you for participating in this interview. Uhm, we could start with the very first question. Please describe your involvement with the merchant marine and the U.S. Navy.

Interviewee: OK, so I am Lieutenant Alejandro Martin Mata. I am a graduate of the United States Marine Academy, class of 2017. Currently I am in the Surface Warfare Officer community. My first tour was the *USS John Paul Jones*, DDG 53 out of Pearl Harbor, Hawaii. Stationed there for three years. Being a surface warfare officer, that was my first tour where I had to earn my SWO pin. Now, being the year of 2022, I'm currently stationed in Sasebo, Japan. I am the Damage Control Assistant for my second tour on board the *USS Chief*. Very different platform from that of a DDG. It is a minesweeper. Uh, lots more crew.

Basically, for the Merchant Marine Academy… Earned my engineering license, although the SWO community is… being an officer in the SWO community, I had to learn the deckie side of the house. So a lot of the navigation rules of the road, mo-boards, stuff like that.

Let's see. How's watch standing...?

Interviewer: Yeah, I can. Uh, how is watch standing in the bridge and engine room handled in the Navy and, it's kind of a two-parter, and how is it regulated in the Navy?

Interviewee: OK so. That's the difference between the Merchant Marine Academy, and well the Merchant Marines and the Navy, right? I've had a long talk with my operations officer on my first tour about this. The Merchant Marines has STCW. They have STCW requirements, meaning, I forget what the alphabet soup is for that, but we, you know, we have to go out to sea for a certain amount of time, and we have to get a lot of OJT, On-the-Job training underneath their belt, you know. Understand what everything is first, before we get qualified, before we become third assistant engineers or what have you. Before we

[9] Transcript included with the permission of the interviewee.

can sit down for our license. Navy does it completely opposite. I can speak both to the to the to the navigation side of the house and the engineering side.

Just to caveat for my first tour, uh, half, not halfway, about 8 months into my three years in my first tour, I switched over to engineering department and been in engineering departments since then, so I'm very familiar with the watch standing requirements too.

Let's start with the navigation side of the house. So, didn't really get to see a lot as a merchant marine as an engineering cadet on board civilian vessels navigation wise. But I did see some. I do understand that the, uh, that the Mates and stuff are the ones that are standing the watch and that there is a helmsman. On a United States Navy surface ship, it is completely different. The bridge is more crowded than anything, so you not only have, so I'll, I'll, I'll break this down. On a standard Navy bridge, you have the helmsman, helmsman who's driving the ship, then you have the conning officer, which is basically the position that I fell to. The counting officer is the one that is actually giving the orders to the helm driving the ship. You have the junior roster, the deck, I had that on my first ship, don't have that on my minesweeper 'cause how small we are. Junior officer of the deck is maintaining the contact picture, and he's also running checklists. He's also running man overboard checklist low visibility ability checklist. He's running the checklist for us to get underway, for us to drop anchor, what have you, deploy the small boat in the water. Right? Then you have the officer of the deck. Now for my SWO pin, I had to get all qualified all the way up to the officer of the deck, and the officer of the deck is the captain's representative on the bridge.

Typically, in the Surface Warfare Officer community, we have this thing called circadian rhythm, which we try to meet. But ultimately, it really doesn't happen because it depends on how… how much, how much manning you have, how much this, this vessel is employed for. So as the officer of the deck, you are the captain's representative, meaning that you are making contact reports to the captain when it falls within his reporting criteria, and, you know, on a merchant ship, although I've only seen a little bit for navigation-wise, we're throwing the engines and everything in auto, and the only thing in merchant cares about is going from point A to point B and getting there as fast as possible, whereas Navy ship, you know, Navy ships maneuvering a lot. There they don't care about getting from point A to point B, they care about the mission objectives. And that's really it.

Umm, how was watchstanding regulated in the Navy. Basically, kind of like what I talked about, with the circadian rhythm, but at the shipboard level, it's the it's the SWO, it's the Senior Watch Officer, and ultimately it's the navigator that we have. Senior Watch Officer is the department head that is coming up with all the watchstanding requirements, right? And the navigator, for us SWOs and stuff, is the one that we can fall to instead of the captain or the executive officer. He's the one that we can fall to for help with some of these navigation requirements. I kind of hit on how does this compare to, with STCW requirements-

Interviewer: Yeah, I was gonna say you sort of hit that, but real quick. So, you mentioned you guys doing circadian rhythms. And I had been doing some reading for my, for this research on Navy watchstanding. And I found that the most common, like watch rotation the Navy uses is a 5/15, which doesn't really follow a circadian rhythm. Can you can you expand a little more on what you said earlier with, with you guys trying to implement circadian watch rotations?

Interviewee: Yeah. OK, so I'll give you two different examples right. During my first tour, my ship was in the yards a lot. We went into basically a SRA, and we didn't come have it for 13–14 months. Now, this is Ensign Mata going after his surface warfare officer pin, and he needed to get underway to get his pin and all that, needed to get underway to get these quals and stuff, and basically, I had to go underway with a different ship. Now I was TAD to, temporarily attached, to the *USS William P Lawrence*, DDG 110, and basically for them, they were employing circadian rhythm. They had a certain amount of time where, watch, they were staying watch. And then for circadian rhythm, they get X amount of time off, like you said. I can't really remember the breakdown, but for the circadian rhythm, they had no meetings during like this resting period, right? They had no shipboard meetings, meaning that, with me being officer, I didn't have to go to meetings or anything, that they wouldn't announce revely like for all hands, to wake up, wouldn't make any announcements over the 1MC, they would allow us to get meaningful rest.

Now, fast forward to now 2022. I am on a minesweeper. And, you know that basically there's not a lot of minesweepers left in the fleet? Decommissioned some, oldest ship in the Navy. Going from a DDG, which was with the *William P Lawrence* was and the *John Paul Jones*. Went from a crew of 305 to about 85 people. Now these 85 people, this ship is so small, these 85 people, we only have five other officers, including myself, that drive the ship, that are, that junior officers that get up on the bridge and stand officer of the deck, stand conning officer, stuff like that, right. So, just this last underway, we were supposed to be out at sea for a little bit, but just this, just this last underway, you caught me in a good time, just this last underway, we are out at sea for five days and basically. Basically, with us being a mine, I'm trying to formulate where my words here… we have this thing called condition 3, which is normal underway steaming, right, and then for a minesweeper, we have condition 2, mike hotel, and then condition 1, mike hotel. And basically I'm standing six hours of watch. And then I have six hours off. Then I come back for another six hours.

So basically, I could be stating condition three. I had the… What did I have? I had the 11:30 to 14:30 watch, and then I would turn around, and I would have the 2030 to 01:30 in the morning. Now when they set condition 2 Mike Hotel or condition 1 mike hotel. Then that time changed, so I could be standing the 2030 to 01:30 and they called and set that condition, then I would have the Midnight to 06:00 in the morning, so there were sometimes where I would have basically over 6 hours of watch. I would have about 8 hours watch, and I was expected to get six hours of rest and then come back. This this ship that I'm on right now is the most tasking for watchstanding, I mean which makes sense because, we don't have that many officers, right? There… It's just case in point, we don't have a lot of Manning. I think that I think that basically-

Interviewer: OK, so with STCW, I'll just remind the remind you what the rules were. I think it was… I was trying to find it in here, it was. Uhm you needed 10 hours of rest a day, it could be split up into two periods, but I think one of those periods couldn't be shorter than six hours.

Interviewee: Yeah.

Interviewer: So. So, what, you kind of touched on it, but it's but it sounds like that type of requirement in the Navy for something like a minesweeper just wouldn't be possible?

Interviewee: Yeah, I can honestly tell you that I, I probably… Normal day with that condition and everything, I there's no way I get 10 hours. I mean, I could tell you that, my, just normal, normal day before setting the watch and stuff, that conditioning and all that, I stood the 11:30 to 14:30 and then, I eat dinner around 16:30, and by 17:30 I was in bed and I wouldn't wake up until about 20:00 to go to my 20:30 watch, and then if they set that condition, you know, I'd be awake until 06:00 in the morning and then I go to sleep. So ultimately, I'm getting a couple hours of sleep before and after my watch period. But there's no way it equals 10 hours.

What are the requirements to become a SWO and to advance through the swell career? So there are a lot of requirements right there. We call them preliminary qualification standards. I had to go through this whole, uh, SWO process. There's certain qualifications that you get ultimately. Let's see… let's see if I can remember. I had to get, like the preliminary qualification standards that I had to get, it's the 300 series, and ultimately you're getting training on it, and you're getting other, your peers and everything, to sign off on it. So me, I had to get like 3M qualifications. I had to get damage control qualifications, up to a certain point. Uh, I had to go from being a conning officer, to a junior officer of the deck, to the officer of the deck, which is, probably one of the hardest quals, the hardest qual that I had to get for a SWO. And then I went on to. Getting Combat Information Center Watch Officer qualified, and then I also went on to getting, it's not a part of the normal SWO Pin process, but I had to get SWC, which is surface warfare coordinator qualified. There's countless others. Boat officer qualified, there was…

(Interviewer changes Teams screen share to show a chart of the PQS qualifications required to earn the SWO pin)

Interviewer: Yeah, I put a list up here if this helps.

Interviewee: Yeah. OK. Yeah, division officer float, 3M, basic damage control. Basic damage control, that's the right NAVEDTRA, but it would be 301 through 307, small boat officer, SWO engineering, Yes, CIC Watch officer, Yeah, Anti-Terrorism Watch Officer, Yeah, ATWO. Uh qualify and serve successfully as an underway officer, so you can just put for that, 43101 is OOD.

Interviewer: OK

(Interviewer corrects chart discrepancy)

Interviewee: Umm yeah, officer of the deck. And Maintenance and Material Management, that's 3M.

Interviewer: Oh, yup. That is it. Yup.

Interviewee: And then for these qualifications too and all that, there's countless others that lead up to that, right? There's little smaller ones that lead up to these big ones… so. And I mean, this took me, this took me a while to get this pin. It really did. A lot of these qualifications, it's like us being engine cadets all over again, and you know, going after just learning engineering. But this time, it's starting from the ground up. It's talking with the other Jos, getting training, or not another, not just other Jos, I went to chief petty officers for training or subject matter experts. I understand that I am, I know what instruction to go to, and what resources and everything to go to. But I am no way shape or form the subject matter expert. Umm. And you know, before, when I first came into the Navy, I didn't know what instructions to go to. Now I know. Now I know what references to use.

So, but to advance through this whole career pipeline, right? Ultimately, it's your first tour, you get your SWO pin. And then after that you get detached you go to, well, it's BDOC, Basic Division Officer Course. Then you go to your ship to serve out your first tour, you get your SWO pin and then after that, you go to the Advanced Division Officer course, ADOC, and then get more training, more simulator time, and then you go into your second tour, and then, your second tour, you're supposed to get you like your EOW, engineering officer of the watch. That's one of the wickets to hit one of the milestones. And then you go on to become a department head. You have to sign for department head though, meaning that you are taking the blood money, which is locking yourself in for another X amount of years.

Umm, but that was my career track, right? These SWO qualifications nowadays, this is this is what I was an originally told and everything when I came into the, my career, my career pipeline and the qualifications. Nowadays with Ensigns now, the SWO community has changed, has gone from a lot of these qualifications. You no longer need like ATWO, or I mean you still need small Boat-O and all that. A lot of it's more simulator based and you're getting more hands-on training. You're, you're getting more simulator time before going out to your ship.

What is the Navy's reasoning of using Jack-of-all-trades approach to SWO?

So, I can't really…. I don't wanna say that. A surface warfare officer in my eyes is basically… When I, when I tell people what I do, as a surface warfare Officer, I tell him a couple of things. I tell him that I lead, fight, drive, and train the ship. And that's ultimately

what a SWO does, is, you can be a division officer, or you can be a department head, you can be an executive officer, you can be a captain. Know your ship for a SWO, right? It doesn't even have to be on ships. SWOs don't have to be on ships, they can be anywhere in the fleet. But ultimately like, like it says in this question, they are Jack of all trades. They have to know a little bit about each thing, because ultimately, you have to know about the engineering plant in order to drive the ship effectively, how to use those engines. You have to know about small boat operations, uhm, small boat operations, so that you can deploy the small boat as officer of the deck. And ultimately, you have to know about the engines to drive the ship as the conn, you have to have to know about the engines in case we have a engineering casualty as officer of the deck, which is that, you know, that big, big milestone, that officer of the deck letter. It all just... the SWO community wants you to know a little bit about each thing, right? And you have to put it together, you have to formulate it, and put it together into what your overall picture was. And, it took me a very, very, long time to realize that I had to know a little bit about each thing and put it together, and formulate it, and think bigger… Think about the overall picture.

Interviewer: Sure. So, you think going for like a specialized career in navigation or engineering would be, a sort of a detriment to the Navy's mission?

Interviewee: Wait, say that again

Interviewer: Umm you think if the Navy were to adopt something closer to the merchant marine or the foreign navies where there's, like, specialized career routes for officers, like a deck officer, engineering Officer, Weapons officer, you think that would be a detriment to the Navy's mission?

Interviewee: I don't think it would be a detriment to the Navy's mission. I know there have, there's been talks about, basically separating the Surface Warfare Officer community between deck and engine. I know a lot of other navies do that. I, being a Prior merchant Marine, I think it would benefit the Navy more. I don't think it would, I mean ultimately it's, ultimately it's... You're either deck or engine. It's got, it's not really affecting the mission. It's having the bodies, or having the officers fill those, fill those spots, to get to ship out to sea, is gonna be the the question.

Interviewer: Hmm

Interviewee: Umm, but I think it would. I think it would benefit, benefit the Navy. I mean it will allow those officers who wanted to be Decker engine to, you know, specialize in something like that, but that's not what the SWO community is, like, we're just like you're saying, it's Jack of all trades. So uh.

Interviewer: OK

Interviewee: What else you got here? How does the Navy currently dress corrective predictive and preventative maintenance?

Interviewer: Yeah. If you could touch on 3M a little bit, talk, talk about what you've seen with the MRC system, and you know, maybe throw in some comparisons to how you've, what you've seen during your times as an Engine cadet and the merchant marine.

Interviewee: OK, so as an engine kit I didn't really get to see a lot, well, I did get to see a lot. We did a lot of, like you could say, on board, like local repairs and stuff and all that. The Navy, it's completely different. Everything is by an MRC. You know, everything is by an MRC. Everything in engineering is by the book. It's EOSS. The Engineering Operational Sequencing System. It's, it's red books, it's red because it's written in blood, it's because these are the mistakes that people made prior, and now these are the steps that the Navy must follow, you know, open this valve, do this, do that.

But, we're talking about maintenance here, so like corrective, predictive, and preventative. Like with me, being a damage control assistant, my guys have preventative maintenance or predictive maintenance, like, they're more preventative, meaning that they have weekly checks, or like daily checks, or something like that. Something like that on like fire hoses or like nozzles or something like that to prepare them for use. Like, for example, my guys will repair a fire station. They have a weekly check on a fire station and then it's an R check. It's required if… It's required if, sorry, it's required if the, do the check on there again on the Firehouse for the fire station if that fire hose is used.

And then for like engineering and stuff like their engine engines and all that, it's based on a time like a counter, right? We have like we have the same thing for the Merchant Marines, but it's all based on a counter like the generators, or the engines, like our main engines, diesel, gas turbine, once it hits a certain amount of hours, it's overhauled. And for like corrective maintenance, we have our, outside of 3M. We have this thing called CSMP. Umm, the current ships maintenance project, basically where we write jobs and these are the jobs that we have to, that we're doing corrective maintenance for. Ultimately, if there is a lot of repairs and everything that needs to happen, we'll do this thing called continuous maintenance availability. Umm. All this can be read about in the JFMM too, I mean, these are availabilities and stuff, like this continuous maintenance availability, we work with our port engineer, and we get jobs from our CSMP for like CASREPs and stuff, and we put them into an availability, prioritize these jobs and stuff, so that they can get repaired. And more times than not, like it depends on the life cycle, it depends on the life cycle of the ship to determine what availability they're gonna be going into. Like, my ship is already, we're in the sustainment phase. We have a lot of continuous maintenance availabilities, but when we move out of the sustainment phase, we go back into the basic phase and that's when we're going to have lengthier availabilities, like possibly a dry docking and stuff to really, really prepare the ship.

So do you have any readiness metrics for the ships that you've served on? What do you mean by…?

Interviewer: Yeah, and if this is anything sensitive, this this isn't For Official Use Only or anything, so you don't have to mention it, but like. Umm, I guess how I guess the readiness metrics or how many hours has the ship, like has the avails shifted to the right? Have you guys missed mission requirements due to downtime? Anything like that?

Interviewee: Wait, so you said this is, that it's not for official use?

Interviewer: Yeah, this isn't classified. This isn't FOUO. So, if it's, if this is classified in your eyes, then we don't have to talk about it.

Interviewee: OK, I don't know whether to bring up the current situation with my ship or not.

Interviewer: OK, we don't have to. I'll, I can get some of this data from the GAO, so it's really not one of my most important questions. I think you've hit everything I really wanted to hear.

Interviewee: You get it from where?

Interviewer: From the GAO, Government Accountability Office, they always publish reports on stuff like this.

Interviewee: OK. OK. Well I can. I mean I can give you an example and everything. When I was in the *John Paul Jones*.

Interviewer: Sure

Interviewee: Ohh, actually not even that. Let's go back to… so between my two tours, I was at the…. My Division 12, I was a part of the LCS community for a little bit. You know, I had stuff going on with my eyeball. I lost vision and all that. So, they stuck me at this command. Yeah, I was the assistant chief engineer and doubled down as the chief engineer at times and basically, this is the LCS community and different, totally different platform from a DDG or an MCM, but these guys, uh, like for example, there was an LCS. Umm, just to, for these LCSs, just to meet mission requirements, we had to CANAB, which is cannibalization request, meaning that we had to pull parts from one LCS, put it on another just to meet mission requirements, just to get the ship operational and it's…. For mission requirements, it's coming from a the TYCOM, the Type commander of what these guys are gonna do, and you can't say if somebody gives you an objective. If somebody tells you you have to fulfill the mission, you're not gonna say no. It's ultimately what we learn is a swell is PESTO. The PESTO pillars, the personal equipment supply, training and ordinance, and part of that equipment is like, you know, your engineering plant status. So, these LCS's would often can have from one another. Being the two variant, the Independence class, and they would pull parts from one another, and they would be able to function, and go out to sea and from this command we deployed two LCS over to Guam.

One of the LCS's is actually over here. It's funny because I just came from that command, I've been on that ship, and they're over here now, so she's funny. Umm but yeah, and then you, as you can see the Navy is starting to decommission some of these LCS's because, there's been ultimately problems with them, but we're pulling so many parts from... Yeah, that's just one of the examples. So. I really haven't served on that ship, served on these ships, but, the LCSs, but I mean I was in involved in their maintenance process.

Interviewer: OK. Well, thank you for participating in the interview and thank you for all of your input. Appreciate you giving us your time.

Interviewee: Yeah, no problem, man. Anything for you, you know that.

[End of Interview]

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