United States Government Accountability Office

Report to the Committee on Armed Services, House of Representatives

May 2021

NAVY READINESS

Additional Efforts Are Needed to Manage Fatigue, Reduce Crewing Shortfalls, and Implement Training

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GAO-21-366

GAO Highlights

Highlights of GAO-21-366, a report to the Committee on Armed Services, House of Representatives

May 2021

NAVY READINESS

Additional Efforts Are Needed to Manage Fatigue, Reduce Crewing Shortfalls, and Implement Training

Why GAO Did This Study

Following two Navy ship collisions in 2017, the Navy found that sailor overwork, fatigue, and training deficiencies contributed to the accidents, and has taken steps to address these issues.

House Report 116-120, accompanying a bill for the National Defense Authorization Act for Fiscal Year 2020, includes a provision for GAO to assess the Navy's management of surface ship sailor fatigue, crewing, and the RRL initiative. This report examines the extent to which the Navy has (1) implemented its fatigue management policy, (2) assigned sufficient crewmembers to its surface ships and tracked crew levels, (3) forecasted its personnel needs as the fleet size grows, and (4) implemented RRL training and measured its effectiveness.

GAO surveyed a generalizable sample of Navy officers on their experiences with the Navy's new fatigue management practices and analyzed ship crewing data for fiscal years 2017 through 2020. GAO also reviewed relevant Navy guidance, documentation, and interviewed relevant officials.

What GAO Recommends

GAO is making eight recommendations to the Navy that, among other things, it revise its guidance and practices to measure sailor fatigue and address the factors causing fatigue, use required positions when reporting crew sizes and projecting personnel needs, and factor training time into sailor workload. DOD concurred with our recommendations.

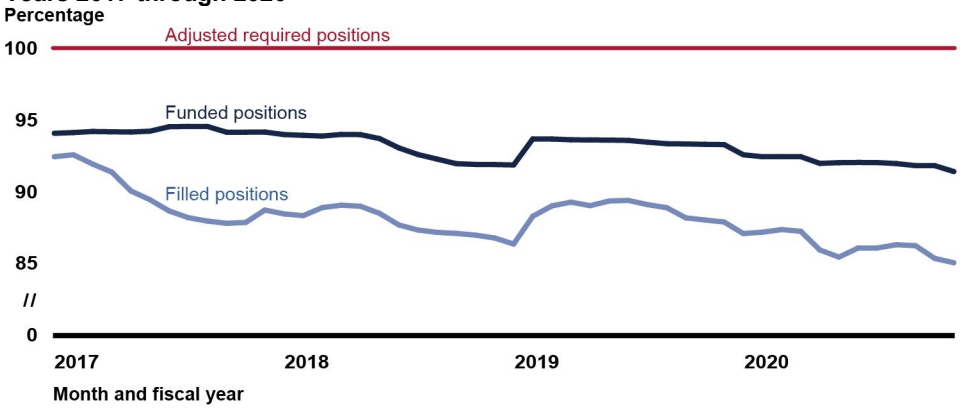
View GAO-21-366. For more information, contact Cary Russell at (202) 512-5431 or russellc@gao.gov.

What GAO Found

The Navy issued a fatigue management policy in 2017, but has inconsistently implemented it and sailors are not receiving adequate sleep. GAO conducted a survey in 2020 and estimates that 14 percent of officers received the then recommended 7 hours or more of sleep a day during their most recent deployment, while 67 percent received 5 hours or less. Navy data show that sailor effectiveness declines after prolonged periods without sleep, equating to impairment levels comparable to intoxication. The Navy updated its policy in December 2020—directing adherence to fatigue guidelines—and is taking steps to improve implementation, but is limited by a lack of quality information on sailor fatigue and the factors that cause lack of sleep. Without this information, the Navy cannot effectively manage fatigue to ensure crews operate ships safely.

The Navy routinely assigns fewer crewmembers to its ships than its workload studies have determined are needed to safely operate them. Until recently, the Navy tracked and internally reported its crewing against the number of funded positions rather than against required positions, a practice which understated crewing shortfalls (see fig.). As a result, the Navy did not accurately measure the full extent of shortfalls, which almost doubled on average from 8 percent in October 2016 to 15 percent in September 2020. Although the Navy began tracking required positions in February 2021, this practice is not reflected in guidance. The Navy also uses funded positions, rather than requirements, to project its future personnel needs. Therefore, it is not accurately communicating to internal decisionmakers the number of personnel it will need as the fleet grows, which may prevent it from effectively mitigating current crewing shortfalls.

Average Surface Fleet Enlisted Crew Positions Required, Funded, and Filled, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Average Surface Fleet Enlisted Crew Positions Required, Funded, and Filled, Fiscal Years 2017 through 2020

	Funded	Filled	Adjusted
2017	0.940219	0.923986	100
	0.94072	0.925334	100
	0.941475	0.918889	100
	0.941268	0.91334	100
	0.941107	0.900287	100
	0.941695	0.894153	100
	0.944759	0.886413	100
	0.944973	0.881746	100
	0.944939	0.879392	100
	0.940973	0.87785	100
	0.940973	0.878443	100
	0.941092	0.887022	100
2018	0.939343	0.884366	100
	0.938817	0.883122	100
	0.938297	0.888742	100
	0.939436	0.890369	100
	0.939302	0.889633	100
	0.936526	0.884707	100
	0.930105	0.876702	100
	0.925509	0.873208	100
	0.92235	0.87155	100
	0.919177	0.870846	100
	0.918648	0.869676	100
	0.91857	0.867696	100
2019	0.918268	0.863483	100
	0.936292	0.882701	100
	0.936254	0.889916	100
	0.935721	0.892501	100
	0.935575	0.890086	100
	0.935509	0.893304	100
	0.935277	0.8937	100
	0.934061	0.890763	100
	0.932994	0.888657	100
	0.932831	0.881604	100
	0.932561	0.88014	100
	0.932388	0.878726	100
2020	0.925338	0.870752	100
	0.923986	0.871684	100
	0.924013	0.873507	100
	0.924026	0.872326	100
	0.919368	0.859377	100
	0.919859	0.854443	100
	0.920001	0.860706	100
	0.919929	0.860756	100

	Funded	Filled	Adjusted
	0.919231	0.862999	100
	0.917809	0.862342	100
	0.917809	0.853523	100
	0.913714	0.850525	100

The Ready Relevant Learning (RRL) initiative is intended to improve sailor performance, and the Navy has several ongoing and planned measures to assess its effectiveness. However, delivering modernized training will require significant upgrades to the Navy's information technology infrastructure, for which it has only recently begun planning. In addition, the Navy has not accounted for the time that sailors will be expected to spend on modernized training when it is fielded, which may exacerbate sailor overwork and fatigue.

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Abbreviations

AMD	Activity Manpower Document
DOD	Department of Defense
IT	information technology
NAVMAC	Navy Manpower Analysis Center
OPNAV	Office of the Chief of Naval Operations
RRL	Ready Relevant Learning
SMD	Ship Manpower Document
SWO	Surface Warfare Officer

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
A Century of Non-Partisan Fact-Based Work

441 G St. N.W.
Washington, DC 20548

May 27, 2021

The Honorable Adam Smith
Chairman
The Honorable Mike Rogers
Ranking Member
Committee on Armed Services
House of Representatives

In 2017, the Navy had four significant mishaps at sea, including two collisions that resulted in the loss of 17 sailors' lives and hundreds of millions of dollars in damage to Navy ships. The Navy completed two internal reviews to identify and correct the root causes of the mishaps, and found that sailor overwork and fatigue, as well as training deficiencies, were contributing factors.[1] The Navy has since acted to address sailor fatigue, resize surface ship crews to handle workload, and improve training in the surface fleet. Some steps it has taken include directing the implementation of more sustainable shift rotations on ships that are intended to provide a better balance of work and sleep for sailors, reevaluating workload and increasing crew size requirements, and reforming training for enlisted sailors through the Ready Relevant Learning (RRL) initiative, which is intended to improve sailor performance and enhance mission readiness.

House Report 116-120, accompanying a bill for the National Defense Authorization Act for Fiscal Year 2020, includes a provision for us to report on the Navy's management of surface ship sailor fatigue, ship crewing, and the Ready Relevant Learning initiative.[2] This report examines the extent to which the Navy (1) has implemented its fatigue management policy, (2) has assigned sufficient crewmembers to its surface ships and tracked crew levels, (3) has forecasted its personnel needs as the fleet size grows and (4) has implemented RRL training and measured its effectiveness.[3]

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[1]U.S. Navy, *Comprehensive Review of Recent Surface Force Incidents* (Oct. 26, 2017), and *Strategic Readiness Review 2017* (Dec. 3, 2017).

[2]H.R. Rep. No. 116-120, at 99-100 (2019).

[3]We also provide information on the fatigue management practices of other maritime communities in appendix II.

To address our objectives, we reviewed relevant Navy guidance, plans, and program documentation. We also interviewed relevant officials and experts. We completed additional analysis for our first and second objectives. For our first objective, we conducted a generalizable survey of recently deployed Navy Surface Warfare Officers responsible for critical ship functions.[4] For our second objective, we analyzed 4 years (fiscal years 2017 through fiscal year 2020) of monthly crewing data for the Navy's surface ships, identified the multiple sets of personnel requirements for each ship, and compared crewing requirements, positions the Navy had funded, and actual crew levels across that time period.[5] We determined that two key principles of internal control, as outlined in *Standards for Internal Control in the Federal Government,* were significant to these objectives: (1) that management should collect quality information to measure effectiveness of an entity's program to address risk and achieve its objectives, and (2) that management should communicate quality information needed to achieve program objectives.[6] Our scope and methodology are discussed in greater detail in appendix I.

We conducted this performance audit from July 2019 to May 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[4]From our generalizable stratified random sample, we received valid and complete responses from 351 officers, representing a 41 percent response rate. Of the 351 responses, 143 officers indicated they had been underway within 12 months prior to our survey and stood watch as Officer of the Deck, Tactical Action Officer, or Engineering Officer of the Watch. These 143 officers form the final sample that is used in our analysis. All estimates derived from this sample and presented in this report have a margin of error, at the 95 percent confidence level, of plus or minus 10 percentage points or fewer, unless otherwise noted. See appendix I for more details.

[5]We analyzed crewing data for the Navy's aircraft carriers, destroyers, cruisers, amphibious assault ships, amphibious transport dock ships, dock landing ships, and mine countermeasures ships. We analyzed data from 140 ships, but the number of ships varied over fiscal years 2017 through 2020 as new ships entered the fleet and others were deactivated or placed in extended modernization. See appendix I for more details about our scope and methodology.

[6]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

Background

In May 2017, we reported that the Navy's reduced crewing initiatives may have been leading to overburdened crews working long hours, and that crew reductions also corresponded with increases in maintenance costs that outweighed the savings achieved through reduced personnel costs.[7] In addition, we found that the Navy's process for determining crew requirements—the number and skill mix of sailors needed on the Navy's ships—did not fully account for all ship workload. We recommended steps to help ensure that the Navy's crew requirements meet the needs of the existing and future surface fleet. The USS *Fitzgerald* and the USS *John S. McCain* collisions in the summer of 2017, and the Navy's subsequent investigations into the causes of these accidents, provided added urgency for addressing the issues of under-crewing, sailor fatigue, and training gaps in the surface fleet.

Managing Fatigue

In addition to the Navy's reviews and collision report, two National Transportation Safety Board reports also cited fatigue as contributing causes for the 2017 collisions. In both situations, bridge watchstanders had little to no sleep the night before the collisions, which impaired the watchstanders' situational awareness and ability to react to an emergency. Furthermore, the safety board's reports specifically stated that the Navy had no fatigue mitigation program to ensure crews received adequate sleep or had mandatory rest periods. Prior to these collisions, the Navy did not actively address fatigue management on its ships, except for recommending circadian rhythm watchbills in 2013.[8] After the 2017 collisions, the Navy issued a fatigue management policy that

[7]GAO, *Navy Force Structure: Actions Needed to Ensure Proper Size and Composition of Ship Crews*, GAO-17-413 (Washington, D.C.: May 18, 2017).

[8]Watchbills are schedules for when sailors stand watch. Circadian rhythm watchbills are designed so that sailors stand watch and sleep at the same time each day, allowing the body to follow its natural biological processes on a 24-hour cycle.

directed the use of circadian rhythm watchbills across the surface fleet and recommended other practices.[9]

This Navy policy further states that sailors require at least 7 to 8 hours of sleep to safely conduct operations, adding that underway conditions and high operational demands make obtaining required sleep difficult.[10] According to the Navy's fatigue management policy, sailors who do not receive adequate sleep over time begin to accumulate sleep debt that has negative effects on their cognitive and physical performance. Moreover, in March 2021, DOD completed a study on the effects of sleep deprivation on service members. This report identified that inadequate sleep can negatively impact a service member's military effectiveness, evidenced by a reduced ability to execute complex cognitive tasks, communicate effectively, quickly make appropriate decisions, maintain vigilance, and sustain a level of alertness required to carry out assigned duties.[11]

According to Navy policy, the Navy heavily relies on the use of circadian rhythm watchbills or fixed watchbills to regulate when sailors sleep and perform watchstanding duties. Circadian rhythm watchbills are intended to ensure that sailors sleep at the same time each day, aligning sailors' watchstanding schedules with the body's natural sleep-wake cycle. The Navy found that rotating watchbills do not align with the body's natural sleep-wake cycles and cause high levels of fatigue, delay reaction times, and decrease cognitive performance. A major component of effective fatigue management on ships is for sailors to receive 7 to 8 hours of sleep at the same time each 24-hour period.

[9]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2, *Comprehensive Fatigue and Endurance Management Policy* (Nov. 30, 2017). This instruction has been superseded by Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2A, *Comprehensive Crew Endurance Management Policy* (Dec. 11, 2020).

[10]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2A, *Comprehensive Crew Endurance Management Policy* (Dec. 11, 2020).

[11]DOD Report to Congressional Armed Services Committees, *Study on Effects of Sleep Deprivation on Readiness of Members of the Armed Forces* (March 2021). This report was in response to section 749 of the National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116–92, § 749 (2019).

Calculating Crew Size

The Navy determines the number of sailors and the skills needed to operate its ships through a standardized crew requirements process; in May 2017, we reported that this process did not fully account for all ship workload.[12] The Navy was using outdated standards to calculate crew size that may have been leading to overburdened crews working long hours. We recommended steps to help ensure the Navy's crew size requirements are current and analytically based. The Navy implemented our recommendations, including updating its guidance to better account for sailors' complete workload. The Navy also recalculated crew sizes for several ship classes, including destroyers and cruisers, leading to 6 to 10 percent increases in the crew requirements for these ships.

Forecasting Personnel Needs

In 2017, we also found that the Navy was not fully assessing the personnel implications of growing its fleet, and had not determined the number or cost of personnel needed to crew the increasing number of ships.[13] We recommended that the Navy identify personnel needs and costs for the planned larger fleet, and in response, the Navy developed its Manpower Projection Tool to quantify long-range personnel needs. The tool's projections are based on the Navy's planned number and type of ships over 30 years. Prior to the development of this tool, Navy personnel projections had been limited to programmed personnel levels within the 5-year future years' defense program. The Navy uses the tool to inform senior naval leadership decisions on force structure, anticipate required resources and their allocation, and guide potential personnel policy changes.

Reforming Training

In August 2017, the Navy outlined planned changes to the traditional training model for enlisted sailors as part of the Sailor 2025

[12]GAO-17-413.

[13]GAO-17-413. The Navy currently has about 300 ships. It plans to increase the fleet size to 355 ships by the early 2030s and to over 400 ships by 2045.

transformation effort.[14] Ready Relevant Learning (RRL) is the Navy's initiative to reform training in order to improve enlisted sailor performance and enhance mission readiness. The goal of RRL is to deliver the right training, at the right time, in the right way, so that sailors are ready to operate their equipment at the extreme technical end of its capability to win the high-end fight. RRL's three primary reform efforts 1) break up initial front-loaded training into blocks and deliver it at transitional points along a sailor's career in order to improve sailors' comprehension and retention of knowledge; (2) take advantage of emerging learning technologies to deliver training at the waterfront or aboard ships when sailors need it, minimizing the need to return to schoolhouses multiple times; and (3) more rapidly develop training content and delivery methodologies while integrating new technologies so that learning is accelerated and remains relevant.

The Surface Fleet Has Inconsistently Implemented the Navy's Fatigue Management Policy and Sailors Are Not Receiving Adequate Sleep

The Navy issued a fatigue management policy in 2017 instructing commanding officers to implement specific practices to manage fatigue onboard its surface ships, but implementation of this policy remains inconsistent.[15] Based on our survey results, we estimate that only about 14 percent of recently deployed surface warfare officers received the recommended 7 or more hours of sleep needed for optimal performance.[16]

[14]Sailor 2025 is the Navy's program to improve and modernize personnel management and training systems to more effectively recruit, develop, manage, reward, and retain the future force.

[15]The entities in the Navy that are responsible for ship readiness include the Office of the Chief of Naval Operations; Commander, U.S. Fleet Forces Command; and Commander, U.S. Pacific Fleet.

[16]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2, *Comprehensive Fatigue and Endurance Management Policy* (Nov. 30, 2017). While the 2017 policy has been superseded by an updated instruction issued in December 2020, the 2017 version of the policy was in effect at the time of our survey and formed the basis for some of our survey questions.

The Navy Issued Fatigue Management Policy after the 2017 Collisions

Following the collisions of the USS *Fitzgerald* and USS *John S. McCain*, the Navy issued a policy in November 2017 that provided fatigue management guidelines for commanding officers to implement when at sea and in port.[17] The Navy found that fatigue was a causal factor in both collisions, and the National Transportation Safety Board's reports on the collisions found that the Navy failed to provide oversight of fatigue mitigation onboard its surface ships. The Navy's 2017 policy lays out practices for fatigue management and references the Naval Postgraduate School's scientifically supported Crew Endurance Handbook for fatigue management on surface ships. The policy directs the use of circadian rhythm principles in watchbills and shipboard routines that would provide sailors with consistent and adequate periods to sleep based on the 24-hour day.[18] The Navy encouraged the use of circadian rhythm watchbills as a primary way to manage fatigue on ships.

The 2017 policy instructs commanding officers to account for an individual's fatigue before conducting operations and further provides practices for commanding officers to consider when planning operations and making decisions, such as:

- establishing a 7-hour sleep minimum,
- limiting continuous work shifts to no more than 8 hours, and
- limiting workdays to no more than 12 hours.

When we began our review in 2019, Navy officials stated that the Navy did not have any processes to systematically collect sailor fatigue data or to measure the extent to which ships were implementing the fatigue management policy. According to Navy officials, the Navy's Afloat Training Group began evaluating whether ships were implementing the Navy's fatigue management policy in early 2020 by using a checklist that includes questions on watch rotations, among others. Additionally, Navy officials stated that the Afloat Training Group performs these evaluations

[17]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2, *Comprehensive Fatigue and Endurance Management Policy* (Nov. 30, 2017).

[18]Circadian rhythm watchbills are designed so that sailors stand watch and sleep at the same time each day, allowing the body to follow its natural biological processes on a 24-hour cycle.

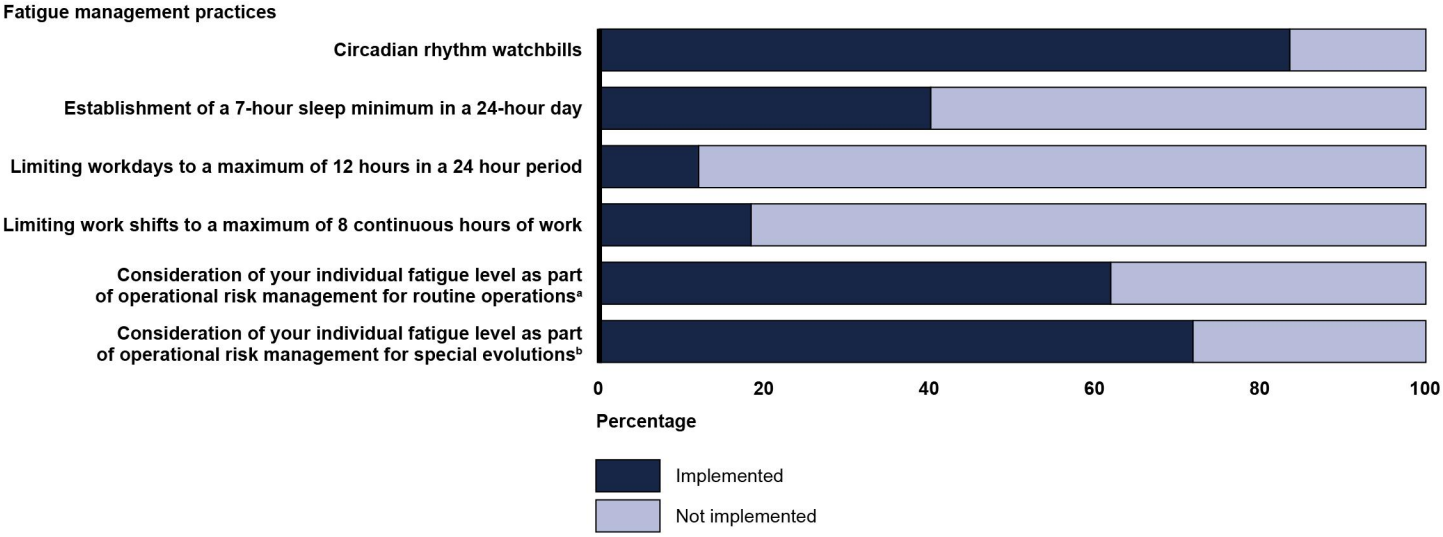
while ships are in the training phase of their operational cycle, which means an evaluation of a ship's fatigue management occurs approximately every 3 years. We found that this checklist identified whether ships had fatigue management practices in place once every 3 years, but not whether ships were effective in managing crew fatigue.

The Navy Has Inconsistently Implemented Its Fatigue Management Policy

We found that the Navy has not consistently implemented its fatigue management policy across the fleet. Specifically, our survey of surface warfare officers revealed that the Navy was inconsistent in its efforts to ensure personnel receive at least 7 hours of sleep during a 24-hour period, limit the duration of workdays, and limit the duration of shifts (see fig. 1). To assess the extent to which the Navy has implemented its fatigue management policy and to gather more information about its effectiveness, we surveyed Surface Warfare Officers who had been to sea in the last 12 months and who stood watch as Officer of the Deck, Tactical Action Officer, or Engineering Officer of the Watch.[19] These officers are responsible for managing the sailors who stand watch over critical ship functions. During the course of our review, the Navy also conducted a survey of surface fleet officers and enlisted personnel that included questions on fatigue management and had results similar to our survey.

[19]We chose to survey sailors in these positions because they are critical for ship operations. Officers of the Deck are in charge of ship safety and navigation. Tactical Action Officers are in charge of combat systems. Engineering Officers of the Watch are in charge of ship propulsion.

Figure 1: Implementation of Fatigue Management Practices on Navy Surface Ships



Source: GAO analysis of survey of Navy Surface Warfare Officers — Fatigue Management and Career Path. | GAO-21-366

Data table for Figure 1: Implementation of Fatigue Management Practices on Navy Surface Ships

	Implemented	Not Implemented
Circadian rhythm watchbills	83.52	16.48
Establishment of a 7-hour sleep minimum in a 24-hour day	40.1	59.9
Limiting workdays to a maximum of 12 hours in a 24 hour period	12.03	87.97
Limiting work shifts to a maximum of 8 continuous hours of work	18.36	81.64
Consideration of your individual fatigue level as part of operational risk management for routine operations	61.86	38.14
Consideration of your individual fatigue level as part of operational risk management for special evolutions	71.81	28.19

Note: Estimates included in this figure have a margin of error, at the 95 percent confidence level, of plus or minus 10 percentage points or fewer.

[a]Operational risk management is a multi-step Navy process for managing risk.

[b]A Navy official stated that special evolutions are events such as underway replenishments that are not routine operations.

Circadian Rhythm Watchbills and Sleep Hour Minimum

Our analysis showed that although the Navy has generally implemented circadian rhythm watchbills, it has been less successful in ensuring that sailors receive at least 7 hours of sleep per day. We estimate that nearly

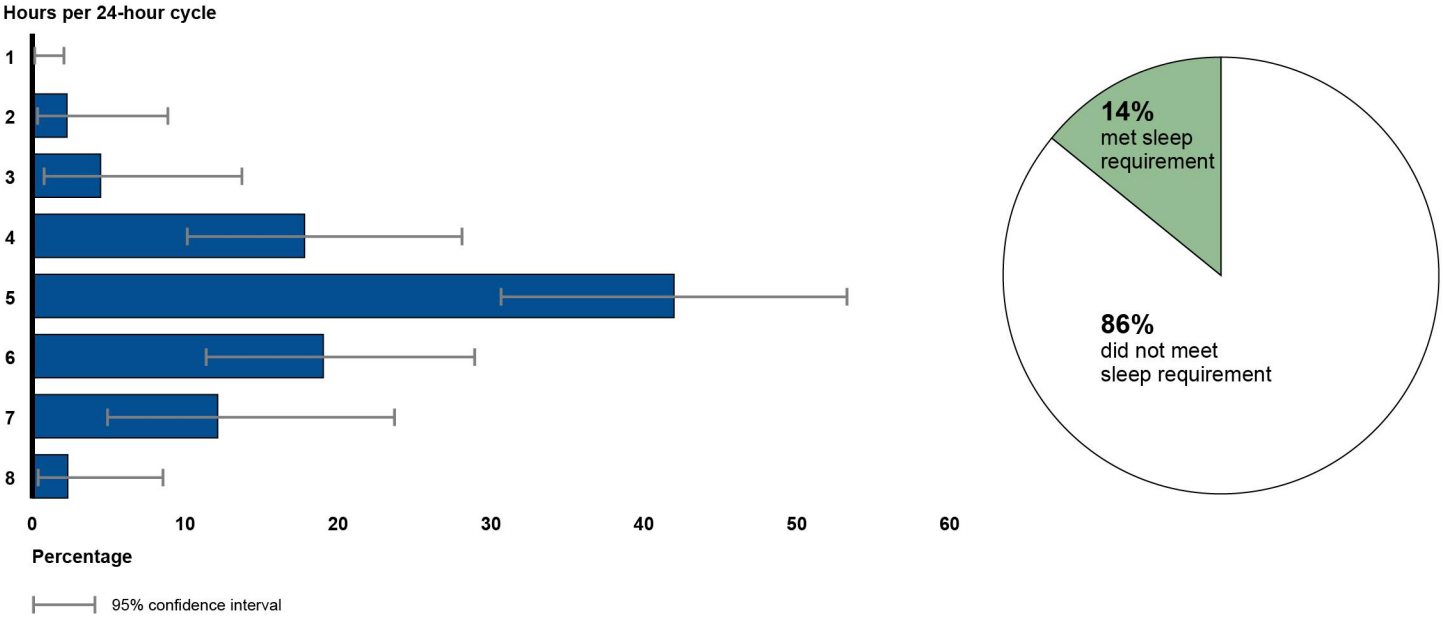
90 percent of surface fleet personnel were assigned to circadian rhythm watchbills during their most recent deployment. According to Navy officials, these results were consistent with findings of the Navy survey conducted in 2020, which found that 85 percent of respondents stood watch using circadian rhythm watchbills.[20] Circadian rhythm watchbills are intended to provide sailors a consistent daily schedule and promote attainment of adequate sleep hours. Our survey estimates that the most common watchbill assigned was the 3 hours on/9 hours off (3/9), recommended by the Naval Postgraduate School's Crew Endurance Team as the most effective watchbill to manage fatigue. Estimates show that for the majority of officers, watch hours were always consistent with the watchbill in place.

Consistent circadian rhythm watchbills should allow sailors to obtain at least 7 hours of continuous sleep each day, but we estimate that the vast majority of personnel received less than 7 hours of sleep per 24-hour period. The Navy's Comprehensive Review conducted in 2017 after the collisions stated that circadian rhythm watchbills alone are not enough to effectively manage fatigue on surface vessels if ships do not manage workload and shipboard routines.[21] Our survey analysis supports this finding. We estimate that 86 percent of officers received less than the target 7 hours of uninterrupted sleep a day, and that most of these respondents were not able to supplement their lack of sleep with a 2-hour continuous nap, per policy. Moreover, 67 percent of officers received 5 hours or less of sleep each day (see fig. 2). Our survey results were consistent with those of the Navy survey conducted in 2020, which found that respondents received an average of 5.4 hours of sleep a day.

[20]According to Navy officials, the Navy conducted a non-generalizable survey and received over 10,000 responses.

[21]U.S. Navy, *Comprehensive Review of Recent Surface Force Incidents* (Oct. 26, 2017).

Figure 2: Hours of Sleep Officers Received While Underway on Navy Ships



Source: GAO analysis of survey of Navy Surface Warfare Officers — Fatigue Management and Career Path. | GAO-21-366

Data table for Figure 2: Hours of Sleep Officers Received While Underway on Navy Ships

Hours	Lower Bound	Response (%)	Upper Bound
1	0	0	2.1171
2	0.1921	2.27	8.9291
3	0.7175	4.46	13.8246
4	10.0118	17.81	28.2151
5	30.5941	41.97	53.3553
6	11.3116	19.03	29.01
7	4.8561	12.13	23.8315
8	0.2364	2.32	8.6417

Note: Estimates included in this figure have a margin of error, at the 95 percent confidence level, of plus or minus 10 percentage points or fewer.

Limiting Workdays and Work Shifts

Survey respondents also reported that their ship's leadership did not implement fatigue management practices pertaining to limiting the number of hours worked within a 24-hour period and the number of hours worked during a single shift. We estimate that 88 percent of officers had workdays that were not limited to the maximum of 12 hours in a 24-hour

period recommended in the Navy's fatigue management policy. Additionally, we estimate that 82 percent of officers' work shifts were not limited to a maximum of 8 continuous hours of work (see fig.1).

Assessing Individual Fatigue

The Navy trains its sailors to continuously manage risk during daily operations through a process called Operational Risk Management. The five steps for evaluating risk through this process are identifying hazards, assessing hazards, making risk decisions, implementing controls, and supervising the operations to watch for deviations. In addition, the Navy's individual risk management process identifies risks associated with individual sailors before conducting operations. Individual risk management, among other things, evaluates an individual's fatigue level to determine whether the individual can support effective operations.

The Navy's 2017 fatigue management policy directs commanding officers to use individual risk management as part of operational risk management when conducting routine operations and special evolutions briefings. However, our analysis identified inconsistent implementation of individual risk management within operational risk management practices. Specifically, we estimate that 38 percent of officers experienced ship leaders who did not consider individual fatigue for routine operations, such as standing watch on the bridge, and 28 percent experienced ship leaders who did not consider individual fatigue for special evolutions, such as underway replenishments (see fig. 1).

Multiple Barriers Inhibit Effective Fatigue Management and Contribute to Fatigue-Related Conditions

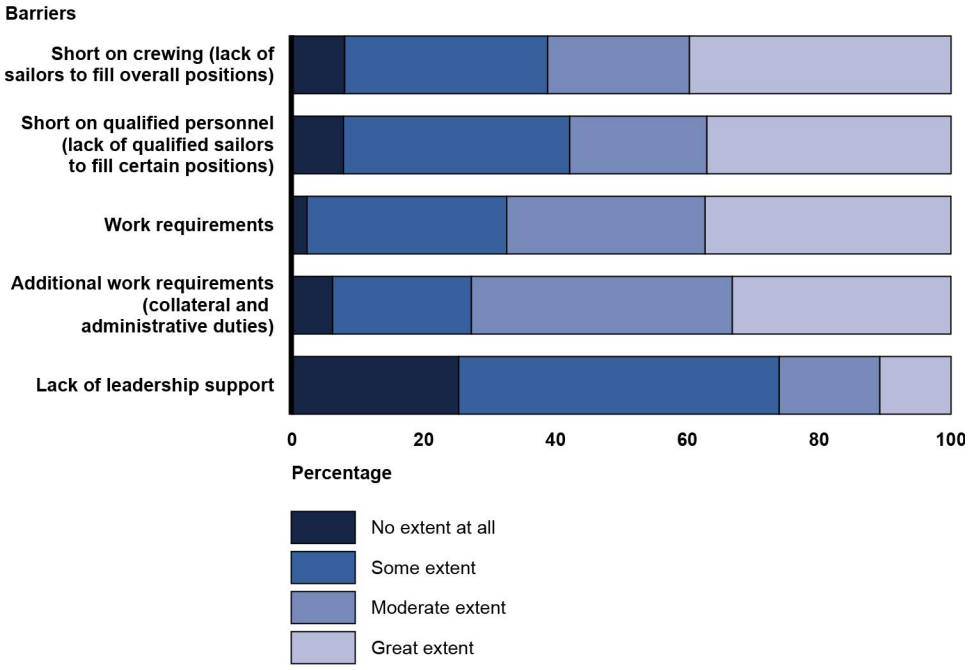
Based on our survey, we found that there are barriers preventing effective fatigue management that are contributing to fatigue-related conditions.

Challenges to Obtaining Sleep

We estimate that the majority of officers consider work requirements and crewing shortages as barriers that prevented effective fatigue management (see fig. 3). Additionally, respondents reported, in response to our open-ended survey questions, that cultural resistance to using fatigue management practices, changing operational requirements, scheduling of meetings, equipment issues, and other unscheduled interruptions also hampered their ability to manage fatigue. Several open-

ended responses emphasized the detrimental effects of crew shortfalls and heavy workload.

Figure 3: Barriers to Effective Fatigue Management Experienced by Officers on Navy Ships



Source: GAO analysis of survey of Navy Surface Warfare Officers — Fatigue Management and Career Path. | GAO-21-366

Data table for Figure 3: Barriers to Effective Fatigue Management Experienced by Officers on Navy Ships

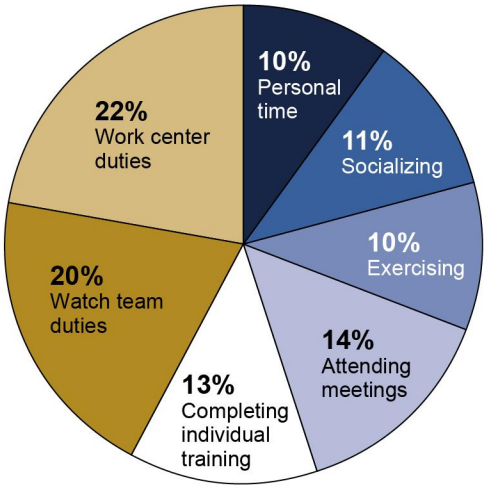
	No extent at all	Some extent	Moderate extent	Great extent
Short on crewing (lack of sailors to fill overall billets)	7.97	30.82	21.51	39.7
Short on qualified personnel (lack of qualified sailors to fill certain billets)	7.8	34.33	20.8	37.08
Work requirements	2.3	30.28	30.09	37.32
Additional work requirements (collateral and administrative duties)	6.15	21.06	39.58	33.2
Lack of leadership support	25.31	48.61	15.27	10.82

Note: Estimates included in this figure have a margin of error, at the 95 percent confidence level, of plus or minus 10 percentage points or fewer.

In addition, the Navy's survey showed that the top three factors that impede sailors' ability to sleep were workload, required meetings, and drills. The Navy also determined through its survey that sailors were spending 69 percent of their time awake performing work-related tasks (see fig. 4). This analysis confirmed that sailors were using the majority of

their day working, which allowed for limited personal time, including sleep. Sailors were spending more than 12 hours a day performing work duties and individual training, counter to the related recommended practice in the Navy's fatigue management policy.

Figure 4: Navy Survey Results on Sailor Daily Wake Time Allocations



Source: Navy survey. | GAO-21-366

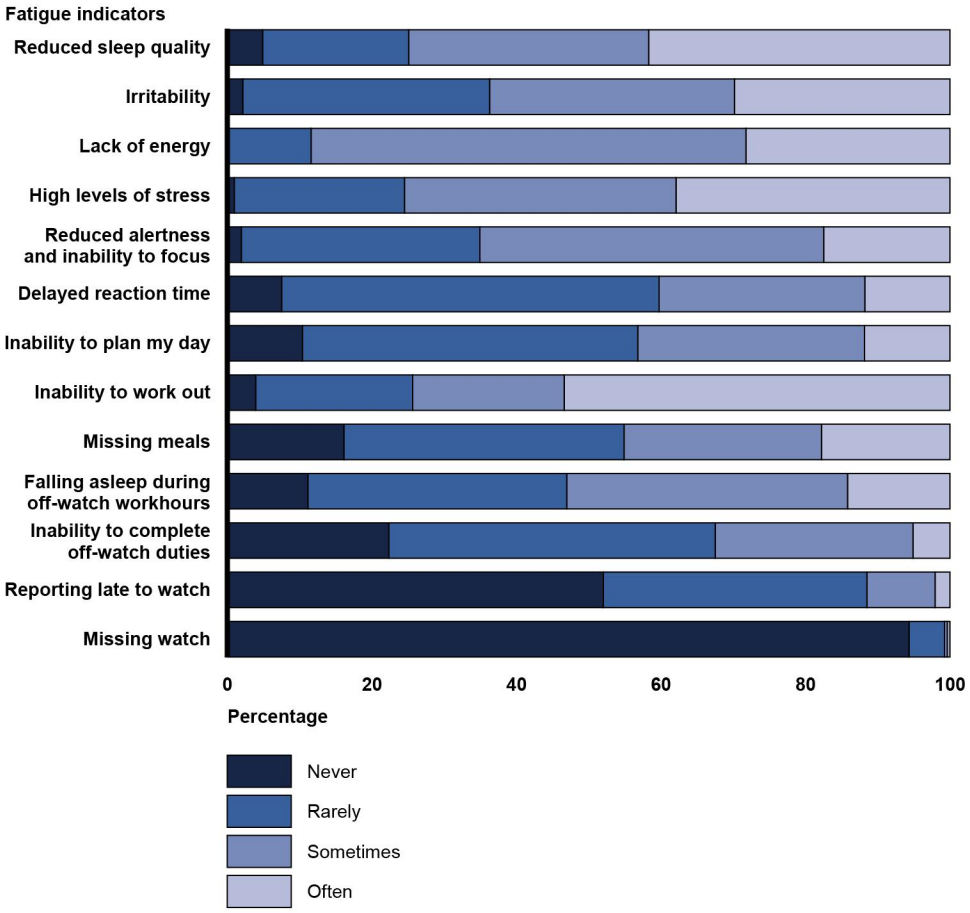
Data table for Figure 4: Navy Survey Results on Sailor Daily Wake Time Allocations

Personal Time	Socializing	Exercising	Attending Meetings	Completing Individual Training	Watch Team Duties	Work Center Duties
10	11	10	14	13	20	22

Effects of Inadequate Sleep

We estimate that nearly all officers sometimes or often experienced some fatigue-related conditions, such as lack of energy and high levels of stress, and that they rarely if ever neglected to perform their watchstanding duties (see fig. 5). In addition, respondents reported, in response to our open-ended survey questions, that they experienced other fatigue-related conditions, including forgetfulness and adverse health effects like sleep apnea. Figure 5 shows the percentage that officers experienced various fatigue-related conditions.

Figure 5: Fatigue-Related Conditions Experienced by Officers on Navy Ships



Source: GAO analysis of survey of Navy Surface Warfare Officers — Fatigue Management and Career Path. | GAO-21-366

Data table for Figure 5: Fatigue-Related Conditions Experienced by Officers on Navy Ships

	Never	Rarely	Sometimes	Often
Reduced sleep quality	4.88	20.23	33.2	41.69
Irritability	2.15	34.15	33.88	29.82
Lack of energy	0	11.6	60.18	28.22
High levels of stress	0.96	23.56	37.57	37.9
Reduced alertness and inability to focus	1.93	33.03	47.57	17.47
Delayed reaction time	7.51	52.24	28.48	11.78
Inability to plan my day	10.39	46.42	31.37	11.83
Inability to work out	3.93	21.73	20.97	53.37
Missing meals	16.13	38.78	27.3	17.79

	Never	Rarely	Sometimes	Often
Falling asleep during off-watch workhours	11.16	35.81	38.86	14.16
Inability to complete off-watch duties	22.36	45.16	27.36	5.13
Reporting late to watch	52.04	36.46	9.44	2.06
Missing watch	94.33	4.91	0.38	0.38

Note: Estimates included in this figure have a margin of error, at the 95 percent confidence level, of plus or minus 10 percentage points or fewer.

Furthermore, we estimate that 84 percent of officers consider that fatigue-related conditions among the crew often or sometimes affected ships operations. For example, one officer in our survey responded that they had observed other officers degrade to near senselessness while attempting to safely navigate a ship—because of leadership's disregard of sleep requirements.

The Fatigue Avoidance Scheduling Tool, which the Navy uses to inform its fatigue management, shows that an individual's effectiveness declines after prolonged periods without proper sleep and eventually deteriorates to an extent comparable to the impairment experienced with a blood alcohol level of .08 percent or higher—the generally recognized threshold for legal intoxication.[22] Sailors' reaction times worsen if they do not receive adequate sleep, and their ability to effectively and safely operate a ship significantly declines. Navy policy states that after sailors have been awake for 18 hours, their performance, efficiency, and decision-making ability rapidly decline to 75 percent of baseline effectiveness or less, and accident rates increase for almost every activity.[23] Therefore, sailor fatigue poses a considerable risk to the safe and effective operation of Navy ships.

The Navy Is Limited in Its Efforts to Address the Causes of Fatigue Despite Recent Improvements

The Navy is taking steps to improve its fatigue management program, but remains limited in its effort to address the causes of fatigue and inadequate sleep because of a lack of quality information upon which to base decisions in real time and address the causal factors. The Navy

[22]The Fatigue Avoidance Scheduling Tool is a program that allows researchers and planners to quantify the effects of various work-rest schedules on human performance.

[23]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2A, *Comprehensive Crew Endurance Management Policy* (Dec. 11, 2020).

considered circadian rhythm watchbills to be a primary tool for effectively managing fatigue on ships. However, our analysis showed that officers were using circadian rhythm watchbills, but were not receiving adequate sleep. The Navy's fatigue management policy establishes a sleep minimum and other guidelines, but the Navy has limited information on the extent to which the policy has been successful at reducing sailor fatigue levels.[24]

Specifically:

1. The Navy has not collected quality and timely fatigue data from sailors in a manner that supports commanders' decision-making while ships are underway because systematic data collection is not required in its guidance and the Navy has not developed a means to collect this data.
2. Prior to our review and the Navy's 2020 survey, the Navy had limited information on the extent to which sailor fatigue was affecting operations. Because the Navy had limited information on the extent of sailor fatigue, it did not take further steps to identify, monitor, or evaluate the factors causing fatigue and inadequate sleep.
3. The Navy has taken limited steps to address these causal factors because it has not identified, monitored, or evaluated information on the causal factors contributing to sailor fatigue.
4. The Navy has not yet established a process for routinely identifying and assisting units that have not implemented its fatigue management policy.

Standards for Internal Control in the Federal Government state that management should collect quality information to measure effectiveness of an entity's program to address risk and achieve its objectives. These standards further state that management should evaluate internal control issues and take appropriate corrective actions for deficiencies on a timely basis.[25] The Navy recognizes the limitations of its program and its need for better information. It has taken recent steps, listed below, to

[24]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2A, *Comprehensive Crew Endurance Management Policy* (Dec. 11, 2020); Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2, *Comprehensive Crew Endurance Management Policy* (Nov. 30, 2017).

[25]GAO-14-704G.

strengthen its fatigue management policy. However, these steps do not fully address the issues we identified.

- **Fatigue Management Policy Reissuance.** In December 2020, the Navy made a number of changes to its fatigue management policy for the surface fleet. In this reissued policy, it directed ships and commanding officers to adhere to all the fatigue management guidelines listed in the policy in deliberate and time-critical planning and decision-making.[26] The Navy also increased the sleep minimum to 7.5 hours and removed the guideline limiting work shifts to a maximum of 8 continuous hours.
- **Command Climate Surveys.** According to Navy officials, the Navy incorporated fatigue management questions into its command climate surveys in late 2020. The Navy conducts these surveys approximately every 18 months. These questions ask about the degree to which workload and environmental factors, among others, affect a sailor's ability to sleep, and about the average amount of time sailors spend on different activities while awake. However, this Navy survey does not collect information about all causative factors that lead to fatigue and inadequate sleep, such as crew shortfalls, administrative and training requirements, and collateral duties. Moreover, the Navy has not formalized a process for analyzing fatigue information from the command climate surveys or for using it to identify and assist ships that are not implementing the Navy's fatigue management policy. Furthermore, climate surveys do not provide timely information on sailors' fatigue levels that could assist commanders with real-time decision-making and mitigate the risks of fatigue on safe and effective ship operations.
- **Navy Testing Collection of Real-time Fatigue Data.** According to Navy officials, the Naval Health Research Center, in coordination with Commander U.S. Naval Surface Forces, began developing a physiological monitoring program in 2020 that will collect sleep data and link it with a watchbill scheduling system.[27] The goal of this effort is to identify a feasible approach for ship leadership and medical staff to evaluate sailors' fatigue as close to real time as possible and make informed decisions about whether a sailor is able to perform mission

[26]Commander, Naval Surface Force, U.S. Pacific Fleet and Commander, Naval Surface Force Atlantic Instruction 3120.2A, *Comprehensive Crew Endurance Management Policy* (Dec. 11, 2020).

[27]The Naval Health Research Center optimizes the operational readiness and health of our armed forces by conducting research, development, testing, and evaluation to inform Department of Defense policy.

requirements. This program would rely on data collected through a wrist-worn tracker that sailors would wear while underway. This effort is in the proof of concept stage and the Naval Health Research Center plans to conduct more testing on its viability; however, officials have already identified multiple challenges pertaining to procuring wrist-worn trackers, gaining permission to use them, and collecting and transmitting data within the secure environment on a ship.

Without systematic collection of timely sleep data, the Navy cannot adequately measure the extent of fatigue and lacks actionable data to make informed decisions, such as determining which crew members are adequately rested to stand watch or perform other operational duties. Additionally, without identifying the underlying factors that are causing fatigue and inadequate sleep, the Navy will be unable to address them, perpetuating the risks of operating with fatigued crews. Lastly, the Navy lacks a process to identify ships that are not implementing its fatigue management policy and assist these ships in taking corrective actions so that sailors are adequately rested for safe operations and optimal performance.

The Navy Assigns Fewer Crewmembers to Its Surface Fleet Than Are Required to Safely Operate and Maintain Its Ships and Tracks Ship Crew Levels against Funded Positions

The Navy assigns fewer crewmembers to its ships than its workload studies have determined are needed to safely operate and maintain them. As the Navy has increased crew size requirements to better align with ship workload, its efforts to allocate funds and assign sailors to fill these required positions have not kept pace. Additionally, the Navy has used funded positions as the measure by which it tracks the extent to which ships are crewed, not crew requirements.[28]

[28]Funded positions are those crew assignments to which the Navy has allocated their appropriated amounts. The Navy also refers to these positions as billets authorized.

The Navy Determines Crew Requirements through Workload Studies and Periodic Adjustments to Manpower Documents

The Navy determines the number of sailors and the skills required to safely and effectively operate its ships through a standardized process. The Navy Manpower Analysis Center (NAVMAC) conducts workload studies on ship classes at least every 5 years and produces a Ship Manpower Document (SMD) that specifies the required officer and enlisted crew positions for each ship class. NAVMAC develops these original crew requirements by measuring afloat and in-port workload and using analytically-based factors and allowances to calculate the required number of crewmembers. These workload studies and the development of crew requirements take up to a year or more to conduct and validate.

In between periodic updates to ship class crew requirements, the Office of the Chief of Naval Operations and the type commanders may adjust the SMD requirements for each ship in that class, as discussed below.[29] The adjusted requirements are captured in Activity Manpower Documents and include changes to the number or type of positions. According to Navy officials, these changes can be based on factors such as equipment changes and fleet-wide directives, as well as variations in equipment and mission between ships of the same class. Navy officials also stated that changes to SMD requirements can take a year or more as they are based on workload studies, but Navy commanders can make monthly adjustments to them based on the needs of the fleet.

The Navy Does Not Fund All Required Positions and Enlisted Positions Are Funded Considerably below the Requirement

The Navy uses adjusted crew requirements from its Activity Manpower Documents as the baseline for requirements in its main personnel database and to inform budget requests. However, the Navy's crew assignment process assumes that not all adjusted crew requirements will

[29]There are two type commanders responsible for performing administrative, personnel, and operational training functions for the surface ships in the Atlantic and Pacific fleets. Aircraft carriers fall under the Atlantic and Pacific fleet Naval Air Force commanders.

be funded.[30] As a result, the Navy allocates funding for a certain number of positions (funded positions) to be filled against the adjusted requirement (see table 1).

Table 1: Navy's Crew Size Requirements and Funding Elements

Crew size measure	Primary command responsible	Description
Original required positions in Ship Manpower Document (SMD)	Navy Manpower Analysis Center (NAVMAC)	NAVMAC determines crew requirements for each ship class through workload studies that identify the number of crewmembers required, as well as the rank and certifications needed, to deliver Office of the Chief of Naval Operations-approved specified capability. NAVMAC seeks to update each class's SMD approximately every 5 years.
Adjusted required positions in Activity Manpower Document (AMD)	Type commanders	Each ship has its own AMD, which is maintained in the Navy's Total Force Manpower Management System database. Various factors, which Navy officials said could include equipment changes, mission requirements, or fleet-wide directives may necessitate small changes to a ship's original SMD crew requirements outside of the 5-year update cycle. Type Commanders may submit out-of-cycle changes on behalf of subordinate commands. The Navy considers the AMD as the authoritative baseline for required crew size in its main personnel database and uses it to inform budget requests.
Funded positions	Deputy Chief of Naval Operations (DCNO) for Warfare Systems (N9)	DCNO N9 assesses the crew requirements produced as a result of the above processes, and funds some or all of the requested positions. Fiscal constraints, as well as legislative limits on the overall number of Navy personnel, can restrict the Navy from funding all required positions.

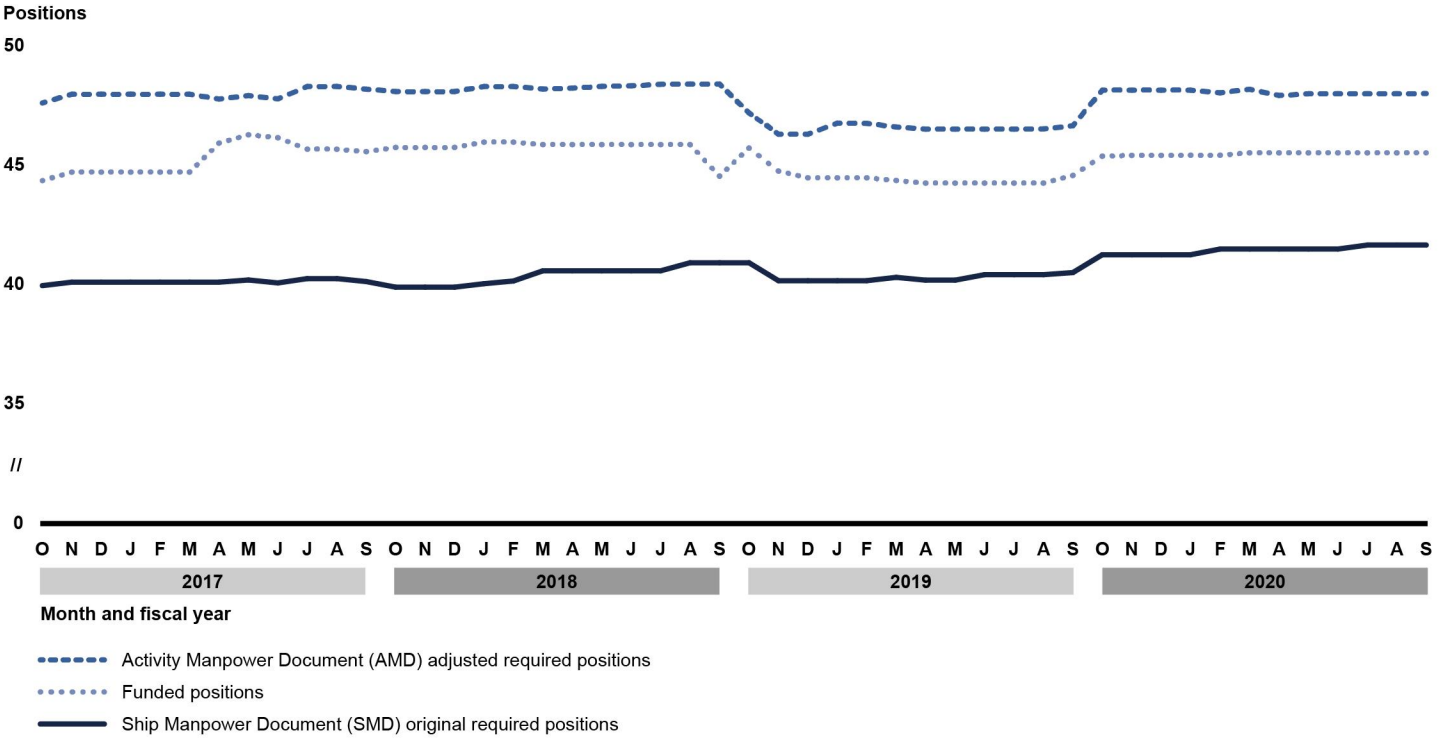
Source: GAO analysis of Navy information. | GAO-21-366

We found that, on average, the Navy adjusts the requirements for officer positions so that the Activity Manpower Document requirement has more officer positions than the SMD. According to the Navy's 2017 Strategic Readiness Review, for over 20 years, the Navy has consistently commissioned more surface warfare officers than the SMDs state would be required. Officials confirmed the review's finding that the Navy has done so to ensure that there are adequate numbers of officers to fill leadership positions at sea.[31] However, the amount of officer positions the Navy allocates funds for is still below the adjusted requirement established in its Activity Manpower Documents (see fig. 6).

[30]Office of the Chief of Naval Operations Instruction (OPNAVINST) 1000.16L, *Navy Total Force Manpower Policies and Procedures* (June 24, 2015) (change transmittal 2, Jan. 9, 2019). OPNAV 1000.16 states that fiscal constraints can restrict the Navy from authorizing (buying) all of its validated total force requirements.

[31]U.S. Navy, *Strategic Readiness Review 2017* (Dec. 3, 2017).

Figure 6: Average Original Required, Adjusted Required, and Funded Positions for Surface Fleet Officers, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 6: Average Original Required, Adjusted Required, and Funded Positions for Surface Fleet Officers, Fiscal Years 2017 through 2020

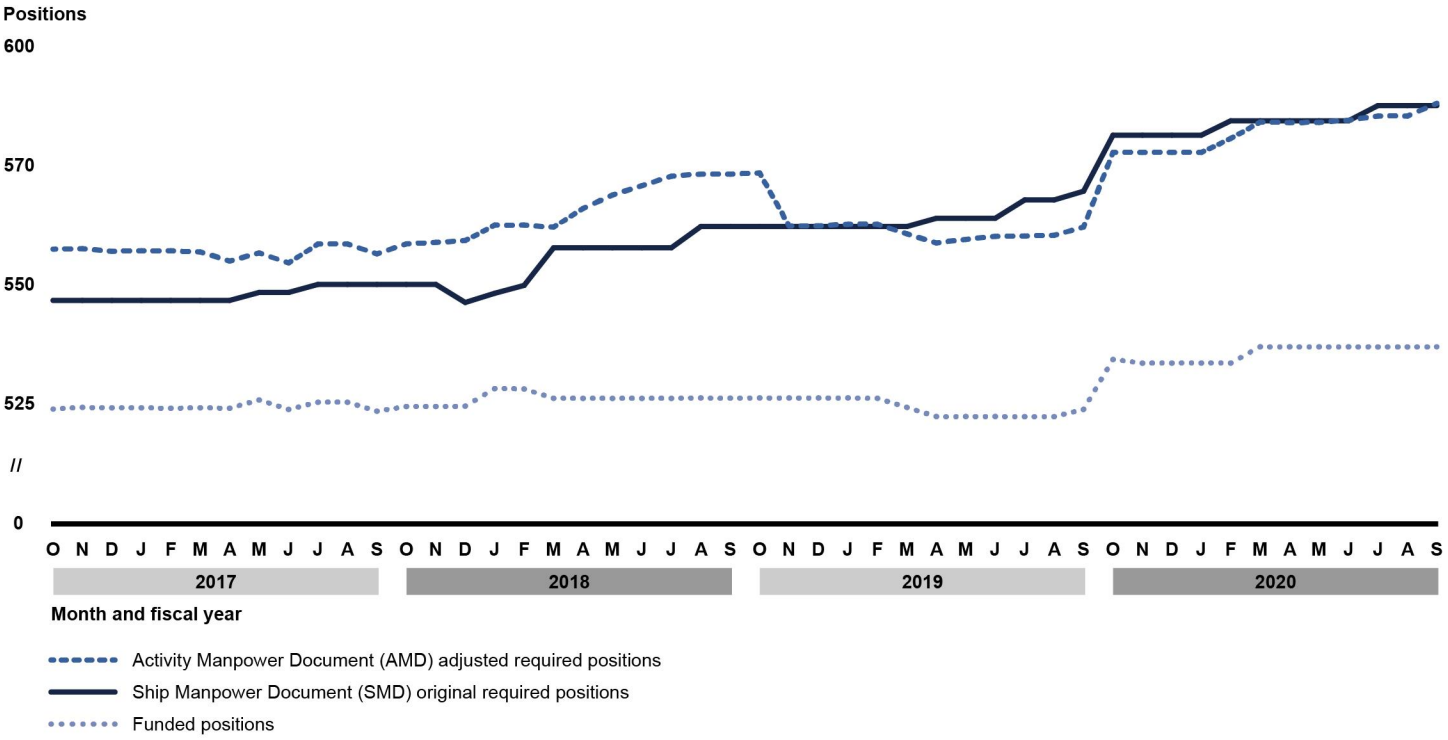
Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2017	Oct	39.896	47.4921	44.2619
2017	Nov	40.0403	47.856	44.616
2017	Dec	40.0403	47.856	44.616
2017	Jan	40.0403	47.856	44.616
2017	Feb	40.0403	47.856	44.616
2017	March	40.0403	47.856	44.616
2017	April	40.0403	47.656	45.824
2017	May	40.1301	47.7984	46.1694
2017	June	40.0081	47.664	46.048
2017	July	40.1885	48.1789	45.5691
2017	Aug	40.1885	48.1789	45.5691

Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2017	Sept	40.065	48.0645	45.4677
2018	Oct	39.832	47.9683	45.6429
2018	Nov	39.832	47.9683	45.6429
2018	Dec	39.832	47.9683	45.6429
2018	Jan	39.9758	48.176	45.864
2018	Feb	40.0887	48.176	45.864
2018	March	40.512	48.0714	45.7619
2018	April	40.512	48.1111	45.7619
2018	May	40.512	48.1825	45.7619
2018	June	40.512	48.2063	45.7619
2018	July	40.512	48.2698	45.7619
2018	Aug	40.848	48.2778	45.7619
2018	Sept	40.848	48.2778	44.4444
2019	Oct	40.848	47.0794	45.619
2019	Nov	40.1016	46.1938	44.6589
2019	Dec	40.1016	46.1938	44.3798
2019	Jan	40.1016	46.6512	44.3798
2019	Feb	40.1016	46.6434	44.3798
2019	March	40.2403	46.4923	44.2692
2019	April	40.1231	46.4046	44.1603
2019	May	40.1231	46.4046	44.1603
2019	June	40.3511	46.4046	44.1603
2019	July	40.3511	46.4046	44.1603
2019	Aug	40.3511	46.4122	44.1603
2019	Sept	40.4385	46.5462	44.4769
2020	Oct	41.1811	48.0234	45.2813
2020	Nov	41.1811	48.0234	45.3125
2020	Dec	41.1811	48.0234	45.3125
2020	Jan	41.1811	48.0234	45.3203
2020	Feb	41.4173	47.9141	45.3203
2020	March	41.4173	48.062	45.4186
2020	April	41.4173	47.8062	45.4186
2020	May	41.4173	47.876	45.4186
2020	June	41.4173	47.876	45.4186
2020	July	41.5827	47.876	45.4186
2020	Aug	41.5827	47.876	45.4186

Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2020	Sept	41.5827	47.8837	45.4186

We also found that, on average, the Navy allocates funds for fewer enlisted positions than either set of requirements for enlisted sailors, who make up at least 90 percent of each ship crew (see fig. 7). The Navy funded no more than 94 percent of adjusted required positions between fiscal year 2017 and fiscal year 2020.

Figure 7: Average Original Required, Adjusted Required, and Funded Positions for Surface Fleet Enlisted Sailors, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 7: Average Original Required, Adjusted Required, and Funded Positions for Surface Fleet Enlisted Sailors, Fiscal Years 2017 through 2020

Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2017	Oct	546.535	557.206	523.896
2017	Nov	546.535	557.298	524.261

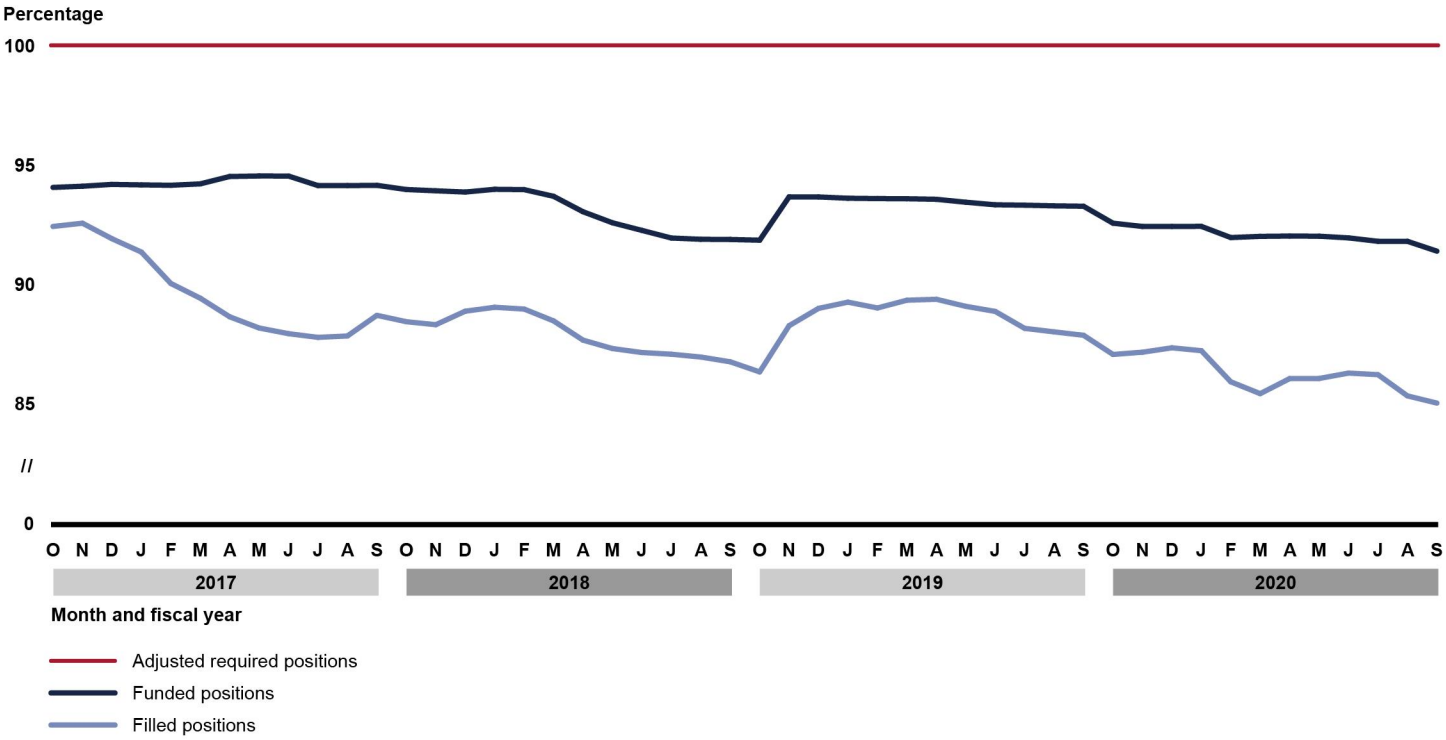
Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2017	Dec	546.535	556.748	524.164
2017	Jan	546.535	556.87	524.164
2017	Feb	546.535	556.87	524.075
2017	March	546.535	556.626	524.172
2017	April	546.535	554.718	524.075
2017	May	548.187	556.423	525.805
2017	June	548.187	554.344	523.821
2017	July	549.866	558.285	525.331
2017	Aug	549.866	558.285	525.331
2017	Sept	549.866	556.221	523.455
2018	Oct	549.866	558.305	524.44
2018	Nov	549.866	558.618	524.44
2018	Dec	546.101	559.008	524.515
2018	Jan	548.016	562.215	528.165
2018	Feb	549.656	562.215	528.09
2018	March	557.484	561.802	526.142
2018	April	557.484	565.672	526.134
2018	May	557.484	568.473	526.127
2018	June	557.484	570.42	526.127
2018	July	557.484	572.389	526.127
2018	Aug	561.914	572.824	526.224
2018	Sept	561.914	572.824	526.179
2019	Oct	561.914	573.061	526.224
2019	Nov	561.914	562.03	526.224
2019	Dec	561.914	562.052	526.224
2019	Jan	561.914	562.381	526.231
2019	Feb	561.914	562.381	526.149
2019	March	561.914	560.4	524.259
2019	April	563.633	558.493	522.346
2019	May	563.633	559.228	522.353
2019	June	563.633	559.875	522.36
2019	July	567.45	559.934	522.324
2019	Aug	567.45	560.088	522.316
2019	Sept	569.266	561.815	523.83
2020	Oct	580.936	577.348	534.242
2020	Nov	580.936	577.348	533.462

Fiscal Year	Month	Ship Manpower Document (SMD) original required positions	Activity Manpower Document (AMD) adjusted required positions	Funded positions
2020	Dec	580.936	577.348	533.477
2020	Jan	580.936	577.348	533.485
2020	Feb	583.936	580.265	533.477
2020	March	583.936	583.654	536.88
2020	April	583.936	583.556	536.872
2020	May	583.936	583.602	536.872
2020	June	583.936	584.045	536.872
2020	July	587.104	584.917	536.842
2020	Aug	587.104	584.917	536.842
2020	Sept	587.104	587.571	536.872

The Navy Is Generally Crewing the Surface Fleet below What Is Funded and Required

The Navy has not only funded fewer positions than are required, but our analysis shows that it has not filled all of its funded positions. These shortfalls have grown over the last 4 fiscal years. We found that the average shortfall between filled positions and required positions has grown from 8 percent in October 2016 to 15 percent in September 2020 (see fig. 8).

Figure 8: Average Positions Required, Funded, and Filled for Surface Fleet Enlisted Crew, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 8: Average Positions Required, Funded, and Filled for Surface Fleet Enlisted Crew, Fiscal Years 2017 through 2020

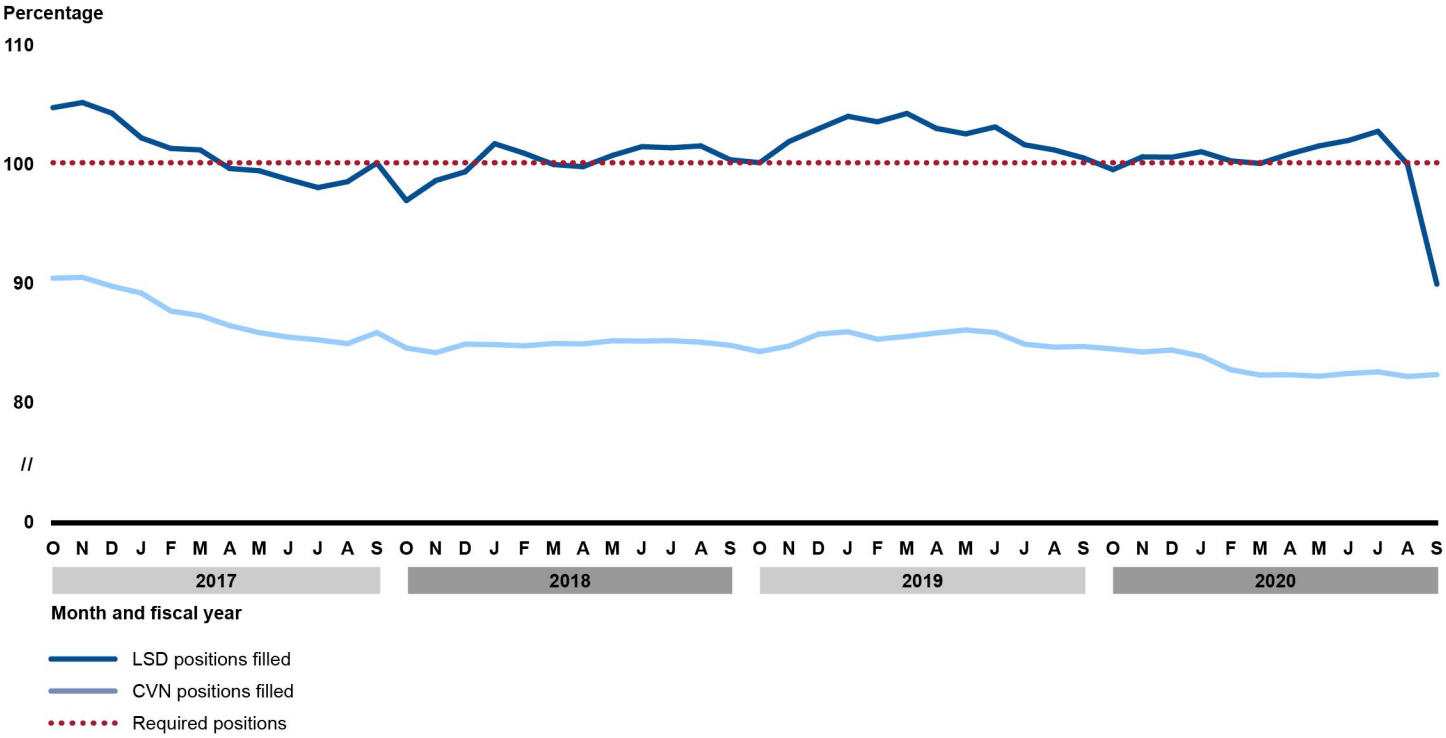
Fiscal Year	Month	Funded positions	Filled positions	Adjusted required positions
2017	Oct	94%	92%	100%
2017	Nov	94%	93%	100%
2017	Dec	94%	92%	100%
2017	Jan	94%	91%	100%
2017	Feb	94%	90%	100%
2017	March	94%	89%	100%
2017	April	94%	89%	100%
2017	May	94%	88%	100%
2017	June	94%	88%	100%
2017	July	94%	88%	100%
2017	Aug	94%	88%	100%
2017	Sept	94%	89%	100%
2018	Oct	94%	88%	100%

Fiscal Year	Month	Funded positions	Filled positions	Adjusted required positions
2018	Nov	94%	88%	100%
2018	Dec	94%	89%	100%
2018	Jan	94%	89%	100%
2018	Feb	94%	89%	100%
2018	March	94%	88%	100%
2018	April	93%	88%	100%
2018	May	93%	87%	100%
2018	June	92%	87%	100%
2018	July	92%	87%	100%
2018	Aug	92%	87%	100%
2018	Sept	92%	87%	100%
2019	Oct	92%	86%	100%
2019	Nov	94%	88%	100%
2019	Dec	94%	89%	100%
2019	Jan	94%	89%	100%
2019	Feb	94%	89%	100%
2019	March	94%	89%	100%
2019	April	94%	89%	100%
2019	May	93%	89%	100%
2019	June	93%	89%	100%
2019	July	93%	88%	100%
2019	Aug	93%	88%	100%
2019	Sept	93%	88%	100%
2020	Oct	93%	87%	100%
2020	Nov	92%	87%	100%
2020	Dec	92%	87%	100%
2020	Jan	92%	87%	100%
2020	Feb	92%	86%	100%
2020	March	92%	85%	100%
2020	April	92%	86%	100%
2020	May	92%	86%	100%
2020	June	92%	86%	100%
2020	July	92%	86%	100%
2020	Aug	92%	85%	100%
2020	Sept	91%	85%	100%

Our analysis of total surface ship positions required, funded, and filled shows that in aggregate, the Navy is increasingly challenged to

adequately crew its ships to its required level. However, our analyses of individual ship classes show that the Navy may be crewing some ship classes more successfully than others. For example, dock landing ships (LSD) met or exceeded the enlisted crewing requirement for 33 of the 48 months we analyzed (see fig. 9).[32] We found that the ship class with the largest shortfall of required crewmembers was Nimitz class aircraft carriers (CVN 68), which was crewed between 82 percent and 90 percent of required positions between fiscal years 2017 and 2020—a shortfall in absolute terms of about 565 and 301 enlisted sailors, respectively. Please see appendix III for detailed crewing information on each of the ship classes we analyzed.

Figure 9: Average Percentage of Required Aircraft Carrier (CVN) and Dock Landing Ship (LSD) Positions Filled, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

[32]In addition to dock landing ships, only one other ship class was crewed to Navy requirements. The America class amphibious assault ship (LHA 6) was crewed to the requirement for 3 of 48 months when there was just one ship of that class.

Data table for Figure 9: Average Percentage of Required Aircraft Carrier (CVN) and Dock Landing Ship (LSD) Positions Filled, Fiscal Years 2017 through 2020

Fiscal Year	Month	CVN positions filled	LSD positions filled	Required positions
2017	Oct	90%	105%	100%
2017	Nov	90%	105%	100%
2017	Dec	90%	104%	100%
2017	Jan	89%	102%	100%
2017	Feb	88%	101%	100%
2017	March	87%	101%	100%
2017	April	86%	100%	100%
2017	May	86%	99%	100%
2017	June	85%	99%	100%
2017	July	85%	98%	100%
2017	Aug	85%	98%	100%
2017	Sept	86%	100%	100%
2018	Oct	85%	97%	100%
2018	Nov	84%	99%	100%
2018	Dec	85%	99%	100%
2018	Jan	85%	102%	100%
2018	Feb	85%	101%	100%
2018	March	85%	100%	100%
2018	April	85%	100%	100%
2018	May	85%	101%	100%
2018	June	85%	101%	100%
2018	July	85%	101%	100%
2018	Aug	85%	101%	100%
2018	Sept	85%	100%	100%
2019	Oct	84%	100%	100%
2019	Nov	85%	102%	100%
2019	Dec	86%	103%	100%
2019	Jan	86%	104%	100%
2019	Feb	85%	103%	100%
2019	March	86%	104%	100%
2019	April	86%	103%	100%
2019	May	86%	102%	100%
2019	June	86%	103%	100%
2019	July	85%	101%	100%
2019	Aug	85%	101%	100%

Fiscal Year	Month	CVN positions filled	LSD positions filled	Required positions
2019	Sept	85%	100%	100%
2020	Oct	84%	99%	100%
2020	Nov	84%	100%	100%
2020	Dec	84%	100%	100%
2020	Jan	84%	101%	100%
2020	Feb	83%	100%	100%
2020	March	82%	100%	100%
2020	April	82%	101%	100%
2020	May	82%	101%	100%
2020	June	82%	102%	100%
2020	July	83%	103%	100%
2020	Aug	82%	100%	100%
2020	Sept	82%	90%	100%

Note: The decline in the percentage of required positions that were filled on LSD ships in late fiscal year 2020 resulted from an increase in the number of required positions due to an update to the Ship Manpower Document.

Navy Increased Crew Requirements but Generally Did Not Allocate Funds for Additional Positions nor Fill Them

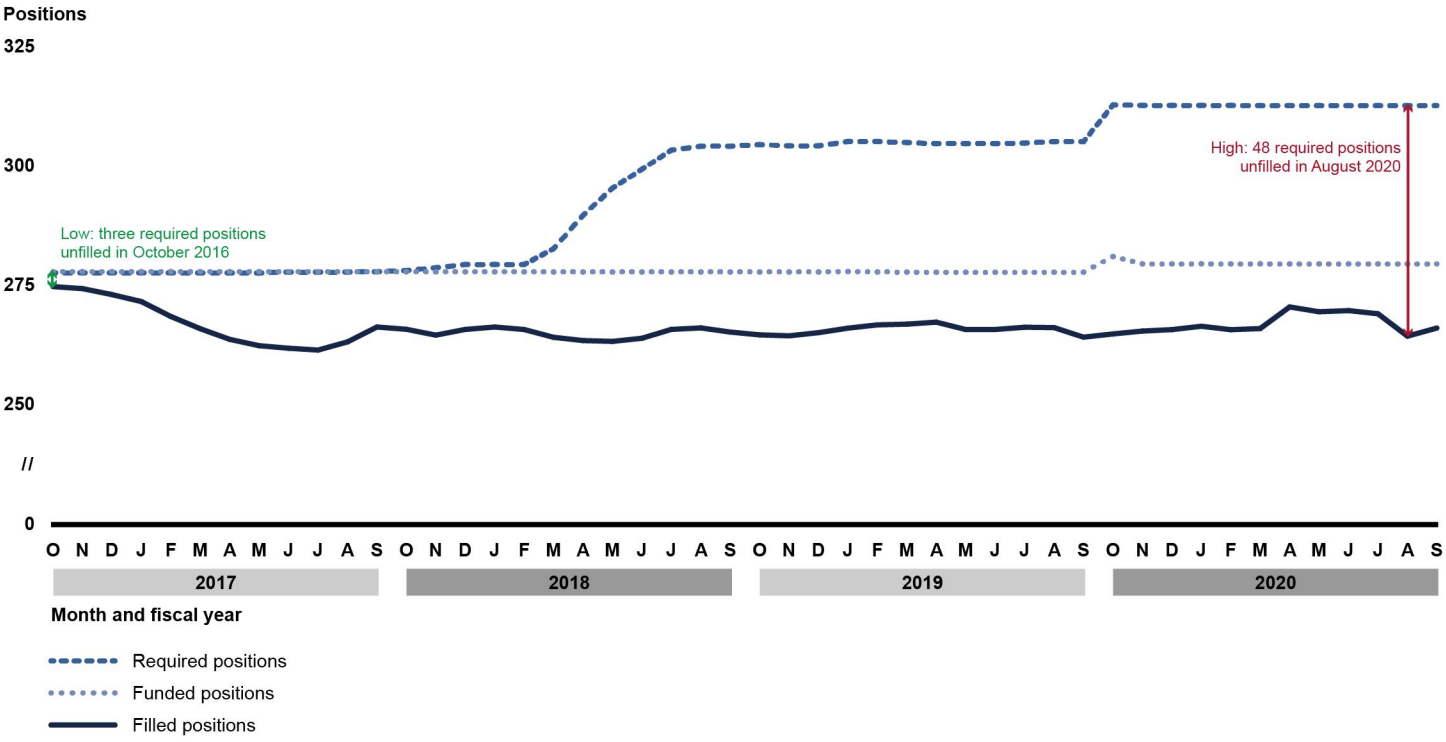
As the Navy has increased crew requirements, the shortfalls of funded and filled positions relative to these requirements have grown. Since 2017, the Navy has taken steps to more accurately measure workload, calculate the required number of crewmembers for its ships, and update crew requirements. However, allocated funds for additional positions have not kept pace with these increased requirements. We reported in 2017 that the Navy's process for determining crew requirements did not adequately capture all workload and that the Navy did not determine its requirements based on current factors and allowances. We made three recommendations to improve the Navy's process for determining crew requirements.[33] In response, the Navy instituted changes to more accurately measure ship workload and updated crew requirements for five ship classes. It expects to complete studies and generate new SMDs for the remaining surface ship classes through 2024. These efforts have resulted in increased crew requirements since 2018. For example, the average crew requirement for Arleigh Burke class destroyers (DDG 51) increased by about 10 percent or 32 personnel. Similarly, crew requirements increased by about 7 percent (27 personnel) for

[33]GAO-17-413.

Ticonderoga class cruisers (CG 47) and about 6 percent (23 personnel) for San Antonio class amphibious transport docks (LPD 17).

According to officials, the Navy has taken steps to fund the new requirements. However, they noted that they cannot fund new positions outside of DOD's annual budgeting and programming cycle, meaning it can take 2 to 3 years before new positions can be authorized as required positions. For example, a large increase of destroyer (DDG 51) requirements occurred in 2018. Navy officials said they allocated funds for new positions against this higher requirement and they will phase these positions in across several years to allow accessions to meet demand and not result in additional unfilled positions. This lag between increased crew requirements and the Navy's gradual funding and filling of additional positions is illustrated in figure 10. While the enlisted requirement for destroyers increased in fiscal year 2018, the number of funded or filled positions did not increase to match the new requirement. As a result, in August 2020, the average enlisted crew aboard destroyers was 85 percent of the requirement—an average of 48 positions fewer than what is required by the Navy's workload studies.

Figure 10: Average Positions Required, Funded, and Filled for Destroyer Enlisted Crews, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 10: Average Positions Required, Funded, and Filled for Destroyer Enlisted Crews, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required positions	Funded positions	Filled positions	High/Low Difference
2017	Oct	277.355	277.597	274.484	3 unfilled
2017	Nov	277.355	277.597	274.065	
2017	Dec	277.355	277.597	272.823	
2017	Jan	277.355	277.597	271.371	
2017	Feb	277.355	277.597	268.274	
2017	March	277.339	277.597	265.726	
2017	April	277.339	277.597	263.516	
2017	May	277.306	277.597	262.194	
2017	June	277.508	277.571	261.667	
2017	July	277.508	277.571	261.286	
2017	Aug	277.508	277.571	262.984	
2017	Sept	277.578	277.547	266.078	
2018	Oct	277.828	277.547	265.609	

Fiscal Year	Month	Required positions	Funded positions	Filled positions	High/Low Difference
2018	Nov	278.406	277.547	264.391	
2018	Dec	279.078	277.547	265.578	
2018	Jan	279.078	277.547	266.078	
2018	Feb	279.078	277.547	265.562	
2018	March	282.369	277.523	263.938	
2018	April	289.292	277.523	263.262	
2018	May	294.969	277.523	263.092	
2018	June	298.892	277.523	263.738	
2018	July	302.862	277.523	265.585	
2018	Aug	303.677	277.523	265.892	
2018	Sept	303.677	277.523	265.031	
2019	Oct	304.015	277.523	264.446	
2019	Nov	303.754	277.523	264.246	
2019	Dec	303.754	277.523	264.908	
2019	Jan	304.662	277.615	265.846	
2019	Feb	304.662	277.523	266.523	
2019	March	304.439	277.5	266.682	
2019	April	304.224	277.478	267.09	
2019	May	304.224	277.478	265.552	
2019	June	304.224	277.478	265.567	
2019	July	304.328	277.478	266.03	
2019	Aug	304.642	277.478	265.955	
2019	Sept	304.642	277.478	263.97	
2020	Oct	312.269	280.746	264.642	
2020	Nov	312.164	279.209	265.239	
2020	Dec	312.164	279.209	265.537	
2020	Jan	312.164	279.224	266.239	
2020	Feb	312.164	279.209	265.522	
2020	March	312.119	279.224	265.761	
2020	April	312.119	279.209	270.254	
2020	May	312.119	279.209	269.254	
2020	June	312.119	279.209	269.493	
2020	July	312.119	279.209	268.836	
2020	Aug	312.119	279.209	264.179	48 unfilled
2020	Sept	312.119	279.209	265.866	

As the Navy continues to update its crew requirements to more accurately reflect ship workload it will be challenged to fund positions and assign crew members to these ships to meet the higher crew levels required. Specifically, meeting the increased requirements will pose challenges due to the lag between updating crew requirements and the funding of additional positions. Funding additional positions within the Navy's limited end strength will be particularly challenging since there is a constraint on the number of sailors available for distribution across the fleet.

We have previously reported that insufficient crew onboard Navy ships could present a safety hazard, a finding also included in the Navy's 2017 Strategic Readiness Review.[34] The review called for adjusting ship crewing levels to allow for adequate crew rest, performance of extraneous and collateral duties, and training that occurs while aboard ship. It also called for ship crewing levels to allow for some excess capacity. However, our analysis of surface ship crew levels shows that this adjustment has not happened—the surface fleet continues to be crewed at levels that are significantly below the requirement determined by the Navy's workload studies. Our survey results suggest that this personnel-to-workload mismatch could be a driving factor in the long work hours and lack of sleep reported by sailors.

The Navy Tracks Ship Crew Levels and Assesses Crewing Targets against the Number of Funded Positions

The Navy regularly tracks fill rates on its ships as well as the number of positions filled with sailors having the right qualifications (known as fit), allowing officials to assess individual ship and overall fleet crew levels.[35] However, this tracking has not provided officials with accurate information on the type and level of strength its ships need to perform the Navy's work and deliver capability specified by the Office of the Chief of Naval Operations (OPNAV). This is because the Navy has historically compared the number of filled positions to the number of funded positions, not to the number of required positions. This means that the Navy has tracked crew levels based on what positions it could afford to fund instead of what

[34]GAO-17-413 and U.S. Navy, *Strategic Readiness Review 2017* (Dec. 3, 2017).

[35]The entities responsible for ship readiness include the Office of Chief of Naval Operations; Commander, U.S. Fleet Forces Command; and Commander, U.S. Pacific Fleet.

Navy studies have determined are needed, masking the full extent of crew shortfalls.

According to the Navy's guidance on total force personnel policies and procedures, crewing requirements identify the type and level of strength needed to perform the Navy's work and deliver OPNAV-specified capability.[36] In addition to the Navy's guidance, *Standards for Internal Control in the Federal Government* state that management should collect quality information to measure effectiveness of an entity's program to address risk and achieve its objectives.[37]

Tracking and Reporting Crew Levels

At the start of our review in 2019, the Navy only tracked and reported the extent to which funded crew positions had been filled. However, Congress required the Navy in late 2019 to begin reporting the extent to which ship crews fall below certain thresholds of required positions to Congress, and the Navy has recently started to use comparisons of filled and required positions in monthly crewing updates used to inform Navy leadership. The John S. McCain National Defense Authorization Act for Fiscal Year 2019 required the Navy to report crews that fell under specified crewing thresholds to Congress, but the Navy's reports used funded positions as the basis for measuring crew sizes and not the crew requirement.[38] The following year's National Defense Authorization Act for Fiscal Year 2020 replaced this reporting provision, mandating the Navy to report crews falling below thresholds by using the total number of military personnel assigned to the ship when compared with both the original SMD requirement and funded positions.[39] The Navy is required to provide quarterly reports to Congress on ships not meeting the thresholds.

The Navy also tracks crew levels internally and has established targets for filling positions on board its deploying ships. When the Navy began implementing its revised operational schedule in November 2014, referred to as the Optimized Fleet Response Plan, it established a general crewing goal of filling at least 95 percent of funded positions on

[36]OPNAVINST 1000.16L.

[37]GAO-14-704G.

[38]Pub. L. No. 115-232, § 525 (2018).

[39]Pub. L. No. 116-92, § 597 (2019).

deploying ships. In August 2019, the Navy issued guidance that established more specific crewing target levels for all of its ships, prioritizing the crewing of surface ships that are homeported overseas and other deploying ships.[40] The guidance stated that ships should be crewed for sustained combat operations by including sufficient sailors to continue operations in the face of casualties. However, the Navy measured these crewing targets in the guidance using funded positions, not the number of positions required to execute all workload and effectively operate the ship, as determined by the Navy's workload study process.

In February 2021, Navy officials notified us that new guidance with updated crewing target levels had been issued.[41] This guidance states that the Navy is working to fully fund the total positions required, but until the number of funded positions equals the number of required positions, the fleet will continue to crew and target to the number of positions funded.[42] In February 2021, the Navy provided us with its latest monthly update on enlisted crewing levels. Previously this document compared positions which were filled and funded, but it now includes comparisons of positions filled, funded, and required. These comparisons show the shortfalls between the number of filled and funded positions, and the considerably larger shortfalls between filled and required positions.

Navy officials told us that they intend to continue including comparisons of filled positions against required positions in the monthly updates, and that they are considering developing another metric comparing filled positions against required positions to assess readiness. However, because the Navy's latest guidance does not require comparisons of required and filled positions, there is no assurance that the Navy's internal monitoring of crew levels will continue to include this information. Without consistent tracking and reporting of required positions that are filled, Navy leaders will lack visibility over the full extent of personnel shortfalls and will be

[40]Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet Notice 1000, *Sea Duty Manning Target Levels* (Aug. 16, 2019). This notice has been superseded by an updated notice issued in February 2021.

[41]Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet Notice 1000, *Sea Duty Manning Target Levels* (Feb. 12, 2021).

[42] The February 2021 guidance states that gaps between required and filled positions will only be reflected in readiness reporting.

hindered in their ability to mitigate risk and make informed decisions about how to distribute personnel across the fleet.

Crewing Targets

In addition to officials having limited information on the extent to which its ships are being crewed to the level of strength that is required, the Navy may not have meaningful crewing targets for its ships. Navy officials could not provide an analytical basis for prior and current crewing targets, and told us that they were not developed through analysis or risk assessment. The most recent guidance establishing these targets states that all deployed units should be ready to fight at the high-end of maritime warfare to support planned and unplanned peacetime operations and wartime combat, placing emphasis on having sufficient numbers of sailors aboard during all operations at sea to address personnel needs for long-term heightened conditions or casualties inflicted during peacetime or wartime.[43] However, these crewing targets are based on comparisons of filled and funded positions, and do not account for the deficits between required and funded positions. Therefore, it is not known whether the minimum targets provide sufficient mitigation for the risks of operating ships with fewer sailors than required.

The Navy Has Projected the Need for Increasing Personnel Levels to Crew a Growing Fleet, but Is Likely Understating the Amount Required

The Navy uses a tool to forecast future personnel needs and develop estimates for future resource needs, but its projections may understate the number of personnel needed to adequately crew the future fleet.[44] The Navy uses its Manpower Projection Tool to estimate the number of active-duty personnel, or active-duty end strength, needed to crew the fleet over the next 30 years.[45] The Navy also uses the tool to project personnel needs at the more granular levels of ratings (occupational

[43]Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet Notice 1000, *Sea Duty Manning Target Levels* (Feb. 12, 2021). These entities promulgated this guidance and are responsible for establishing crewing targets.

[44]This tool was developed and is operated by the Office of the Chief of Naval Operations.

[45]The Navy had 347,432 active-duty personnel as of January 2021.

specialties) and pay grades and to accessions needed to address personnel turnover. For example, the tool has allowed Navy officials to identify growing needs and potential future personnel shortfalls for certain ratings.

The information generated by this tool is used by a number of organizations within the Navy to inform resource decisions. For example, the Navy's recruitment and retention officials use this information to develop incentives to influence retention behavior and mitigate projected personnel shortfalls. The Navy also uses the programmed number of positions and annual accession projections from its tool to prepare its training pipeline to absorb incoming personnel and inform training resource decisions. A Navy instruction guides the process for planning and resourcing out-year training requirements, and Navy officials told us that the training pipeline is adequately funded to meet the training needs of sailors across the current budget cycle and the 2020 future years' defense program.[46] However, officials added that the Navy will be challenged to absorb higher numbers of new personnel into the training pipeline as the number of ships and required positions continues to grow over the next several years.

In 2019, the Navy provided us with its personnel projections based on the 355-ship requirement determined by the 2016 force structure assessment and the associated 30-year shipbuilding for fiscal year 2020.[47] Based on that plan, the Navy's projections showed a need for annual increases of personnel through 2024 to crew an increasing number of ships, with sustained growth in end strength peaking in fiscal year 2033. The Navy projected that active-duty end strength will need to increase, from about 345,000 personnel in fiscal year 2020 to about 371,000 personnel in fiscal year 2033, an 8 percent increase. In December 2020, the Navy released an updated 30-year shipbuilding plan covering fiscal years 2022 to 2051.[48] The plan is based on an updated force structure assessment that calls for reaching 355 ships by the early 2030s, and to continue growing the fleet to 405 crewed ships in 2051. The Navy is in the process of

[46]Office of the Chief of Naval Operations Instruction 1500.47C, *Navy Training Quota Management* (May 15, 2014). This instruction establishes guidelines and responsibilities for optimizing training resources and managing and controlling training capacity.

[47]Office of the Chief of Naval Operations, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020* (March 2019).

[48]Office of the Chief of Naval Operations, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels* (December 9, 2020).

updating its personnel projections based on this new shipbuilding plan and will generate final projections after the fiscal year 2022 budget is approved.

The Navy's December 2020 shipbuilding plan calls for a larger fleet size, and it states that it is essential that consistent funding levels are scaled to support the size of the fleet. Navy officials added that there is a risk to underestimating costs, leading to insufficient funding requests and ultimately degraded readiness. The Navy did not use its Manpower Projection Tool to develop the shipbuilding plan's sustainment cost estimate, which includes estimated costs for personnel. However, the Navy did use the tool's personnel projections to provide us with an estimate of long-range personnel costs associated with a larger fleet, finding that enlisted personnel costs would rise from about $36 billion in fiscal year 2021 to $67 billion in fiscal year 2049.[49] This estimate is based on the prior shipbuilding plan with a maximum of 355 ships.

The Manpower Projection Tool's inputs can be adjusted to account for changing crewing assumptions on future shipbuilding programs, but the Navy has not used crewing requirements to develop its projections. The Navy has generated its personnel projections—that is, future end strength needs—using the current number of funded positions, even though officials have told us that crew requirements could be used to generate more accurate projections. Funded positions are a measure of the personnel for which the Navy has allocated funding, not a measure of the personnel that are required to adequately crew the fleet. As discussed above, we found that between fiscal years 2017 and 2020, the Navy allocated funds for between 91 and 94 percent of the enlisted positons required by analytically-based workload studies. Therefore, the Navy's projections are likely underestimating the amount of personnel that will be needed to safely and effectively crew the growing fleet by as much as 9 percent. Similarly, cost estimates based on these projections also risk underrepresenting the future costs needed to fully crew the fleet by a similar amount.

The Manpower Projection tool was developed in response to Navy requirements, our 2017 recommendation that the Navy identify personnel needs and costs for the planned larger fleet, and a law that requires the

[49]This long-range personnel cost estimate associated with the larger Navy was calculated in then-year dollars adjusted for inflation.

Navy to identify personnel needs and costs associated with a planned larger fleet size.[50] It has improved the Navy's ability to forecast long-term personnel needs; however, the Navy has used inputs to this tool that underestimate the personnel required to crew the future fleet, which may hinder informed strategic decision-making and potentially contribute to future personnel shortfalls. *Standards for Internal Control in the Federal Government* state that management should communicate quality information needed to achieve program objectives.[51] Using projections based on crew requirements would more accurately forecast the crewing needs of the future fleet, better inform workforce and training planners, and lead to more accurate cost estimates.

The Navy Is Implementing and Evaluating Ready Relevant Learning but Has Not Fully Assessed How It May Affect Sailor Workload

The Navy is in the process of implementing its Ready Relevant Learning (RRL) initiative, meant to provide more timely and targeted training to enlisted sailors, and has several ongoing and planned measures to assess its effectiveness.[52] However, full implementation will require significant upgrades to the Navy's information technology (IT) infrastructure, for which it has only recently begun planning. In addition, the Navy has not fully assessed how the time that sailors will be expected to spend on modernized RRL training when it is fielded will affect workload.

The Navy Is Implementing Ready Relevant Learning

Since laying out the vision and guidance for Ready Relevant Learning in 2017, the Navy has taken actions to implement key elements of the initiative (see table 2). First, the Navy has divided accession training into blocks for delivery at points in sailors' careers that align with the work

[50]Pub. L. No. 115-232, § 524 (2018).

[51]GAO-14-704G.

[52]The Office of the Chief of Naval Operations is the entity overseeing implementation of RRL.

being accomplished for all planned ratings.[53] Currently, RRL implementation is focused on accession training, or "A school," where junior sailors receive the technical training in their selected occupation prior to their first sea tour. Ultimately, the career-long learning continuum will expand to include journeyman and master-level training.

Second, the Navy has modernized the training curriculums for over half of the planned ratings. The modernizing of training curriculums entails assessing current training content, identifying any training gaps, and correcting these gaps to produce a fleet-validated training requirements document for each rating. The Navy is in the process of analyzing the remaining training curriculums to both modernize their content and determine the best modes of delivery. Lastly, the Navy has reported that it has delivered modernized training for four ratings. The Navy's process manual for RRL states that this evolution of training is being staged in increments to best maximize resources while minimizing impacts to current sailors.[54]

[53]The Navy is not dividing training into blocks for sailors assigned to ships homeported overseas (Forward Deployed Naval Forces), due to the costs involved with transporting sailors back to U.S. training facilities.

[54]U.S. Fleet Forces Command, *Ready Relevant Learning Sailor 2025 Process Manual* (Aug. 20, 2020).

Table 2: Implementation of Ready Relevant Learning

Phase	Description	Implementation status as of February 2021
Block learning	Divide training into phased blocks to avoid knowledge atrophy and align training more closely with point and time of need in a sailor's career. **Block 0** consists of a new sailor's induction training (bootcamp), and initial accession training ("A school"), where sailors receive the technical training in their selected occupation prior to their first sea tour. The Navy has reduced the amount of time sailors initially spend in A school. More advanced **Block 1** training is provided after the first 2 years of a sailor's sea tour. The Navy plans to provide **Block 2** of increasingly advanced training prior to sailors beginning their second sea tour.	This phase has been fully implemented for accession-level training for all of the 47 planned ratings (enlisted sailor occupations). The Navy has begun to train enlisted sailors in phased blocks over their first two sea tours. To date, over 2,100 sailors have completed **Block 1** training.
Requirements development	Establish the exact scope and span of the knowledge and skills that will need to be addressed through RRL training for most ratings. This includes reviews and revision of training curricula, to include establishing performance objectives, related task steps, and decisions on how to best deliver new course content, such as through simulations or mobile platforms.	The Navy has finalized requirements for 37 of 71 planned ratings.
Content conversion	Design and develop the modernized training content that will be delivered to sailors.	The Navy has completed conversion of training content for eight ratings, with conversion in process for an additional 24.
Modernized delivery	Provide converted training content to sailors through training technology that ranges from simple visual demonstration tools such as videos to more complex, immersive simulators and virtual trainers. According to the Navy, modernized delivery will provide for a more flexible and immersive learning experience than traditional instructor-led training and will allow for more repetition on-ship at the site of a sailor's performance.	The Navy has reported that it has completed modernized delivery for four ratings, each of which include tools such as interactive self-directed courseware, game-based virtual simulation software, demonstration videos, and step-by-step guides.

Source: GAO analysis of Navy documents and interviews with Navy officials. | GAO-21-366

The Navy Has Several Ongoing and Planned Measures to Assess the Effectiveness of RRL Training

RRL is still in the early stages of implementation, with most revised training content still requiring conversion and delivery. Block learning has been fully implemented, although insufficient time has progressed for any sailors to complete training in both Blocks 1 and 2; therefore, the Navy has not been able to fully measure and assess the effectiveness of this phased training. The Navy has ongoing efforts to assess the effectiveness of eventual RRL training, including surveying sailors and their immediate supervisors on current "as is" training to provide a

baseline to compare against future RRL training. Officials noted the difficulty of gathering sufficient data from surveys, so they are planning ship visits to conduct sailor interviews on training efficacy. Efforts are also underway to conduct interviews with the sailors who have completed Block 1 training in 2021. Additionally, student assessments are completed at the Navy's schoolhouses to measure proficiency and also to measure the quality of instruction, overall course value, and the ability to meet fleet requirements.

For the final assessment and feedback phase of RRL implementation, the Navy will require the use of training effectiveness evaluation plans. This is a process to ensure that the training being delivered is effectively transferring knowledge and skills to sailors and is increasing sailors' ability to operate and maintain systems and equipment. Use of this process is being incorporated into the Navy's training guidance. After new training is delivered, training effectiveness evaluation plans must contain the following four elements:

- Reaction: measure how students react to the training they receive by delivering post-training questionnaires.
- Learning: gather what students have learned from the training by conducting pre-tests and post-tests and measuring the difference.
- Behavior: determine if and how students used new skills and abilities in their day-to-day jobs.
- Results: assess overall results from changed behavior and new skills. If the new training is effective and properly utilized, it must result in an increase in fleet readiness.

In the RRL process manual, the Navy acknowledges that showing the effect on fleet readiness will be the most difficult part of the model to prove since there are a variety of factors that influence readiness. It adds that if enough readiness indicators are identified and their trends examined—typically over a 3 to 5 year period after new training is implemented—the metrics can show correlation between training and readiness. This process is still under development and the Navy expects that it will be modified as training is fielded; the goal is that standardized assessment methods will provide timely feedback and enable quicker course adjustments.

These training effectiveness evaluation plans will be conducted by type commanders.[55] Navy officials told us that they expect this type commander involvement to better evaluate whether enlisted training meets fleet needs, as previously there was little type commander involvement or objective measures of training effectiveness from the fleet. Lastly, a reporting requirement in the National Defense Authorization Act for Fiscal Year 2018 mandates that the Navy certify that RRL methods meet or exceed existing training delivery approaches and that re-engineered content is complete and modernized delivery is functional prior to transitioning from traditional curriculums, among other things.[56] This high-level attention to the RRL initiative is also reflected in its governance and oversight structure; a charter defines the roles and responsibilities of RRL key stakeholders, and an executive steering committee and integration board meet regularly to oversee the initiative.

Full Implementation of RRL Will Require Significant Information Technology Upgrades

RRL program costs obligated to date total about $429 million, and the Navy has to complete requirements development for 34 ratings, content conversion for 16 ratings, as well as deliver the IT infrastructure to provide training delivered with modernized content for all planned ratings. Navy officials told us that the modernized delivery phase is in early stages of conception and that significant work remains to develop the means to provide training over the full range of enlisted ratings.

The Navy has not yet determined how afloat RRL training content will be delivered—whether through on-ship computer terminals, handheld computers, or other means—nor has it developed or procured the range of software and hardware with which it will be delivered. The primary challenge of delivering modernized content to individual sailors is the limited information technology (IT) infrastructure both aboard ships and in shore facilities. Computer terminals, networks, and bandwidth on ships is primarily utilized for ship operations and communications, and the Navy acknowledges that it is insufficient for transferring the vast amounts of data needed to deliver modernized training content. In July 2020, the Navy completed a document detailing the technical requirements of

[55]Navy type commands perform administrative, personnel, and training functions for a “type” of weapon system (e.g., surface ships, submarines, or aircraft carriers).

[56]Pub. L. No. 115-91, § 545 (2017).

hosting RRL training on ships and in shore facilities.[57] In December 2020, the Navy further enumerated these needs in its RRL IT concepts of operation document.[58]

The Navy found that RRL requires a modern interface system, hosting capability, and a robust delivery framework to integrate with existing Navy programs, as well as the addition of new systems or functionality. To address IT system shortfalls, the Navy recognizes the need to fund and acquire systems like an RRL integrated training environment and increases in network transport capacities.[59] To tackle these and other RRL implementation challenges, the RRL IT Concepts of Operation call for a reprioritization of funding across Navy resource sponsors, along with a phased roll-out of RRL solutions over time in order to balance RRL capability upgrades with adequate resourcing and available IT system capabilities. To this end, the document outlines 13 key issues of continued RRL implementation, identifies actions and offices responsible for addressing them, and assigns completion dates for these actions. The identification of these issues and the plans to address them are an important step in ensuring that the Navy will adequately resource the RRL initiative to completion.

The Navy's 2017 Strategic Review stated that if fully funded, RRL has the potential to markedly improve training Navy-wide, but emphasized that successful implementation will require significant effort over a sustained period of time. The review stressed the importance of preserving adequate resources required to implement and sustain RRL. The recommendations included in the Navy's RRL IT Concepts of Operation will designate an RRL program office and resource sponsor in order to better define formal policy, guidance, roles, and responsibilities to support the IT architecture development and sustainment. Continued management attention to RRL implementation can help assure the initiative's success.

[57]Commander, U. S. Fleet Forces Command, *Data Interface, Transport and Hosting Requirements for Ready Relevant Learning* (July 10, 2020).

[58]Commander, U. S. Fleet Forces Command, *Information Technology Hosting and Transport for Ready Relevant Learning Concepts of Operation* (Dec. 29, 2020).

[59]The Navy has determined that RRL training content delivery requires a dedicated, excepted network that is not reliant on the same wide-area network circuits as other Navy networks, and provides a service model reactive to the requirements and priorities of the training mission.

The Navy Has Not Fully Factored RRL into Sailor Workload

RRL training will rely in part on self-directed coursework and on-the-job training, but the Navy has not determined how modernized training will affect sailor workload. Navy officials informed us that they are building training that can be taken anywhere, including while ships are underway, but will not deliver training underway until there is a modernized IT infrastructure that aligns this to point of need. The focus of RRL is integrating brick and mortar schoolhouses with hands-on labs, flexible waterfront training, and mobile distance learning with current content, modern technology, and complete learning continuums. A major element of RRL involves sailors being able to access self-directed training and performance support while underway on their ships. The Navy expects that increasing accessibility of training on the waterfront and underway will significantly reduce the time, cost, and operational impacts of bringing sailors to schoolhouses for training.

The Navy intends to take advantage of emerging learning technologies so that sailors receive training more efficiently aboard their ships, and states that training options should take place in the work environment and align with appropriate operations and maintenance tasking. However, in 2017, we found that the Navy was not accurately accounting for on-the-job training when calculating the size and composition of ship crews, and that the time sailors spent training resulted in reduced hours for sleep, personal, or other allotted work time.[60] We recommended that the Navy comprehensively reassess sailor workload. The Navy's Operational Afloat Work Study Final Report, issued in November 2018, found that sailors were spending a longer amount of time training than the 7 hours previously allotted in a workweek, and recommended adding a new individual training allotment, as well as an adjustment to the time allotted for collective training.[61] According to Navy analysis, these adjustments more accurately capture the time sailors spend on individual training, on-the-job training, drills, certification events, and other forms of unit training.

[60]GAO-17-413.

[61]Navy Manpower Analysis Center, *Operational Afloat Work Study Final Report* (November 2018). The Navy now uses the term "productive availability factor" in lieu of the standard workweek in its guidance and instruction.

In January 2019, the Navy incorporated these changes in its instruction and corrected the previous underestimation of time sailors spent on training.[62] This instruction requires that individual training be accurately factored into sailors' workweeks to ensure that sailors have enough time to perform their work duties and stand watch. Additionally, the John S. McCain National Defense Authorization Act for Fiscal Year 2019 contains a provision that the Secretary of the Navy shall identify and quantify any increased or new requirements with respect to Navy ship crews, including Ready, Relevant Learning training periods and additional work that affects readiness and technical qualifications for Navy ship crews.[63] The Navy's workload study was conducted prior to full RRL implementation, and training has yet to be delivered to sailors at the point and time of need, which is expected to partly be when sailors are aboard their ships.

The Navy's 2017 Strategic Review stated that overly optimistic workload assessments create a cycle of unbalanced personnel allocations and unachievable individual ship workloads, and added that Navy models must include a process that accurately accounts for any additional hours and compensates by requiring either elimination of other work requirements or increases in crewing. The Navy has taken steps to consider the effects of block learning on sailors' in-port workload, and found that it will have minimal to no effect on crew requirements. However, most modernized training has yet to be fielded and the Navy has not analyzed the potential effects of pushing more training workload to sailors while they are afloat and expected to be performing other duties. Our past work has shown that when the time sailors spend on training is not sufficiently captured in workload studies or the development of crew requirements, time sailors spend on unaccounted-for training had to be taken out of sleep, personal time, or other allotted work time.[64] Without factoring RRL training into sailors' at-sea and in-port workload, the Navy risks overburdening sailors and limiting their ability to complete their other work and still receive adequate sleep.

[62]Office of the Chief of Naval Operations Instruction (OPNAVINST) 1000.16L, *Navy Total Force Manpower Policies and Procedures* (June 24, 2015) (change transmittal 2, Jan. 9, 2019).

[63]Pub. L. No. 115-232, § 524 (2018).

[64]GAO-17-413.

Conclusions

The Navy is not achieving its primary fatigue management objective that sailors receive 7.5 hours of sleep per day. As a result, the Navy is not ensuring that its sailors are sufficiently rested for optimal performance and safety. We are encouraged that the Navy has taken several steps to collect more information on fatigue in the surface fleet, but the Navy is not well positioned to monitor the effectiveness of its approach because it is not measuring and managing fatigue in a timely manner. Ship commanders and Navy leadership are hindered from making effective operational decisions without real time and actionable information on the extent of fatigue on their ships. Moreover, the Navy is not routinely tracking or addressing potential underlying causes of fatigue and inadequate sleep, like crew shortfalls and work requirements.

The Navy has been hindered from effectively addressing the factors contributing to crew fatigue by not accurately measuring the extent of its crew shortfalls. Crew requirements define what the Navy needs to execute all ship workload, but the Navy's longstanding practice of tracking and reporting on crew levels against funded positions instead of against required positions masked the extent of crew shortfalls and misinformed Navy leaders on the extent to which its ships had the crew onboard needed for optimal performance, safety, and readiness. Additionally, the crewing targets that the Navy established are also based on the amount of funded positions that are filled rather than required positions, so they may not provide adequate minimum thresholds for safely operating ships. We are encouraged that the Navy measured crew shortfalls against the number of required positions in February 2021 internal tracking of crew levels. However, Navy guidance does not call for tracking and reporting crew levels against required positions, which raises concerns about whether this practice will be sustained over the long term. In addition, the Navy also uses funded positions, rather than requirements, to project its future personnel needs. As a result, the Navy is not generating an accurate demand signal for personnel as the size of the fleet potentially increases, preventing the Navy from effectively mitigating crewing shortfalls and perpetuating these shortfalls into the future.

The RRL initiative is an ambitious undertaking to overhaul enlisted training and deliver modernized training to sailors while they are at the waterfront or aboard ships, and will require careful planning, effective resourcing, and continued coordination between multiple stakeholders for successful implementation. Without accounting for this additional training

time in sailors' at-sea and in-port workload, the Navy risks exacerbating sailor overwork and fatigue.

Recommendations for Executive Action

We are making the following eight recommendations to the Department of Navy:

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet revise guidance to require systematic collection of quality and timely fatigue data from sailors that are accessible to operational commanders to support underway decision-making. (Recommendation 1)

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet use collected data on sailor fatigue to identify, monitor, and evaluate factors that contribute to fatigue and inadequate sleep such as the effects of crew shortfalls, work requirements, administrative requirements, and collateral duties. (Recommendation 2)

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet take actions to address the factors causing sailor fatigue and inadequate sleep. (Recommendation 3)

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet establish a process for identifying and assisting units that have not implemented its fatigue management policy. (Recommendation 4)

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet revise guidance to institutionalize the practice of using crew requirements to track and report positions that are filled. (Recommendation 5)

The Secretary of the Navy should ensure that the Commander, U.S. Fleet Forces Command and Commander, U.S. Pacific Fleet establish crewing

targets that are based on analysis and assessment of risk. (Recommendation 6)

The Secretary of the Navy should ensure that the Office of Chief of Naval Operations uses crew requirements to project future personnel needs. (Recommendation 7)

The Secretary of the Navy should ensure that the Office of the Chief of Naval Operations accounts for additional sailor workload resulting from the continued implementation of Ready Relevant Learning when determining crew requirements. (Recommendation 8)

Agency Comments

We provided a draft of this report to DOD and the Department of Homeland Security for review and comment. In written comments (reproduced in appendix V), the Navy, on behalf of DOD, concurred with our recommendations. The Department of Homeland Security had no comments on our draft.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Acting Secretary of the Navy, and other interested parties. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have questions about this report, please contact me at russellc@gao.gov or (202) 512-5431. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VI.

Cary Russell
Director, Defense Capabilities and Management

Appendix I: Scope and Methodology

To assess the extent to which the Navy had implemented its fatigue management policies across the fleet, we conducted a web-based survey of a generalizable, stratified random sample of U.S. Navy Surface Warfare Officers (SWO) who had been underway within 12 months prior to our survey who stood watch as an Officer of the Deck, Tactical Action Officer, or Engineering Officer of the Watch. This survey was developed and implemented as part of a joint effort with another one of our engagements reviewing U.S. Navy Surface Warfare Officer Career Paths (GAO-21-218). The target population defined for that engagement was defined to be all U.S. Navy Surface Warfare Officers of ranks O-1 through O-6 and was inclusive of the officers within the scope of this engagement. We defined the target population for this survey to be a subpopulation of all officers and only included officers of ranks O-1 through O-6 who had been to sea in the last 12 months and stood watch as Officer of the Deck, Tactical Action Officer, or Engineering Officer of the Watch while underway. These officers manage sailors that stand watch over critical ship functions and can provide authoritative information on the use of watchbills and fatigue management practices. To conduct the survey, we developed questions covering, among other things, compliance with Navy fatigue guidance, amount of sleep obtained while underway, barriers to implementing fatigue guidance, and fatigue conditions that respondents experienced.

Based on the scope of both engagements, we requested and the Navy provided a list of all officers who met the population definition for both surveys, which resulted in a sample frame of 8,606 Surface Warfare Officers. We selected a stratified sample of 852 officers from this sample frame to support surveys for both engagements. We stratified the sampling frame into eight mutually-exclusive strata first by identifying officers who were deployed in the last 12 months and were qualified for one or more of Officers of the Deck-Underway, Engineering Officer of the Watch and/or Tactical Action Officer watch stations. Next, we stratified the sampling frame by rank and gender. We computed sample sizes necessary to obtain a precision of at least plus or minus 10 percentage points, at the 95 percent confidence level, for each subpopulation of interest. Finally, we inflated sample sizes within each stratum based on an expected response rate of 50 percent.

To minimize errors that might occur from respondents interpreting our questions differently than we intended, we developed the survey with the assistance of several of our survey specialists, including an independent review by another survey specialist on the draft instrument as part of our internal peer review process. We provided a draft of the questions to a Navy subject matter expert for their review and made changes as appropriate. Furthermore, we pretested our survey with five volunteers who had served in the role of Officer of the Deck (including males and females and in grades O-3 through O-6). During each pretest, all of which were conducted by phone, we tested whether (1) the instructions and questions were clear and unambiguous, (2) the terms we used were accurate, and (3) pretest participants could offer a potential solution to any problems identified. We noted any potential problems identified by the reviewers and through the pretests and modified the questionnaire based on the feedback received. A full copy of the survey questions is provided in appendix IV.

We conducted the survey between August 2020 and October 2020. To maximize our response rate, we sent notification emails and reminder emails to encourage recipients to complete the survey. In total, the combined survey received responses from 351 of the 852 Surface Warfare Officers selected in our sample, for an unweighted response rate of 41 percent.[1] The weighted response rate, which controls for the disproportionate sample design, was 38 percent. Within the 351 responses, 143 respondents indicated in the survey that they had been underway in the last 12 months and stood watch as Officer of the Deck, Tactical Action Officer, or Engineering Officer of the Watch. Based on these 143 survey respondents, we generated weighted estimates generalized to the estimated subpopulation of 3,742 (+/- 7.6 percent).

A statistician conducted analyses to produce weighted estimates as described above. Another statistician verified the analyses. We conducted an analysis of our survey results to identify potential sources of nonresponse bias using two methods. First, we examined the response propensity of the sampled Surface Warfare Officers by several demographic characteristics. These characteristics included rank, gender, and number of days at sea during the last deployment, and designator

[1]Our initial sample design included 858 officers in the sample. During the fielding of our survey, we identified six SWOs that were out of scope and removed these SWOs from our sample frame and sample. As a result, we selected a sample of 852 SWOs from the population of 8,606 SWOs in our population.

code.[2] Our second methodology consisted of comparing weighted estimates from respondents and nonrespondents to known population values for these demographic characteristics. We conducted statistical tests of differences, at the 95 percent confidence level, between estimates and known population values, and between respondents and nonrespondents.

Based on this analysis, we observed significant differences in response propensities for all of the characteristics we examined. Specifically, we found that lower ranking Surface Warfare Officers, females, officers with more days at sea during the last deployment and who had not fully qualified as a Surface Warfare Officer were all significantly underrepresented by our respondents. Additionally, we found significant differences between weighted estimates from the respondents when compared to known population values for rank, number of days at sea, and designator code.

To ensure that the survey results appropriately represented the population of Surface Warfare Officers, we calculated weights to adjust for the differential response propensities we observed. The nonresponse adjustment was calculated using a propensity-based weighting class adjustment where adjustment cells were based on quintiles of the predicted response propensities estimated by a logistic regression model that included rank, gender, and the number of days at sea during the last deployment. To compute the final adjusted sampling weight, we applied a simple ranking procedure to ensure adjusted weights summed to the number of Surface Warfare Officers in the population and by stratum.

We repeated the nonresponse bias analysis using the adjusted weights and found no significant differences with known population values and the weighed estimates for all of the characteristics we examined. This provided us with evidence that the nonresponse weighting class adjustments help mitigate any potential nonresponse bias introduced by the differences in response propensities we identified for the characteristics we included in this analysis.

Because we followed a probability procedure based on random selections, our sample is only one of a large number of samples that we might have drawn. Since each sample could have provided different

[2]Surface Warfare Officers are split into two different designator codes. Designator code 1160 officers are still considered trainees, while 1110 are fully qualified Surface Warfare Officers.

estimates, we express our confidence in the precision of our particular sample's results as a 95 percent confidence interval (e.g., +/- 10 percentage points). All estimates included in this report have a margin of error of +/- 10 percentage points or fewer, unless otherwise noted.

We calculated the frequency of responses to our closed-ended survey questions and reviewed responses to the open-ended questions for themes or issues relevant to our objectives. For all open-ended survey questions, two analysts independently reviewed the responses to identify themes or issues relevant to our objectives. In addition, for open-ended survey questions discussed in this report, we used professional judgment and our interviews with Navy officials to identify common themes from across the responses and determine the frequencies for such themes. In order to do so, one analyst evaluated question responses and coded the information into categories of themes. A different analyst checked the coded information for accuracy. The analysts then discussed and resolved any initial disagreements in the coding to arrive at final themes. We determined that the information and communication component of internal control was significant to this objective, along with the underlying principle that management should use quality information to measure effectiveness of an entity's program and evaluate performance in achieving key objectives and addressing risks.[3] We also determined that the monitoring component of internal control was significant to this objective, along with the underlying principle that management should evaluate and document internal control issues and determine appropriate corrective actions.

For our second objective, we analyzed monthly officer data from the Navy's Officer Assignments Information System and monthly enlisted data from the Navy's COGNOS system for fiscal years 2017 through 2020. We determined that the information and communication component of internal control was significant to this objective, along with the underlying principle that management should use quality information to measure effectiveness of an entity's program and evaluate performance in achieving key objectives and addressing risks.[4] We compared the monthly officer and enlisted data from the two systems noted above to monthly officer and enlisted Activity Manpower Requirements (AMD) data from the Navy's Total Force Manpower Management System, in addition

[3]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

[4]GAO-14-704G.

to Ship Manpower Document (SMD) requirements produced as a result of the Navy's workload studies process. We included ships which were in scheduled maintenance, but excluded ships which were in extended modernization or which the Navy agreed were not conducting normal operations. We also excluded Littoral Combat Ships (LCS) because of changes to the ships' crewing construct and the ongoing development of their crew requirements. We have other ongoing work examining these ships. More information on the number of ships we included in our sample, as well as the ships we excluded, is available in appendix III.

For our third objective, we reviewed Navy documentation about the Manpower Projection Tool, shipbuilding plans, and a Navy instruction on training.[5] We determined that the information and communication component of internal control was significant to this objective, along with the underlying principle that management should use quality information to measure effectiveness of an entity's program and evaluate performance in achieving key objectives and addressing risks.[6] We reviewed the projections that Navy officials created with the Manpower Projection tool and the cost estimates communicated to Navy decision-makers based on these projections. We interviewed officials about the factors, assumptions, and methodology used to create personnel projections and about long-range personnel cost estimates.

For our fourth objective, we analyzed Ready Relevant Learning (RRL) program documentation, including annual reports to Congress on RRL implementation status, approved RRL functional requirements documents for multiple ratings, RRL information technology (IT) requirements letter, RRL IT Concepts of Operation, and the RRL process manual. We also interviewed officials responsible for implementing and overseeing the initiative.

We interviewed officials, or where appropriate, obtained documentation from the following:

- Office of the Chief of Naval Operations
- Commander, U.S. Fleet Forces Command
- Commander, Naval Surface Force Atlantic

[5]Office of the Chief of Naval Operations Instruction 1500.47C, *Navy Training Quota Management* (May 15, 2014).

[6]GAO-14-704G.

- Commander, Naval Surface Force, U.S. Pacific Fleet
- Commander, Naval Submarine Force Atlantic
- Commander, Naval Submarine Force, U.S. Pacific Fleet
- Naval Education and Training Command
- Naval Personnel Command
- Navy Manpower Analysis Center
- Naval Postgraduate School
- Naval Health Research Center
- United States Coast Guard
  - Office of Cutter Forces (CG-751)
  - Safety Assurance and Risk Reduction (CG-1132)

Appendix II: Fatigue Management in Other Maritime Communities

We also analyzed documentation from, and interviewed officials in, the Navy submarine community and U.S. Coast Guard to identify their practices for managing fatigue. We collected relevant documents, analyzed fatigue policies, and interviewed officials from the Navy's submarine community and the U.S Coast Guard to understand their process for managing fatigue on vessels underway.

We identified additional steps taken by other maritime communities to assess the risks posed by fatigue. We found that the Coast Guard, Navy submarine community, and the Navy surface community have taken similar steps to manage fatigue on vessels at sea.[1] Some of these steps include fatigue management training and promoting the use of crew endurance handbooks that provide information on fatigue mitigation strategies.

We also found that the Coast Guard takes additional steps to assess risks that the Navy does not. For example, the Coast Guard uses an annual risk factor assessment that includes specific fatigue management questions to determine how effectively crews manage fatigue. These questions ask crewmembers to provide detailed information on the number of hours of sleep they received during a typical week, if they worked more than 12 hours a day, implementation of circadian rhythm watchbills, and various other factors to determine the state of fatigue for an operational unit. According to Coast Guard officials, this risk assessment provides operational commanders with timely information on crew fatigue and allows commanders to adjust ship practices to mitigate fatigue-related incidents.

[1]Sleep requirements vary among communities in the U.S. Navy. For example, the Navy aviation community directs that crew members be given an opportunity for at least 8 hours of uninterrupted sleep prior to flight duty.

Appendix III: Ship Crewing Profiles

Aircraft Carrier – Nimitz Class (CVN 68)

Nimitz class (CVN 68) aircraft carrier

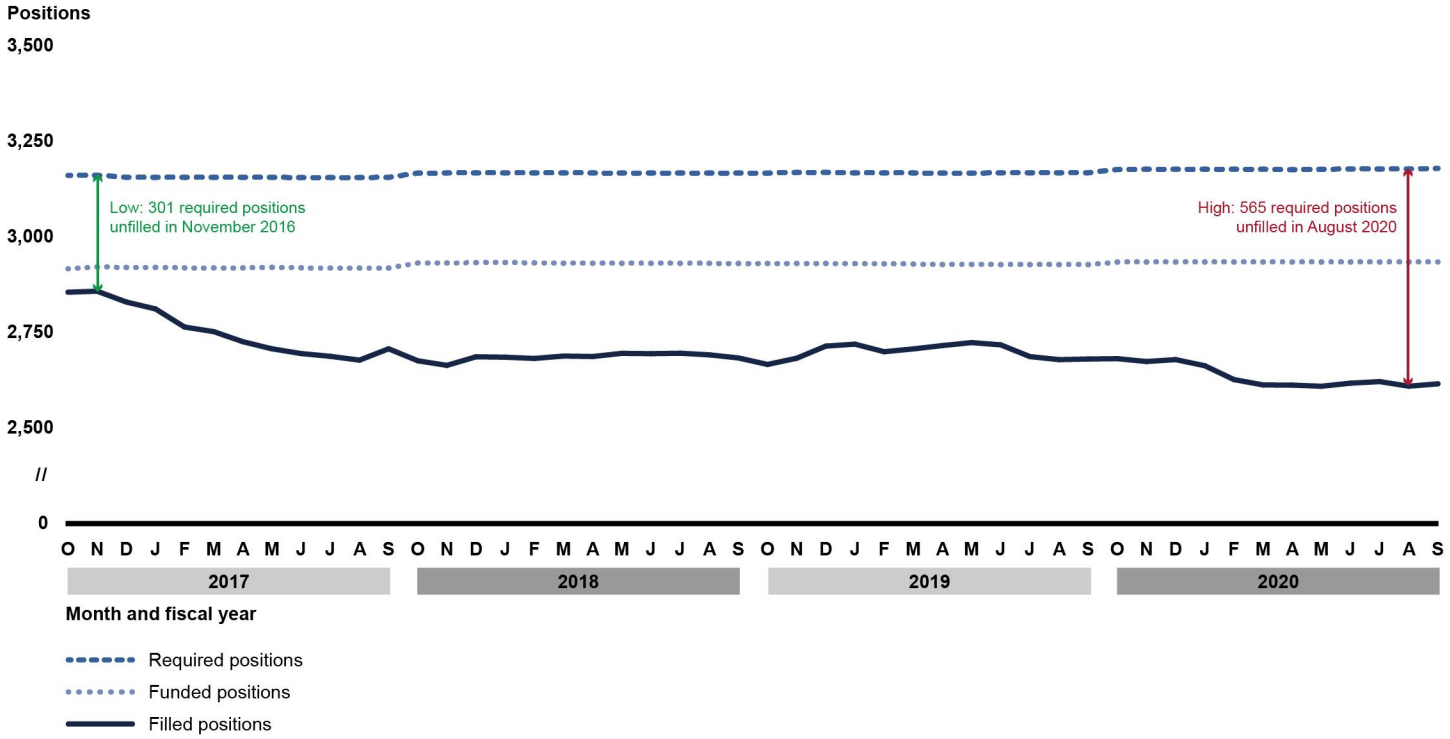
Source: U.S. Navy/PO3 J. Holbert. | GAO-21-366

Aircraft carriers are the largest ships in the Navy, each crewed by several thousand sailors and carrying about 60 aircraft, along with their pilots and flight crew. Aircraft carriers deploy alongside a carrier strike group comprised of smaller ships, and give the United States the ability to strike a wide variety of targets across the world by air.

There were 10 Nimitz class aircraft carriers included in our sample. We did not include the Navy's new Ford class aircraft carrier as it had not yet begun normal operations by the end of fiscal year 2020.

The average number of enlisted positions filled on aircraft carriers fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 11). The smallest shortfall occurred in November 2016, while the largest shortfall of about 565 required positions unfilled occurred in August 2020. In September 2020, the average enlisted crew size was about 82 percent of the requirement, totaling about 560 required positions unfilled. The Navy's most recent aircraft carrier workload study and Ship Manpower Document—which specifies the required officer and enlisted positions for each ship class—was conducted in 2014, with an update scheduled for fiscal year 2022.

Figure 11: Average Required, Funded, and Filled Enlisted Crewmember Positions for Aircraft Carriers, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 11: Average Required, Funded, and Filled Enlisted Crewmember Positions for Aircraft Carriers, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	3155	2912.3	2851.4	
2017	Nov	3155.3	2917.2	2854	301 unfilled
2017	Dec	3150.1	2915.9	2825.9	
2017	Jan	3150	2915.9	2807.9	
2017	Feb	3150	2914.7	2760.8	
2017	March	3150	2914.7	2748.9	
2017	April	3150	2914.7	2722.7	
2017	May	3150	2916	2704.2	
2017	June	3149.4	2914.8	2691.9	
2017	July	3149.4	2914.2	2684.7	
2017	Aug	3149.4	2914.2	2674.8	
2017	Sept	3150	2914.2	2704.3	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	3161	2927.4	2673.1	
2018	Nov	3161.4	2927.4	2661.2	
2018	Dec	3161.4	2928.4	2683.5	
2018	Jan	3161.4	2928.7	2682.4	
2018	Feb	3161.4	2927.7	2679.2	
2018	March	3161.4	2926.8	2685.4	
2018	April	3161.4	2926.7	2684.2	
2018	May	3161.3	2926.5	2692.4	
2018	June	3161.3	2926.5	2691.6	
2018	July	3161.3	2926.5	2692.7	
2018	Aug	3161.3	2926.5	2688.6	
2018	Sept	3161.3	2926.1	2680.5	
2019	Oct	3160.9	2926.1	2663.6	
2019	Nov	3162.7	2926.1	2679.8	
2019	Dec	3162.9	2926.1	2711.3	
2019	Jan	3161.4	2925.6	2716.3	
2019	Feb	3161.4	2925.1	2696.7	
2019	March	3161.4	2924.6	2704	
2019	April	3161	2923.4	2712.7	
2019	May	3160.9	2923.6	2720.4	
2019	June	3161.8	2923.1	2714.5	
2019	July	3161.8	2923.1	2684	
2019	Aug	3161.8	2923.1	2676.1	
2019	Sept	3161.8	2923.1	2677.7	
2020	Oct	3170.4	2929.8	2678.6	
2020	Nov	3171.1	2929.8	2671.2	
2020	Dec	3171.1	2930	2676.2	
2020	Jan	3171.1	2930	2660.2	
2020	Feb	3171.1	2930	2624.3	
2020	March	3171.1	2930	2610.3	
2020	April	3169.8	2930	2609.9	
2020	May	3170.8	2930	2606.9	
2020	June	3171.8	2930	2615	
2020	July	3171.7	2930	2619	
2020	Aug	3171.7	2930	2607.1	565 unfilled
2020	Sept	3173.2	2930	2613.2	

Amphibious Assault Ship - America Class (LHA 6)

America class (LHA 6) amphibious assault ship

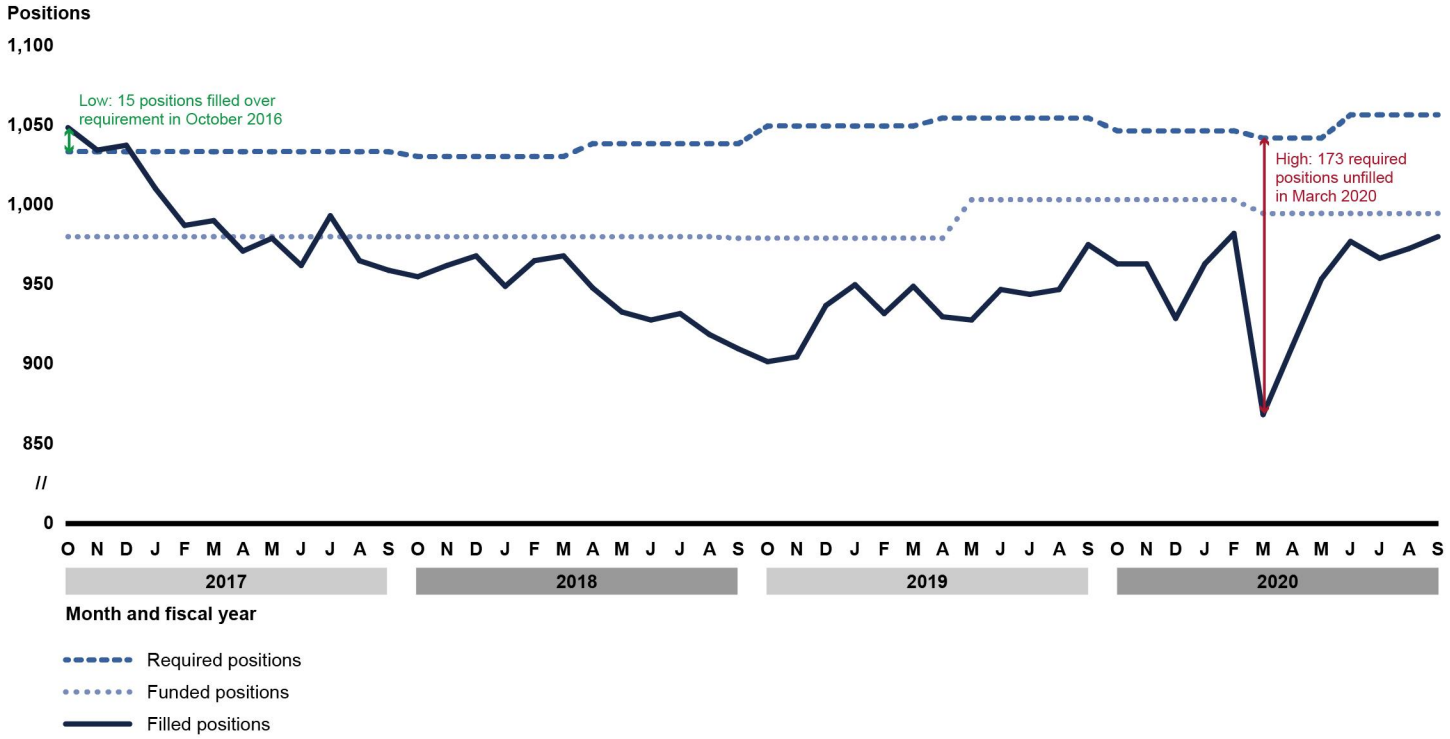
Source: U.S. Navy/PO3 V. Zine. | GAO-21-366

America class amphibious assault ships are designed to carry Marine expeditionary units, including helicopters and fixed-wing aircraft, and operate alongside other amphibious warfare ships in amphibious ready groups.

There were two America class ships in our sample, with the second, the newly-commissioned USS *Tripoli* (LHA 7), added in March 2020.

The average number of enlisted positions filled on America class amphibious assault ships fell short of the Navy's requirement for most of the fiscal year 2017 through fiscal year 2020 period (see fig. 12). The largest surplus—when the average crew size exceeded the requirement—occurred in October 2016, while the largest shortfall occurred in March 2020, totaling about 173 required positions unfilled. The average number of filled positions in September 2020 was 93 percent of the requirement, equating to about 76 required positions unfilled. The Navy used a preliminary study to determine the crew size and composition of America class ships until it performed a workload study and validated requirements in June 2019.

Figure 12: Average Required, Funded, and Filled Enlisted Crewmember Positions for America Class Amphibious Assault Ships, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 12: Average Required, Funded, and Filled Enlisted Crewmember Positions for America Class Amphibious Assault Ships, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	1032	979	1047	15 over
2017	Nov	1032	979	1033	
2017	Dec	1032	979	1036	
2017	Jan	1032	979	1009	
2017	Feb	1032	979	986	
2017	March	1032	979	989	
2017	April	1032	979	970	
2017	May	1032	979	978	
2017	June	1032	979	961	
2017	July	1032	979	992	
2017	Aug	1032	979	964	
2017	Sept	1032	979	958	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	1029	979	954	
2018	Nov	1029	979	961	
2018	Dec	1029	979	967	
2018	Jan	1029	979	948	
2018	Feb	1029	979	964	
2018	March	1029	979	967	
2018	April	1037	979	947	
2018	May	1037	979	932	
2018	June	1037	979	927	
2018	July	1037	979	931	
2018	Aug	1037	979	918	
2018	Sept	1037	978	909	
2019	Oct	1048	978	901	
2019	Nov	1048	978	904	
2019	Dec	1048	978	936	
2019	Jan	1048	978	949	
2019	Feb	1048	978	931	
2019	March	1048	978	948	
2019	April	1053	978	929	
2019	May	1053	1002	927	
2019	June	1053	1002	946	
2019	July	1053	1002	943	
2019	Aug	1053	1002	946	
2019	Sept	1053	1002	974	
2020	Oct	1045	1002	962	
2020	Nov	1045	1002	962	
2020	Dec	1045	1002	928	
2020	Jan	1045	1002	962	
2020	Feb	1045	1002	981	
2020	March	1040.5	993.5	868	173 unfilled
2020	April	1040.5	993.5	910.5	
2020	May	1040.5	993.5	952.5	
2020	June	1055	993.5	976	
2020	July	1055	993.5	965.5	
2020	Aug	1055	993.5	971.5	
2020	Sept	1055	993.5	979	

Amphibious Assault Ship - Wasp Class (LHD 1)

Wasp class (LHD 1) amphibious assault ship

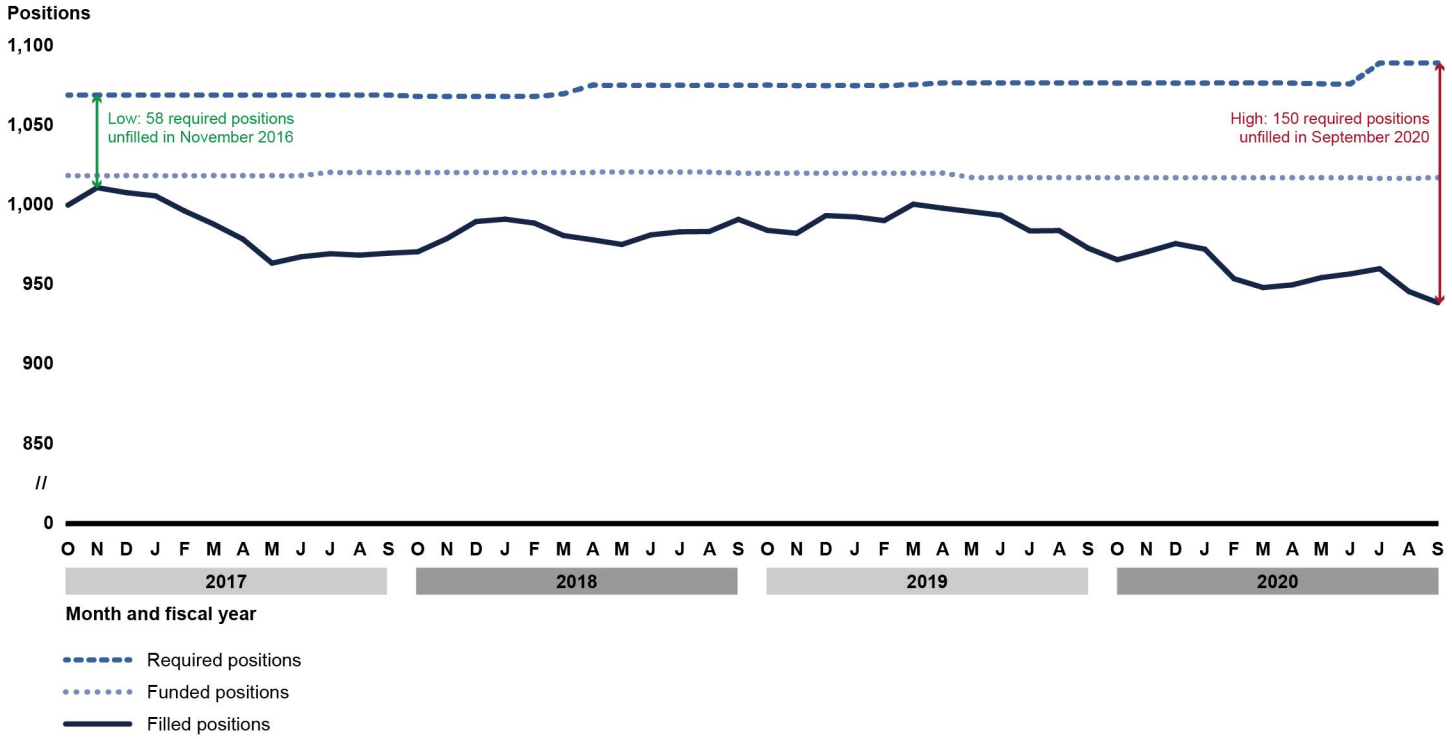
Source: U.S. Navy/PO3 T. King. | GAO-21-366

Similar in size and usage to newer America class amphibious assault ships, Wasp class ships are designed to carry Marine expeditionary units, including helicopters and fixed-wing aircraft, and operate alongside other amphibious warfare ships in amphibious ready groups.

There were eight Wasp class ships in our sample. USS *Bonhomme Richard* (LHD 6) was destroyed in a fire while undergoing maintenance in July 2020 and remained in our sample through the remainder of fiscal year 2020.

The average number of enlisted positions filled on Wasp class amphibious assault ships fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 13). The smallest shortfall occurred in November 2016, while the largest shortfall occurred in September 2020, when the average enlisted crew size was 86 percent of the requirement, equating to about 150 required positions unfilled. The Navy plans to update its requirements for Wasp class ships in fiscal year 2021.

Figure 13: Average Required, Funded, and Filled Enlisted Crewmember Positions for Wasp Class Amphibious Assault Ships, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 13: Average Required, Funded, and Filled Enlisted Crewmember Positions for Wasp Class Amphibious Assault Ships, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	1067.33	1017.11	998.667	
2017	Nov	1067.33	1017.11	1009.56	58 unfilled
2017	Dec	1067.33	1017.11	1006.44	
2017	Jan	1067.33	1017.11	1004.44	
2017	Feb	1067.33	1017.11	995	
2017	March	1067.33	1017.11	986.778	
2017	April	1067.33	1017.11	977.444	
2017	May	1067.33	1017.11	962.444	
2017	June	1067.33	1017.11	966.444	
2017	July	1067.33	1019.11	968.333	
2017	Aug	1067.33	1019.11	967.444	
2017	Sept	1067.33	1019	968.667	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	1066.44	1019.11	969.556	
2018	Nov	1066.44	1019.11	977.778	
2018	Dec	1066.44	1019.11	988.444	
2018	Jan	1066.44	1019.11	989.889	
2018	Feb	1066.44	1019.11	987.444	
2018	March	1068.11	1019.11	979.667	
2018	April	1073.56	1019.11	977	
2018	May	1073.44	1019.22	974.111	
2018	June	1073.44	1019.22	980.111	
2018	July	1073.44	1019.22	982	
2018	Aug	1073.44	1019.22	982.222	
2018	Sept	1073.44	1018.67	989.778	
2019	Oct	1073.56	1018.67	982.889	
2019	Nov	1073.22	1018.67	981.111	
2019	Dec	1073.22	1018.67	992.111	
2019	Jan	1073.22	1018.67	991.333	
2019	Feb	1073.22	1018.67	989	
2019	March	1073.78	1018.67	999.222	
2019	April	1074.89	1018.67	996.778	
2019	May	1074.89	1015.89	994.556	
2019	June	1074.89	1015.89	992.333	
2019	July	1074.89	1015.89	982.556	
2019	Aug	1074.89	1015.89	982.778	
2019	Sept	1074.89	1015.89	971.778	
2020	Oct	1074.78	1015.78	964.556	
2020	Nov	1074.78	1015.78	969.444	
2020	Dec	1074.78	1015.78	974.667	
2020	Jan	1074.78	1015.78	971.222	
2020	Feb	1074.78	1015.78	952.778	
2020	March	1074.78	1015.78	947.222	
2020	April	1074.78	1015.78	948.889	
2020	May	1074.33	1015.78	953.444	
2020	June	1074.33	1015.78	955.778	
2020	July	1087.33	1015.33	959	
2020	Aug	1087.33	1015.33	944.778	
2020	Sept	1087.33	1015.78	937.778	150 unfilled

Amphibious Transport Dock - San Antonio Class (LPD 17)

San Antonio class (LPD 17) amphibious transport dock

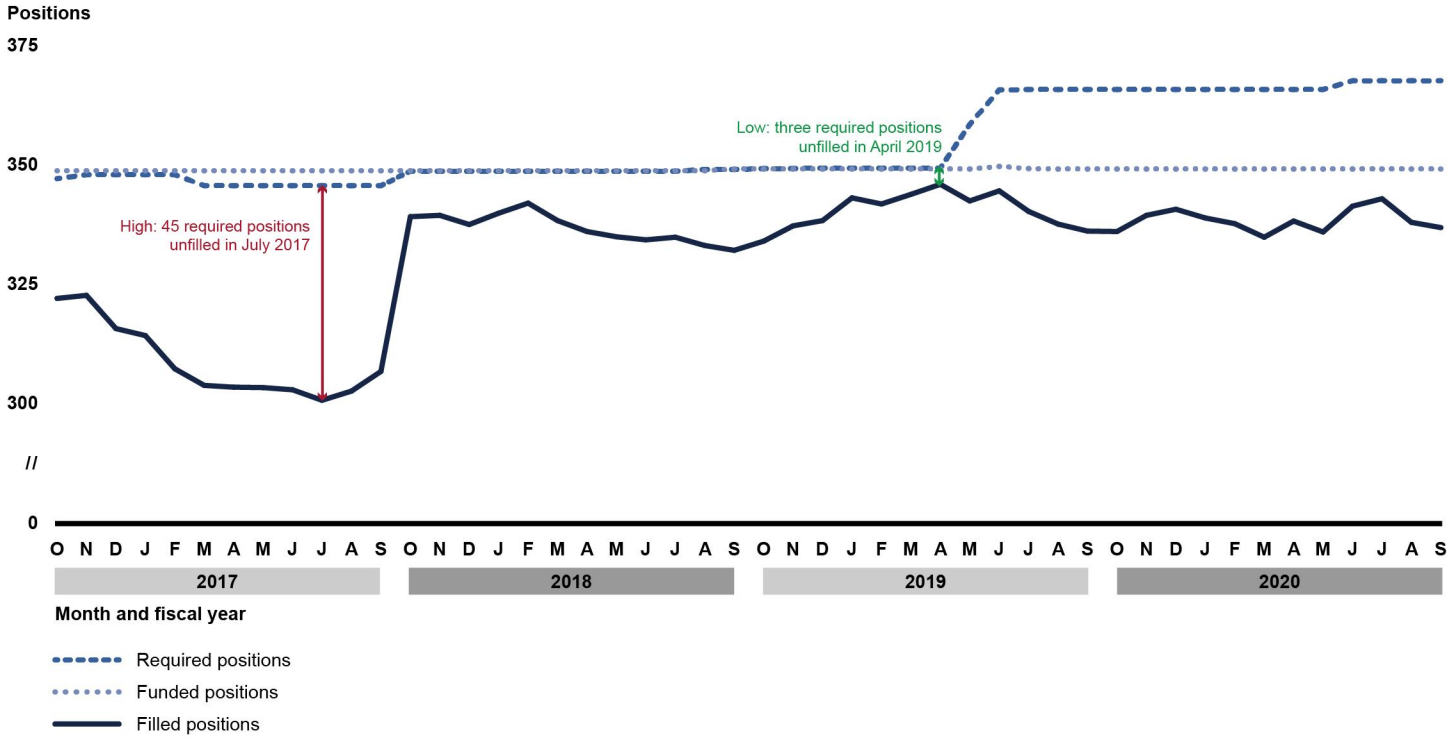
Source: U.S. Navy/CPO W. Tonacchio. | GAO-21-366

Amphibious Transport Dock ships are designed to transport Marines and their equipment and allow them to land using helicopters, landing craft, and amphibious vehicles. This class was designed to have a smaller crew size than earlier ships of this type.

There were 11 of these ships in our sample.

The average number of enlisted positions filled on amphibious transport docks fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 14). The smallest shortfall occurred in April 2019, while the largest shortfall of about 45 required positions unfilled occurred in July 2017. The Navy increased the amphibious transport dock crew size requirement from 351 to 371 enlisted sailors in April 2019, but has not commensurately increased the number of funded or filled positions. As a result, the average number of filled positions in September 2020 was about 92 percent of the requirement, equating to about 31 required positions unfilled.

Figure 14: Average Required, Funded, and Filled Enlisted Crewmember Positions for Amphibious Transport Docks, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 14: Average Required, Funded, and Filled Enlisted Crewmember Positions for Amphibious Transport Docks, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	346.727	348.364	321.818	
2017	Nov	347.545	348.364	322.455	
2017	Dec	347.545	348.364	315.545	
2017	Jan	347.545	348.364	314.091	
2017	Feb	347.545	348.364	307.182	
2017	March	345.273	348.364	303.727	
2017	April	345.273	348.364	303.364	
2017	May	345.273	348.364	303.273	
2017	June	345.273	348.364	302.818	
2017	July	345.273	348.364	300.636	45 unfilled
2017	Aug	345.273	348.364	302.545	
2017	Sept	345.273	348.364	306.636	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	348.273	348.364	338.818	
2018	Nov	348.273	348.364	339.091	
2018	Dec	348.273	348.364	337.182	
2018	Jan	348.273	348.364	339.545	
2018	Feb	348.273	348.364	341.636	
2018	March	348.273	348.364	338	
2018	April	348.273	348.364	335.727	
2018	May	348.273	348.364	334.636	
2018	June	348.273	348.364	334	
2018	July	348.273	348.364	334.545	
2018	Aug	348.636	348.364	332.818	
2018	Sept	348.636	348.727	331.818	
2019	Oct	348.818	348.727	333.727	
2019	Nov	348.818	348.727	336.909	
2019	Dec	348.909	348.727	338	
2019	Jan	348.909	348.727	342.727	
2019	Feb	348.909	348.727	341.455	
2019	March	348.909	348.727	343.455	
2019	April	348.909	348.727	345.545	
2019	May	358	348.727	342.091	
2019	June	365.182	349.273	344.182	
2019	July	365.273	348.818	339.909	
2019	Aug	365.273	348.727	337.273	3 unfilled
2019	Sept	365.273	348.727	335.818	
2020	Oct	365.273	348.727	335.727	
2020	Nov	365.273	348.727	339.091	
2020	Dec	365.273	348.727	340.364	
2020	Jan	365.273	348.727	338.545	
2020	Feb	365.273	348.727	337.364	
2020	March	365.273	348.727	334.545	
2020	April	365.273	348.727	337.909	
2020	May	365.273	348.727	335.636	
2020	June	367.091	348.727	341	
2020	July	367.091	348.727	342.545	
2020	Aug	367.091	348.727	337.636	
2020	Sept	367.091	348.727	336.545	

Cruiser - Ticonderoga Class (CG 47)

Ticonderoga class (CG 47) cruiser

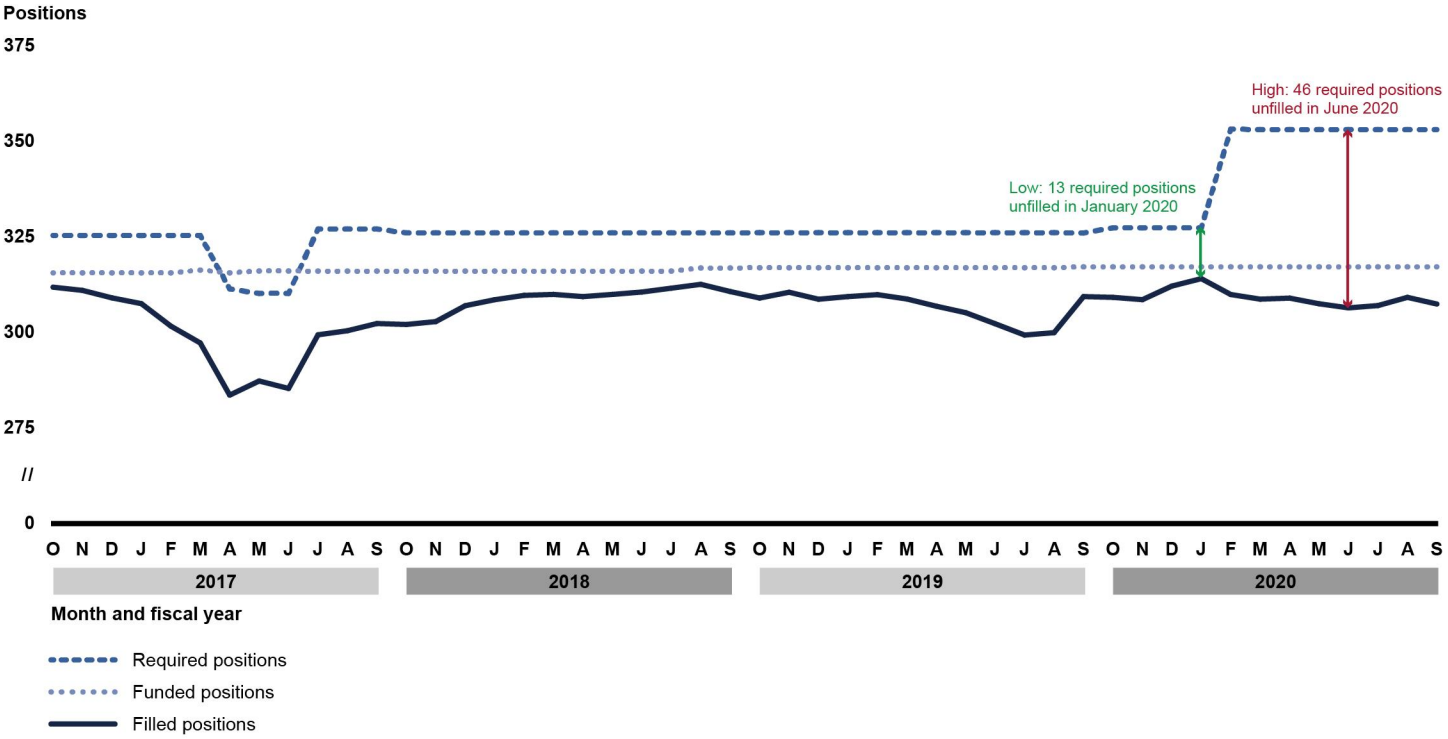
Source: U.S. Navy/PO2 J. Troutman. | GAO-21-366

Cruisers are large surface combatants and can carry out a number of missions, including launching Tomahawk missiles to strike land targets; ballistic missile defense; defending aircraft carriers; combating surface ships, aircraft, and submarines; and patrolling sea lanes.

There were 22 cruisers in our sample, but we excluded seven ships from our analysis while they underwent extended modernization periods.

The average number of enlisted positions filled on cruisers fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 15). The smallest shortfall occurred in January 2020 and the largest shortfall of about 46 required positions unfilled occurred in June 2020. The Navy increased the crew size requirement in January 2020, but has not commensurately increased the number of funded or filled positions. As a result, the average number of filled positions in September 2020 fell to 87 percent of the requirement, equating to 45 positions unfilled.

Figure 15: Average Required, Funded, and Filled Enlisted Crewmember Positions for Cruisers, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 15: Average Required, Funded, and Filled Enlisted Crewmember Positions for Cruisers, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	324.889	315.167	311.444	
2017	Nov	324.889	315.167	310.611	
2017	Dec	324.889	315.167	308.667	
2017	Jan	324.889	315.167	307.167	
2017	Feb	324.889	315.167	301.333	
2017	March	324.889	315.889	296.944	
2017	April	311	315.167	283.389	
2017	May	309.824	315.647	287.059	
2017	June	309.824	315.647	285.118	
2017	July	326.562	315.625	299.062	
2017	Aug	326.562	315.625	300.125	
2017	Sept	326.562	315.625	302	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	325.562	315.625	301.75	
2018	Nov	325.562	315.625	302.5	
2018	Dec	325.562	315.625	306.625	
2018	Jan	325.562	315.625	308.187	
2018	Feb	325.562	315.625	309.312	
2018	March	325.562	315.625	309.562	
2018	April	325.562	315.625	309	
2018	May	325.562	315.625	309.562	
2018	June	325.562	315.625	310.187	
2018	July	325.562	315.625	311.187	
2018	Aug	325.562	316.437	312.187	
2018	Sept	325.562	316.437	310.312	
2019	Oct	325.625	316.5	308.625	
2019	Nov	325.625	316.5	310.125	
2019	Dec	325.625	316.5	308.312	
2019	Jan	325.625	316.5	309	
2019	Feb	325.625	316.5	309.5	
2019	March	325.625	316.5	308.375	
2019	April	325.625	316.5	306.5	
2019	May	325.625	316.5	304.812	
2019	June	325.625	316.5	301.937	
2019	July	325.625	316.5	299	
2019	Aug	325.625	316.5	299.625	
2019	Sept	325.533	316.733	309	
2020	Oct	326.867	316.733	308.8	
2020	Nov	326.867	316.733	308.2	
2020	Dec	326.867	316.733	311.733	
2020	Jan	326.867	316.733	313.667	13 unfilled
2020	Feb	352.533	316.733	309.533	
2020	March	352.4	316.733	308.333	
2020	April	352.4	316.733	308.6	
2020	May	352.4	316.733	307.133	
2020	June	352.4	316.733	306.067	46 unfilled
2020	July	352.4	316.733	306.667	
2020	Aug	352.4	316.733	308.8	
2020	Sept	352.4	316.733	307.067	

Destroyer - Arleigh Burke Class (DDG 51)

Arleigh Burke class (DDG 51) destroyer

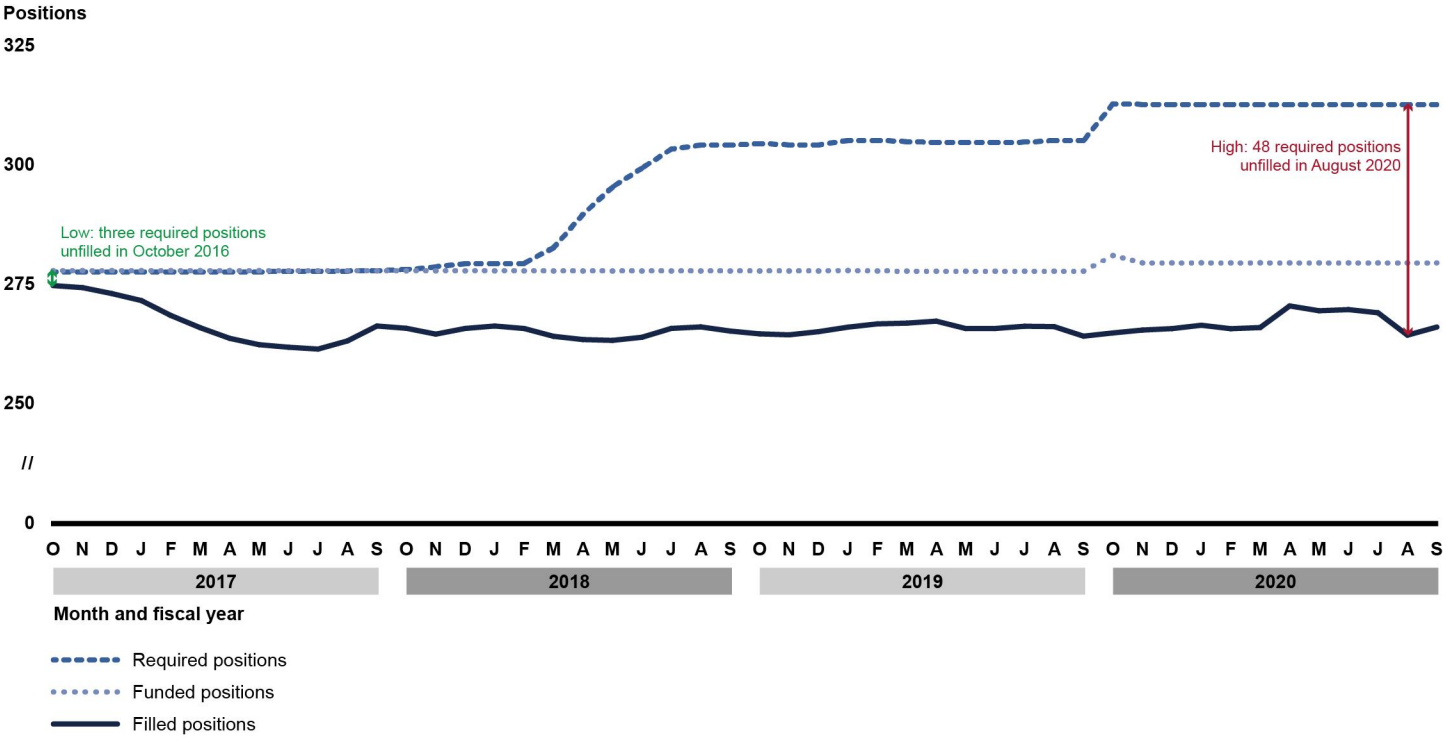
Source: U.S. Navy/PO2 A. Corona. | GAO-21-366

Arleigh Burke class destroyers are the most numerous ships in the surface fleet, with more currently under construction. These large surface combatants can carry out a number of missions, including launching Tomahawk missiles to strike land targets; ballistic missile defense; defending aircraft carriers; combating surface ships, aircraft, and submarines; and patrolling sea lanes.

There were 68 destroyers in our sample, including six newly-constructed ships added upon commissioning.

The average number of enlisted positions filled on destroyers fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 16). The smallest shortfall occurred in October 2016 and the largest shortfall of about 48 required positions unfilled occurred in August 2020. The Navy increased the crew size requirement for most destroyers during fiscal year 2018, but has not commensurately increased the number of funded or filled positions. In September 2020, the average enlisted crew size was 85 percent of the requirement, totaling about 46 required positions unfilled.

Figure 16: Average Required, Funded, and Filled Enlisted Crewmember Positions for Destroyers, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 16: Average Required, Funded, and Filled Enlisted Crewmember Positions for Destroyers, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	277.355	277.597	274.484	3 unfilled
2017	Nov	277.355	277.597	274.065	
2017	Dec	277.355	277.597	272.823	
2017	Jan	277.355	277.597	271.371	
2017	Feb	277.355	277.597	268.274	
2017	March	277.339	277.597	265.726	
2017	April	277.339	277.597	263.516	
2017	May	277.306	277.597	262.194	
2017	June	277.508	277.571	261.667	
2017	July	277.508	277.571	261.286	
2017	Aug	277.508	277.571	262.984	
2017	Sept	277.578	277.547	266.078	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	277.828	277.547	265.609	
2018	Nov	278.406	277.547	264.391	
2018	Dec	279.078	277.547	265.578	
2018	Jan	279.078	277.547	266.078	
2018	Feb	279.078	277.547	265.562	
2018	March	282.369	277.523	263.938	
2018	April	289.292	277.523	263.262	
2018	May	294.969	277.523	263.092	
2018	June	298.892	277.523	263.738	
2018	July	302.862	277.523	265.585	
2018	Aug	303.677	277.523	265.892	
2018	Sept	303.677	277.523	265.031	
2019	Oct	304.015	277.523	264.446	
2019	Nov	303.754	277.523	264.246	
2019	Dec	303.754	277.523	264.908	
2019	Jan	304.662	277.615	265.846	
2019	Feb	304.662	277.523	266.523	
2019	March	304.439	277.5	266.682	
2019	April	304.224	277.478	267.09	
2019	May	304.224	277.478	265.552	
2019	June	304.224	277.478	265.567	
2019	July	304.328	277.478	266.03	
2019	Aug	304.642	277.478	265.955	
2019	Sept	304.642	277.478	263.97	
2020	Oct	312.269	280.746	264.642	
2020	Nov	312.164	279.209	265.239	
2020	Dec	312.164	279.209	265.537	
2020	Jan	312.164	279.224	266.239	
2020	Feb	312.164	279.209	265.522	
2020	March	312.119	279.224	265.761	
2020	April	312.119	279.209	270.254	
2020	May	312.119	279.209	269.254	
2020	June	312.119	279.209	269.493	
2020	July	312.119	279.209	268.836	
2020	Aug	312.119	279.209	264.179	48 unfilled
2020	Sept	312.119	279.209	265.866	

Dock Landing Ship - Whidbey Island Class (LSD 41) and Harper's Ferry Class (LSD 49)

Harper's Ferry class (LSD 49) dock landing ship

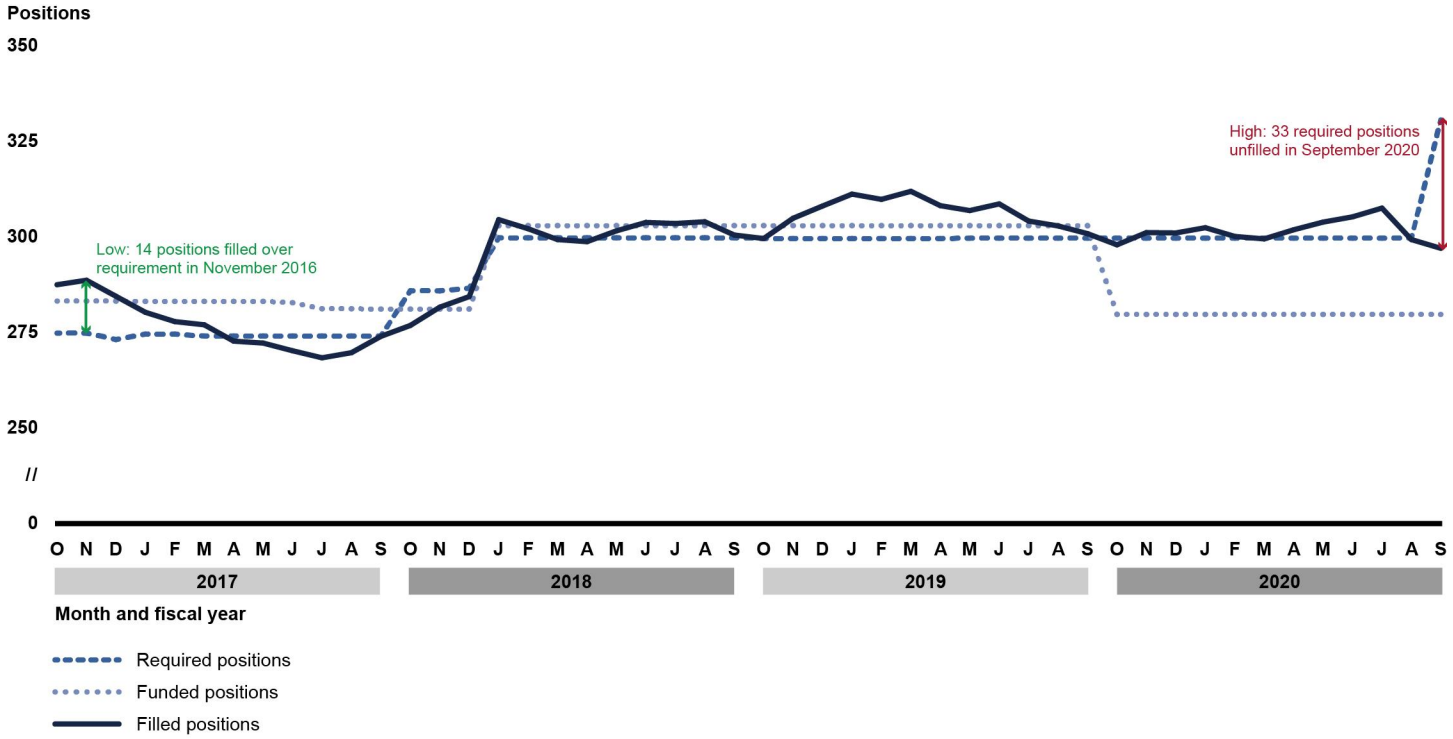
Source: U.S. Navy/Cpl. T. Seims. | GAO-21-366

Dock landing ships are the smallest class of amphibious warfare ships, and are designed to transport Marines and their equipment and allow them to land using helicopters, landing craft, and amphibious vehicles.

This class is made up of eight older Whidbey Island class ships and four newer Harper's Ferry class ships. We excluded the USS *Tortuga* (LSD 46) from our analysis after it entered extended modernization in January 2018.

Unlike the other amphibious warfare ships, dock landing ships met or exceeded enlisted crew size requirements for much of the fiscal year 2017 through fiscal year 2020 period (see fig. 17). The largest surplus—when the crew size exceeded the requirement—was in November 2016 and the largest shortfall was in September 2020, when the average number of filled positions totaled about 90 percent of the Navy's requirement, equating to about 33 required positions unfilled. The Navy updated the crew size requirements for newer Harper's Ferry class ships in April 2016, and updated the requirement for the older Whidbey Island class ships in June 2020.

Figure 17: Average Required, Funded, and Filled Enlisted Crewmember Positions for Dock Landing Ships, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 17: Average Required, Funded, and Filled Enlisted Crewmember Positions for Dock Landing Ships, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	274.5	282.833	287.083	
2017	Nov	274.5	282.833	288.25	14 over
2017	Dec	272.833	282.833	284.083	
2017	Jan	274.25	282.75	279.917	
2017	Feb	274.25	282.75	277.5	
2017	March	273.75	282.75	276.667	
2017	April	273.75	282.75	272.417	
2017	May	273.75	282.75	271.917	
2017	June	273.75	282.417	269.917	
2017	July	273.75	280.833	268.083	
2017	Aug	273.75	280.833	269.417	
2017	Sept	273.75	280.75	273.667	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	285.5	280.75	276.5	
2018	Nov	285.5	280.75	281.25	
2018	Dec	286.167	280.75	284	
2018	Jan	299.273	302.455	304	
2018	Feb	299.273	302.455	301.636	
2018	March	299.273	302.455	298.818	
2018	April	299.273	302.455	298.273	
2018	May	299.273	302.455	301.091	
2018	June	299.273	302.455	303.273	
2018	July	299.273	302.455	303	
2018	Aug	299.273	302.455	303.455	
2018	Sept	299.273	302.455	300	
2019	Oct	299.091	302.455	299.091	
2019	Nov	299.091	302.455	304.364	
2019	Dec	299.091	302.455	307.545	
2019	Jan	299.091	302.455	310.636	
2019	Feb	299.091	302.455	309.273	
2019	March	299.091	302.455	311.364	
2019	April	299.091	302.455	307.636	
2019	May	299.182	302.455	306.364	
2019	June	299.182	302.455	308.091	
2019	July	299.182	302.455	303.636	
2019	Aug	299.182	302.455	302.364	
2019	Sept	299.182	302.455	300.364	
2020	Oct	299.182	279.364	297.455	
2020	Nov	299.182	279.364	300.636	
2020	Dec	299.182	279.364	300.545	
2020	Jan	299.182	279.364	301.909	
2020	Feb	299.182	279.364	299.636	
2020	March	299.182	279.364	299	
2020	April	299.182	279.364	301.364	
2020	May	299.182	279.364	303.364	
2020	June	299.182	279.364	304.727	
2020	July	299.182	279.364	307	
2020	Aug	299.182	279.364	298.818	
2020	Sept	329.909	279.364	296.545	33 unfilled

Mine Countermeasures Ship - Avenger Class (MCM 1)

Avenger class (MCM) mine countermeasure ship

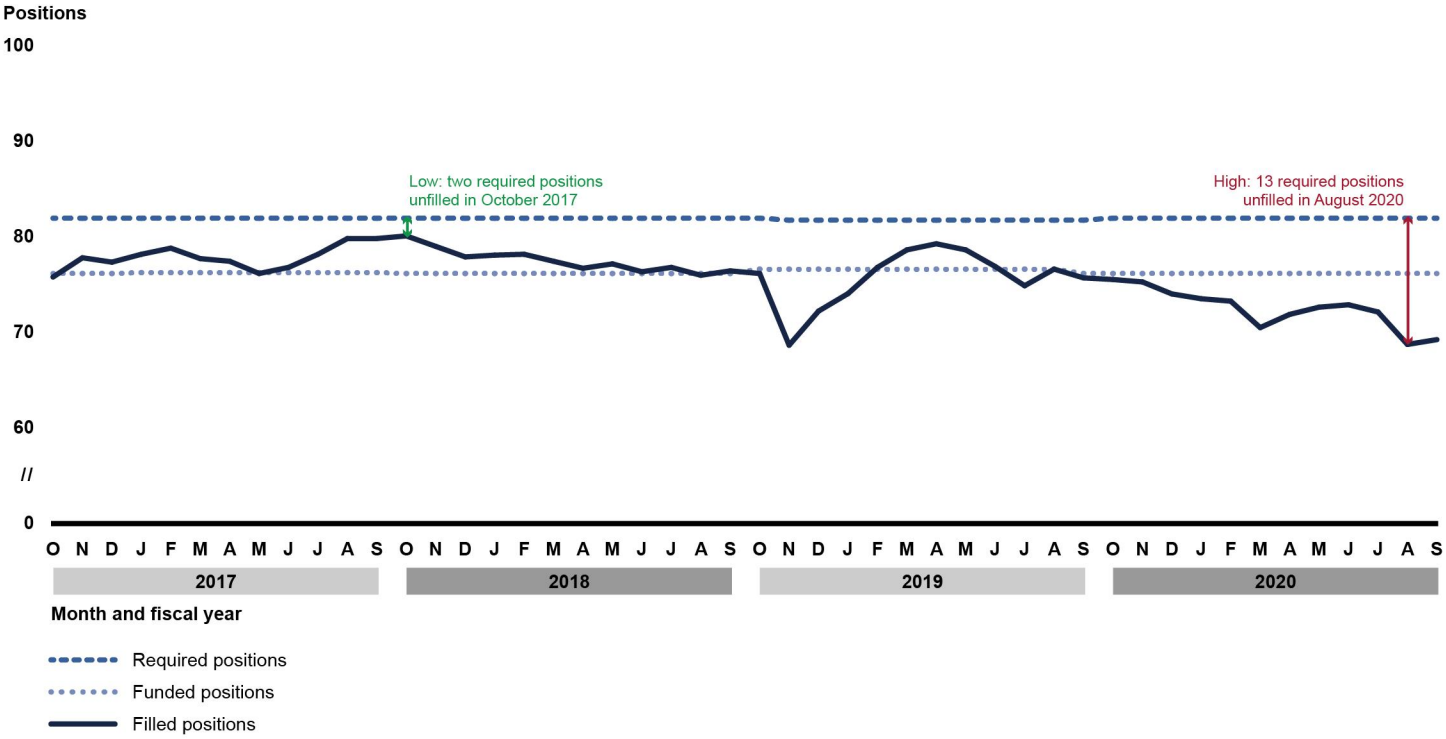
Source: U.S. Navy/LTJG A. Fairbanks. | GAO-21-366

The Navy relies on these ships, operating alongside helicopters, to conduct mine countermeasure operations. They are designed with features such as fiberglass-sheathed wooden hulls that enable them to operate in minefields. The Navy is gradually retiring these ships as this capability is supposed to transition to the Littoral Combat Ship.

There were 11 mine countermeasures ships in our sample, but we excluded three ships from our analysis at the start of fiscal year 2020, as the Navy drew down their crews in preparation for decommissioning.

The average number of enlisted positions filled on mine countermeasure ships fell short of the Navy's requirement from fiscal year 2017 through fiscal year 2020 (see fig. 18). The smallest shortfall occurred in October 2017 and the largest shortfall, about 13 positions, occurred in August 2020. The average number of filled positions in September 2020 fell to about 85 percent of the requirement, equating to about 13 required positions unfilled. Mine countermeasures ships are in the process of being decommissioned, and as a result, the Navy does not plan to update the crew size requirements.

Figure 18: Average Required, Funded, and Filled Enlisted Crewmember Positions for Mine Countermeasures Ships, Fiscal Years 2017 through 2020



Source: GAO analysis of U.S. Navy data. | GAO-21-366

Data table for Figure 18: Average Required, Funded, and Filled Enlisted Crewmember Positions for Mine Countermeasures Ships, Fiscal Years 2017 through 2020

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2017	Oct	81.75	76	75.6364	
2017	Nov	81.75	76	77.6364	
2017	Dec	81.75	76	77.1818	
2017	Jan	81.75	76.0909	78	
2017	Feb	81.75	76.0909	78.6364	
2017	March	81.75	76.0909	77.5455	
2017	April	81.75	76.0909	77.2727	
2017	May	81.75	76.0909	76	
2017	June	81.75	76.0909	76.6364	
2017	July	81.75	76.0909	78	
2017	Aug	81.75	76.0909	79.6364	
2017	Sept	81.75	76.0909	79.6364	

Fiscal Year	Month	Required	Funded	Filled	High/Low Difference
2018	Oct	81.75	76	79.9091	2 unfilled
2018	Nov	81.75	76	78.8182	
2018	Dec	81.75	76	77.7273	
2018	Jan	81.75	76	77.9091	
2018	Feb	81.75	76	78	
2018	March	81.75	76	77.2727	
2018	April	81.75	76	76.5455	
2018	May	81.75	76	77	
2018	June	81.75	76	76.1818	
2018	July	81.75	76	76.6364	
2018	Aug	81.75	76	75.8182	
2018	Sept	81.75	76	76.2727	
2019	Oct	81.75	76.4545	76	
2019	Nov	81.5455	76.4545	68.5455	
2019	Dec	81.5455	76.4545	72.0909	
2019	Jan	81.5455	76.4545	73.9091	
2019	Feb	81.5455	76.4545	76.6364	
2019	March	81.5455	76.4545	78.4545	
2019	April	81.5455	76.4545	79.0909	
2019	May	81.5455	76.4545	78.4545	
2019	June	81.5455	76.4545	76.7273	
2019	July	81.5455	76.4545	74.7273	
2019	Aug	81.5455	76.4545	76.4545	
2019	Sept	81.5455	76	75.5455	
2020	Oct	81.75	76	75.375	
2020	Nov	81.75	76	75.125	
2020	Dec	81.75	76	73.875	
2020	Jan	81.75	76	73.375	
2020	Feb	81.75	76	73.125	
2020	March	81.75	76	70.375	
2020	April	81.75	76	71.75	
2020	May	81.75	76	72.5	
2020	June	81.75	76	72.75	
2020	July	81.75	76	72	
2020	Aug	81.75	76	68.625	13 unfilled
2020	Sept	81.75	76	69.125	

Appendix IV: Survey of Fatigue Management on Surface Ships

We administered a web-based survey that included the questions listed below to determine the extent to which the surface Navy had implemented its fatigue management policy. A few open-ended survey questions (those without response options) were included and information was analyzed by completing a content analysis. Although the format has been modified for readability purposes, this appendix accurately replicates the content of the web-based survey questions and response options. Further, the survey questions shown in this appendix were part of a broader survey questionnaire which contained additional questions outside the scope of this review. These questions are not shown below.[1] Terms used in the survey were defined when they first appeared in the survey and provided to respondents through pop-ups windows in subsequent questions. For more information about our methodology for designing and administering the survey, see appendix I.

SECTION I: Background

1. **What is your current rank?** *(Please mark ☒ only one response)*

   ☐ O1

   ☐ O2

   ☐ O3

   ☐ O4

   ☐ O5

   ☐ O6

   ☐ Other, please specify.

2. **Approximately how many years have you served as an active duty SWO?**

   ☐ 1 - 6

[1]Specifically, survey questions 26-40 were omitted from this appendix. For more information, see appendix I.

☐ 7 - 12

☐ 13 - 19

☐ 20 or more

3. **Are you currently underway?** *(Please mark ☒ only one response)*

☐ Yes

☐ No → **SKIP TO QUESTION #5**

4. **How many days have you been underway?** *(Please mark ☒ only one response)*

☐ Less than 5 continuous days

☐ 5 to 10 continuous days

☐ 11 to 15 continuous days

☐ 16 continuous days or more

5. **Have you stood watch as an Officer of the Deck (OOD), Engineering Officer of the Watch (EOOW), or Tactical Action Officer (TAO) underway in the last 12 months?** *(Please mark ☒ only one response)*

☐ Yes

☐ No

6. **Have you completed the PQS for the following watch stations?** *(Please mark ☒ one response for each station)*

	Yes	No
a) Officer of the Deck (OOD) Underway	☐	☐
b) Engineering Officer of the Watch (EOOW)	☐	☐
c) Tactical Action Officer (TAO)	☐	☐

7. **On what type of ship did you stand watch as OOD, EOOW, or TAO during your current or most recent underway period?** *(Please mark ☒ only one response)*

☐ Aircraft Carrier (CVN)

☐ Amphibious Assault Ship (LHA/LHD)

☐ Amphibious Command Ship (LCC)

☐ Amphibious Transport Dock (LPD)

☐ Cruiser (CG)

☐ Destroyer (DDG)

☐ Dock Landing Ship (LSD)

☐ Littoral Combat Ship (LCS)

☐ Mine Countermeasure Ship (MCM)

☐ Other, please specify:

SECTION II: Fatigue Questions

8. **In general, did you stand watches during your current or most recent underway period*?*** *(Please mark ☒ only one response)*

☐ Yes

☐ No

9. **Did your watchstation predominantly use a fixed or rotating watchbill during the underway period?** *(Please mark ☒ only one response)*

☐ Fixed Watchbill *(Standing watch the same time every day although your watch times may rotate every two/three weeks or after port visits)*

☐ Rotating Watchbill *(Standing watch at different times every day)* → **SKIP TO QUESTION #11**

10. **If you are/were a watchstander, which fixed watchbill, if any, did your watchstation predominantly use during the underway period?** *(Please mark ☒ only one response)*

☐ Fixed 6 hours on/6 hours off (2-section)

☐ Fixed 7 hours on/5 hours off/5 hours on/7 hours off (2-section)

☐ Fixed 12 hours on/12 hours off (2-section)

☐ Fixed 4 hours on/8 hours off (3-section)

☐ Fixed 5 hours on (dayshifts) or 3 hours on (nightshifts) (3-section)

☐ Fixed 3 hours on/9 hours off (4-section)

☐ Fixed 6 hours on/18 hours off (4-section)

☐ Other, please specify:

☐ I did not stand watch on a fixed schedule

11. **If you are/were a watchstander, which rotating watchbill, if any, did your watchstation predominantly use during the underway period?** *(Please mark ☒ only one response)*

☐ Rotating 4 hours on/8 hours off

☐ Rotating 5 hours on/10 hours off (3-section)

☐ Rotating 5 hours on/15 hours off (4-section)

☐ Rotating 6 hours on/12 hours off

☐ Other, please specify:

☐ I did not stand watch on a rotating schedule

12. **In a typical week during your current or most recent underway period, how often were your actual watch hours consistent with the watchbill in place?** *(Please mark ☒ only one response)*

☐ Rarely if ever

☐ Less than half the time

☐ About half the time

☐ More than half the time

☐ Always

13. **Which fatigue management practices did your ship's leadership implement?** *(Please mark ☒ one response for each row)*

	Practice	Implemented	Not Implemented
a)	Circadian rhythm watchbills (watchbills based on a fixed 24-hour day in which Sailors stand watch and sleep at the same times each day)	☐	☐
b)	Establishment of a 7-hour sleep minimum in a 24 hour day; either by one uninterrupted 7-hour period or an uninterrupted 5-hour period with an uninterrupted 2-hour nap	☐	☐

	Practice	Implemented	Not Implemented
c)	Consideration of your individual fatigue level as part of operational risk management for routine operations	☐	☐
d)	Consideration of your individual fatigue level as part of operational risk management for special evolutions (e.g. underway replenishment)	☐	☐
e)	Limiting workdays to a maximum of 12 hours in a 24 hour period	☐	☐
f)	Limiting work shifts to a maximum of 8 continuous hours of work	☐	☐

14. What other fatigue management practices, if any, did your ship's leadership implement?

15. **Typically, how many hours of continuous sleep did you get while underway during each 24 hour cycle?** *(Please mark ☒ only one response)*

☐ 1 hour per 24 hour cycle

☐ 2 hours per 24 hour cycle

☐ 3 hours per 24 hour cycle

☐ 4 hours per 24 hour cycle

☐ 5 hours per 24 hour cycle

☐ 6 hours per 24 hour cycle → **SKIP TO QUESTION 17**

☐ 7 hours per 24 hour cycle → **SKIP TO QUESTION 17**

☐ 8 hours or more per 24 hour cycle → **SKIP TO QUESTION 17**

16. **If you typically received 5 hours or less of continuous sleep, how often were you able to mitigate this loss with an uninterrupted 2 hour nap?** *(Please mark ☒ only one response)*

☐ Rarely if ever

☐ Less than half the time

☐ About half the time

☐ More than half the time

☐ Always

17. **How often, if at all, did you experience the following fatigue-related conditions due to lack of sleep *during the underway period?*** *(Please mark ☒ one response for each row)*

Fatigue Related Condition	Never	Rarely	Sometimes	Often
a) Reduced sleep quality	☐	☐	☐	☐
b) Irritability	☐	☐	☐	☐
c) Lack of energy	☐	☐	☐	☐
d) High levels of stress	☐	☐	☐	☐
e) Reduced alertness and inability to focus	☐	☐	☐	☐
f) Delayed reaction time	☐	☐	☐	☐
g) Inability to plan my day	☐	☐	☐	☐
h) Inability to work out	☐	☐	☐	☐
i) Missing meals	☐	☐	☐	☐
j) Falling asleep during off-watch workhours	☐	☐	☐	☐
k) Inability to complete off-watch duties	☐	☐	☐	☐
l) Reporting late to watch	☐	☐	☐	☐
m) Missing watch	☐	☐	☐	☐

18. **What other fatigue-related issues related to your daily schedule, if any, did you experience during the underway period?**

19. **How often, if at all, do you feel that fatigue-related conditions among the crew affect ship operations?**

☐ Never

☐ Rarely

☐ Sometimes

☐ Often

20. **In general, was the amount of rest you received during your current or most recent underway period:** *(Please mark ☒ only one response)*

☐ Much less than needed

☐ Somewhat less than needed

☐ About right

☐ Somewhat more than needed

☐ Much more than needed

21. **In general, was the amount of rest other crew members in your watchstation received during your recent underway period:** *(Please mark ☒ only one response)*

☐ Much less than needed

☐ Somewhat less than needed

☐ About right

☐ Somewhat more than needed

☐ Much more than needed

22. **To what extent, if at all, did each of the following barriers prevent effective fatigue management during your current or recent underway period?** *(Please mark ☒ one response in each row)*

Barrier	No extent at all	Some extent	Moderate extent	Great extent
a) Work requirements	☐	☐	☐	☐
b) Additional work requirements (i.e. collateral and administrative duties)	☐	☐	☐	☐
c) Lack of leadership support	☐	☐	☐	☐
d) Short on manning (lack of sailors to fill overall billets)	☐	☐	☐	☐
e) Short on qualified personnel (lack of qualified sailors to fill certain billets)	☐	☐	☐	☐

23. What other barriers, if any, prevented effective fatigue management during your current or most recent underway period?

24. **To what extent, if at all, did each of the following environmental factors affect your ability to obtain sufficient sleep?** *(Please mark ☒ one response in each row*

Environmental Factor	No extent at all	Some extent	Moderate extent	Great extent
a) Light in berthing area	☐	☐	☐	☐
b) Noise in berthing area	☐	☐	☐	☐
c) Smell in berthing area	☐	☐	☐	☐
d) Temperature in berthing area	☐	☐	☐	☐

25. **What other environmental factors, if any, affected your ability to obtain sufficient sleep?**

26. **What additional comments, if any, would you like to make about any topic covered in this survey?**

Appendix V: Comments from the Department of Navy

DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
(MANPOWER AND RESERVE AFFAIRS)
1000 NAVY PENTAGON
WASHINGTON, D.C. 20350-1000

MEMORANDUM FOR DIRECTOR, MILITARY PERSONNEL PLANS AND POLICY DIVISION, OFFICE OF THE CHIEF OF NAVAL OPERATIONS

SUBJECT: Navy Readiness: Additional Efforts Are Needed to Manage Fatigue, Reduce Crewing Shortfalls, and Implement Training

Ref: Draft Audit Report: GAO-21-366, May 2021

The Department of the Navy (DoN) responses to the recommendations outlined in the referenced draft report are provided below:

- Recommendation #1: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet revise guidance to require systematic collection of quality and timely fatigue data from sailors that are accessible to operational commanders to support underway decision-making.
    - **DoN RESPONSE: Concur**
- Recommendation #2: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet use collected data on sailor fatigue to identify, monitor, and evaluate factors that contribute to fatigue and inadequate sleep such as the effects of crew shortfalls, work requirements, administrative requirements, and collateral duties.
    - **DoN RESPONSE: Concur**
- Recommendation #3: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet take actions to address the factors causing sailor fatigue and inadequate sleep.
    - **DoN RESPONSE: Concur**
- Recommendation #4: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet establish a process for identifying and assisting units that have not implemented its fatigue management policy.
    - **DoN RESPONSE: Concur**

- Recommendation #5: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the ·Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet revise guidance to institutionalize the practice of using crew requirements to track and report positions that are filled.

  - **DoN RESPONSE: Concur**. DON concurs that full crew requirements should be used to track and report positions that are filled for readiness reporting purposes and in support of informing distribution of personnel across the fleet. However, as discussed in the report (see page 28-29), total personnel available for distribution is limited to funded billets which are constrained to the end strength authorized and appropriated for by Congress.

- Recommendation #6: The Secretary of the Navy should ensure that the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet establish crewing targets that are based on analysis and assessment of risk.

  - **DoN RESPONSE: Concur**

- Recommendation #7: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations uses crew requirements to project future personnel needs.

  - **DoN RESPONSE: Concur.** DON agrees that full crew requirements should be used when projecting future personnel needs for programming and budgeting purposes, to ensure the full cost and risk implications of manpower funding decisions are considered. Long lead time personnel decisions, such as recruiting and promotion quotas, must remain tied to programmed end strength in the future years defense plan program of record which is the DON's best estimate of the actual funding that will be available for the personnel that man the fleet and shore establishment.

- Recommendation #8: The Secretary of the Navy should ensure that the Office of the Chief of Naval Operations accounts for additional sailor workload resulting from the continued implementation of Ready Relevant Learning when determining crew requirements.

  - **DoN RESPONSE: Concur**

Should you have any further questions, please contact Ms. Heather McIntosh-Braden, heather.mcintosh1@navy.mil or (703) 693-4489.

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Michael R. Melillo
Principal Director
Office of the Deputy Assistant Secretary of the Navy (Military Manpower and Personnel)

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Text of Appendix V: Comments from the Department of Navy

Page 1

MEMORANDUM FOR DIRECTOR, MILITARY PERSONNEL PLANS AND POLICY DIVISION, OFFICE OF THE CHIEF OF NAVAL OPERATIONS

SUBJECT: Navy Readiness: Additional Efforts Are Needed to Manage Fatigue, Reduce Crewing Shortfalls, and Implement Training

Ref: Draft Audit Report: GAO-21-366, May 2021

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Recommendation #1: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet revise guidance to require systematic collection of quality and timely fatigue data from sailors that are accessible to operational commanders to support underway decision-making.

DoN RESPONSE: Concur

Recommendation #2: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet use collected data on sailor fatigue to identify, monitor, and evaluate factors that contribute to fatigue and inadequate sleep such as the effects of crew shortfalls, work requirements, administrative requirements, and collateral duties.

DoN RESPONSE: Concur

Recommendation #3: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet take actions to address the factors causing sailor fatigue and inadequate sleep.

DoN RESPONSE: Concur

Recommendation #4: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the Commander, U.S. Fleet Forces Command,

and Commander, U.S. Pacific Fleet establish a process for identifying and assisting units that have not implemented its fatigue management policy.

DoN RESPONSE: Concur

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Recommendation #5: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations and the ·Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet revise guidance to institutionalize the practice of using crew requirements to track and report positions that are filled.

DoN RESPONSE: Concur. DON concurs that full crew requirements should be used to track and report positions that are filled for readiness reporting purposes and in support of informing distribution of personnel across the fleet. However, as discussed in the report (see page 28-29), total personnel available for distribution is limited to funded billets which are constrained to the end strength authorized and appropriated for by Congress.

Recommendation #6: The Secretary of the Navy should ensure that the Commander, U.S. Fleet Forces Command, and Commander, U.S. Pacific Fleet establish crewing targets that are based on analysis and assessment of risk.

DoN RESPONSE: Concur

Recommendation #7: The Secretary of the Navy should ensure that the Office of Chief of Naval Operations uses crew requirements to project future personnel needs.

DoN RESPONSE: Concur. DON agrees that full crew requirements should be used when projecting future personnel needs for programming and budgeting purposes, to ensure the full cost and risk implications of manpower funding decisions are considered. Long lead time personnel decisions, such as recruiting and promotion quotas, must remain tied to programmed end strength in the future years defense plan program of record which is the DON's best estimate of the actual funding that will be available for the personnel that man the fleet and shore establishment.

Recommendation #8: The Secretary of the Navy should ensure that the Office of the Chief of Naval Operations accounts for additional sailor workload

resulting from the continued implementation of Ready Relevant Learning when determining crew requirements.

DoN RESPONSE: Concur

Should you have any further questions, please contact Ms. Heather McIntosh-Braden, heather.mcintosh1@navy.mil or (703) 693-4489.

Michael R. Melillo Principal Director

Office of the Deputy Assistant Secretary of the Navy (Military Manpower and Personnel)

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

Cary Russell at (202) 512-5431 or russellc@gao.gov.

Staff Acknowledgements

In addition to the contact named above, Suzanne Wren (Assistant Director), Steven Banovac (Analyst in Charge), Chris Cronin, Alexandra Gonzalez, Chad Hinsch, David L. Jones, Suzanne Kaasa, Terry Richardson, Michael Silver, Matt Thompson, and Lillian M. Yob made key contributions to this report.

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