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Applying Civilian Ship Manning Practice to USN Ships

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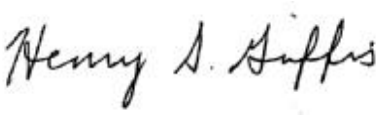

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Contents

Executive summary

AOs, AEs, AFSs, and AOEs have been transferred to the Military Sealift Command (MSC) for operation by civil service mariners, and some towed array ships and submarine rescue ships have been outsourced to commercial operators—all at considerable savings to the U.S. Navy (USN) in both military billets and cost. The Chief of Naval Operations staff has asked: "Is it possible to reduce manning on surface combatants to the same degree that MSC and private operators have been able to reduce manning on noncombatants?"

To answer this question, we examined the ship manning practices of MSC, foreign navies, and the private sector and then identified differences with the manning practices used for USN military ships that cause larger USN crews.

We found no evidence that the smaller crews on MSC ships resulted in degraded performance. In fact, for all metrics examined (replenishment quantities and rates, readiness, injuries, collisions, fires, groundings, and oil spills), MSC civilian crew performance was equal to or better than that of USN military crews.

We found the following salient differences between MSC and USN workforce. The MSC seagoing workforce is older and more experienced. Its members have had more time at sea than USN military officers and enlisted personnel with comparable years of service, and they have had more than twice as much time at sea compared with USN military personnel with 20 or more years of service. Although a much lower percentage of MSC officers have college degrees than their military counterparts, they are better qualified technically than their nonnuclear USN counterparts. They are also more likely than USN military officers to be directly involved in hands-on maintenance activity—a practice that results in a need for fewer nonofficers.

One reason for the greater technical capability of MSC crews is the more focused education and practical training of civilian mariners,

based on U.S. Coast Guard (USCG) standards for civilian crews. Another reason is that MSC engineering officers are placed into engineering billets aboard ship based on their technical qualifications and the technical needs of the ship, whereas many naval officers are placed into engineering billets aboard ship primarily to gain broad experience for future, higher level positions aboard ship and within the Navy. As a consequence of this "generalist" approach, many officers in technical billets on USN surface ships share the following characteristics:

- They can be a training burden to more experienced crew members, which increases crew workload and contributes to larger crews.
- They are limited in their ability to teach or guide subordinates in technical areas or to contribute significantly to solving technical problems,
- They spend considerable time standing watch on the bridge and in other departments rather than dedicating all of their time to operation and maintenance of the engineering plant.

MSC, the private sector, and virtually all foreign navies eschew the USN generalist approach used by the Surface Warfare Unrestricted Line Officer community and instead employ a two-track career path for officers—deck (operations), which can lead to the position of ship Master/Commanding Officer, and engineering, which can lead to the position of Chief Engineer aboard ship (but not Commanding Officer). Both the generalist and the two-track systems have advantages and disadvantages, but the two-track approach is more likely to ensure better engineering management with fewer personnel.

We found high rates of turnover on both MSC and USN ships, but replacement crew members are better qualified upon arrival on MSC ships than on USN ships, so the adverse consequences of high turnover are more severe on the USN ships. If the Navy were to decrease its crew turnover by as little as 10 percent on all ships, we estimate that crew sizes could be reduced by about 1.4 percent without affecting readiness, which would save over 1,400 surface ship billets and more than $152 million per year. If the Navy also increased Commanding

Officer tenure rates, data show that the time that ships are free of mission-degrading failures would increase.

We observed that the Navy, unlike the private sector, assigns menial galley and laundry tasks to technically trained enlisted personnel for as many as 3 to 4 months after their first arrival aboard ship, a practice that reduces morale and productivity and degrades technical proficiency. Numerous studies show marked deterioration of new skills when they are not applied soon after training. Six studies, in fact, show that delaying application of new skills for 90-180 days after training causes skill loss equivalent to using only the bottom 8 percent of A-school graduates. Based on these and other studies, we estimate that the cost to the Navy of diverting skilled sailors to menial tasks on surface ships is in excess of $30 million annually.

There are essentially three layers of management on USN ships (officers, noncommissioned officers, and enlisted) contrasted with two levels in the MSC/private sector (officer and non-officer). MSC and the private sector have a relatively flat non-officer workforce, with only two to three different pay levels, and only four levels of officers compared to the five or six different officer ranks commonly found on USN ships. Moreover, there is no layering among the non-officers; they all report to an officer, not to other non-officers.

Even after accounting for differences in ship system complexities, the Navy has a larger variety of enlisted ratings and specialties than do MSC and the private sector because the Navy tends to favor more narrowly defined skills in the enlisted ranks. This reduces training time per person but can inflate crew sizes because more people are necessary to maintain many different types of equipment aboard ship. For example, ship manning policy requires that Navy Enlisted Classifications (NECs) for "essential" equipment be assigned to two separate billets. Recently, a report by Naval Surface Warfare Center (NSWC) Carderock indicated that, if equipment NECs were assigned only to one billet for some specialties on the DDG-51 class, a reduction of six billets per ship could be realized—"a savings of over $40 million annually" for the DDG-51 ship class alone.

USN Ship Manning Document policy assumes that a crew must be able to "fight the ship" (continue to carry out its mission) while

performing damage control and fighting an onboard fire, even though USN experience over the past half century (and MSC/private sector practice) has been to cease operations until fires and/or damage are contained. A vestige of World War II experience, this policy leads to increased crew size.

Like nearly all military organizations, the U.S. Navy relies on closed-loop accession policies, with all promotion from within and virtually no lateral entry of personnel from outside, as one sees at MSC or in the private sector. This can cause overmanning because it requires a pyramid-shaped workforce profile in which the size of the base of lower ranks depends on both the total number of higher level billets Navy-wide and projected attrition rates. For example, as of December 2004, the Navy carried 1,125 more junior Surface Warfare Officers (SWOs) than necessary for current requirements, solely to prepare for future billets. These excess junior officers are distributed throughout the fleet, overmanning[1] most surface combatants, at a cost of well over $150 million in 2004. Overmanning of enlisted billets is also common. Of 115 combatants surveyed, a total of 1,634 enlisted personnel were assigned in excess of authorized billets, for an additional cost to the Navy of about $80 million annually.

These types of inefficiencies, as well as the need for unskilled labor, technically skilled officers/enlisteds, and future leaders, suggest that the Navy may require more of an oval-shaped workforce profile, rather than the pyramid-shaped profile of today. Such a profile, combined with a reformed compensation system, could allow for a pattern of accessions similar to that of MSC and the private sector, in which lateral entry and in-and-out paths would be possible and changes in the length of at least some military careers could be accommodated.

The Navy has recognized the adverse consequences of too many narrow specialists in the enlisted ranks and is making progress in reducing the number of ratings. Similarly, such programs as the Optimum Manning Experiment and Smart Ship have helped reduce the number of watchstanders and enlisted billets aboard USN ships, but

1. Manning in excess of authorized billets.

more can be done to reduce crew sizes and improve the quality of USN ship operation and maintenance overall.

The Navy probably cannot achieve the full amount of reduced manning that MSC achieves, but if the Navy wishes to move further towards the levels of manning being achieved by MSC and the private sector, we believe it should consider these changes:

- Stop assigning insufficiently trained officers to engineering departments aboard ship.
- Implement a two-track career path for SWOs—similar to that used in MSC, the private sector, and nearly all foreign navies—as the best means to ensure that all shipboard engineers are trained and capable at engineering plant operation and maintenance.
- Shift the USN SWO culture to expect hands-on participation of officers in ship engineering departments, to reduce the need for large supporting crews.
- Increase emphasis on lateral entry and workforce pyramid reduction to achieve a more optimal workforce profile.
- End the practice of assigning technically trained enlisted personnel to menial tasks aboard ship for laundry and galley duty.
- Minimize frequent watchstanding rotations, to allow adequate periods of uninterrupted sleep for watchstanders. This is especially important for those assigned to minimally manned ships, to improve effectiveness and safety.
- Increase at-sea tours of key personnel, such as Commanding Officer and Chief Engineer, and other careerists with 10 to 20 years' service, to gain maximum benefit from their experience.
- Consider changing ship requirement documents to require manning suitable to "fight or save the ship", rather than "fight *and* save the ship", because the nature of modern warfare has changed.

Before adopting these changes, the Navy should initiate one or two pilot programs, as described in detail in appendices F and G, to:

— Verify Navy capability to operate Navy ships with crews reduced to sizes comparable to the MSC/commercial construct

— Identify standard Navy operational, reporting, and administrative procedures and requirements that require changes to enable reduced-size crews

— Form the basis for transition to reduced-size crews on other legacy ships, LCS, and other new construction ships.

Introduction

A recent CNA paper prepared for the Military Sealift Command [1] found that MSC could operate all four Navy Command ships (LCC-19/20 and AGF-3/11) with 618 civilian mariners compared with 1,533 Navy personnel doing essentially the same functions (these numbers exclude the Command staffs, which remain the same on the MSC-operated ships as on the Navy-operated ships).

Such a substantial reduction of operating personnel is not unusual when USN ships are taken over by MSC. In the past, AOs, AEs, AFSs, and AOEs have been transferred to MSC for operation by civil service mariners, and some towed array ships and submarine rescue ships have been outsourced to commercial operators—all at considerable savings to the Navy in both military billets and cost.

While civilianizing and outsourcing has been successful for operation of noncombatants, combatants will continue to be USN manned, and the Navy has focused on ways to reduce manning of these ships. Navy initiatives to date have tended to reduce manning mainly through technical changes (such as increasing the use of automation and remote sensors and by using equipment, materials, and coatings that require less onboard maintenance) and through process changes, such as performing more maintenance off ship. MSC and the private sector, however, have gone beyond these types of improvements toward more fundamental structural changes, enabling them to achieve significantly smaller crews than the Navy for identical ships.

In this study, we focus on the differences between USN[2] and MSC/commercial manning models and cultures to identify ways to achieve more substantial USN ship manning reductions.

2. Although MSC ships are, of course, U.S. Navy ships, in this report we distinguish between the civilian-manned MSC ships and the military-manned ships operated by the rest of the Navy by referring to the military-manned ships as "USN" ships.

We examine (through the use of documentation reviews and interviews) ship manning procedures/policies used by MSC, other navies, and the private sector. We also compare relative performance and readiness to identify (a) any major differences between the same ship types manned at different levels and (b) other differences in how ships are operated and maintained and how personnel are trained.

In the executive summary, and throughout this report, we estimate specific savings that we think could be achieved if certain reforms were implemented. However, these estimated savings are not additive and it would be inaccurate to assume that, if all reforms were to be implemented, the total savings could equal the sum of the separate estimates for each.

MSC and USN comparability

What are the differences in manning between USN and MSC ships, and how do they affect performance? Table 1 summarizes differences in the manning of USN auxiliaries that have been transferred to MSC.

Table 1. Summary of manning differences when transferred to MSC

Ship class	Navy crew	CIVMAR crew	MilDet
Oilers (AO)	324	106	21
Ammunition Ships (AE)	413	123	40
Provisions Ships (AFS)	486	135	49
Multiproduct Ships (AOE)	583	160	28

As shown in the table, USN ships operated by military crews have consistently required more manning than those same ships operated by civilian mariners (CIVMARs) augmented with Navy military detachments. How could there be large differences in manning of similar ships that perform nearly identical functions, and how do the ships with reduced manning perform relative to those same ships with larger crews? In this section, we compare the performance of USN and MSC-manned auxiliary ships.

Replenishment quantities

Although MSC has been operating former USN auxiliary ships for more than three decades, actual replenishment data for USN and MSC ships have only been gathered on a consistent basis since the beginning of FY02. In table 2, we compare the AOE-10 replenishment performance with that of three ships of the same class while under MSC command over the same period, FY02-04. The data are limited and reflect not only each ship's replenishment performance but also

the requirements placed on the ship by the operating fleet—which is generally beyond the control of the replenishment ship.

Table 2. USN and MSC cargo transfers, FY02-04[a]

Amount of fuel or cargo	AOE-10 USS *Bridge*	TAOE-6, -7, -8 USNS *Supply, Rainier, Arctic*
Fuel (thousands of barrels/quarter)		
JP-5	99	31-107
DFM	138	76-246
All fuel	237	107-353
All dry cargo (pallets/quarter)	3,029	910-2,997

a. No data were gathered for USN or MSC ships before 2002. After 2002, the only auxiliary still in the Navy inventory was the AOE-10; all others had been transferred to MSC. Source: Carl Douglas, *Military Sealift Command Logistics Ships: Replenishments and Costs, FY 2002-2004,* March 2005 (CNA Research Memorandum D0011173.A2/Final).

The data show a comparability of quantity transferred; the USN ship's deliveries per quarter are approximately the same as the range of deliveries from the MSC ships per quarter. Neither amount was significantly higher or lower than the other.

Replenishment rates

Despite the fact that rapid transfer of cargo during connected replenishment (CONREP) is desired to minimize the period of restricted CV maneuvering, few data are available on the relative speeds of USN and MSC underway transfers. However, we located one limited study [2] on the relative performance of civilian and Navy-manned CLF ships that compared underway replenishment rates during the Desert Storm operation in 1991. In that study, data needed to construct cargo-transfer rates by provisions ships in Desert Storm were obtained from message reports, CV deck logs, and AFS / TAFS data files.

Table 3 lists ten CV CONREPs by Navy-manned AFSs, for which data were available during Desert Storm. *Sylvania* (AFS-2) supported the Red Sea operations; *San Diego* (AFS-6) supported the Persian Gulf forces.

Table 3. CV /CVN CONREPs by Navy-manned AFSs[a]

Date	AFS	Customer	Pallets	CONREP time (hours)	Pallets per hour
19 Jan 1991	*Sylvania*	*Saratoga*	656	8.7	75.6
21 Jan 1991	*Sylvania*	*Kennedy*	363	6.2	58.5
30 Jan 1991	*Sylvania*	*America*	161	3.1	51.9
6 Feb 1991	*Sylvania*	*America*	134	2.2	60.9
7 Feb 1991	*Sylvania*	*Saratoga*	230	3.7	62.1
14 Feb 1991	*San Diego*	*Ranger*	83	0.9	92.0
16 Feb 1991	*San Diego*	*Roosevelt*	93	1.5	62.0
21 Feb1991	*San Diego*	*America*	75	1.3	57.7
18 Mar 1991	*San Diego*	*Roosevelt*	181	2.7	67.0
1 Apr 1991	*San Diego*	*Roosevelt*	222	3.6	61.7
Total			**2,198**	**33.9**	**64.9**

a. The time for each CONREP was taken from CVCVN logs as the elapsed time between the tensioning of the first rig and detensioning of the last rig.

Data for five CV CONREPs by two civilian-manned MSC ships are listed in table 4. As shown in the table, the average civilian-manned transfer rate of 79.9 pallets per hour exceeds the observed Navy-manned provisions ship transfer rate of 64.9 pallets per hour by 15 pallets per hour. Also, the CONREP event with the highest transfer rate, 93.8 pallets per hour, was recorded by the civilian-manned *Sirius* TAFS-8 delivery to *Kennedy,* on 17 February 1991.

Table 4. CV CONREPs by TAFS[a]

Date	TAFS	Customer	Pallets	CONREP time (hours)	Pallets per hour
2 Feb 1991	*Spica*	*Midway*	155	1.7	91.2
17 Feb 1991	*Sirius*	*Kennedy*	300	3.2	93.8
22 Feb 1991	*Spica*	*Midway*	87	1.4	62.1
25 Feb 1991	*Sirius*	*Saratoga*	65	1.2	54.2
2 Mar 1991	*Spica*	*Midway*	168	2.2	76.4
Total			**775**	**9.7**	**79.9**

a. The time for each CONREP was taken from CV logs as the elapsed time between the tensioning of the first rig and detensioning of the last rig.

Because the transfer rate depends on the crew's ability to handle cargo and operate the rigs efficiently and reliably, we think net transfer rate can be a reasonable indicator of a crew's performance.

USN and MSC ships' time under way

The following list, based on 1983-2002 Navy ship employment histories (EMPSKDs), shows how much of the time USN and MSC ships are under way:

- DD—33 percent
- DDG—32 percent
- CG—35 percent
- FFG—33 percent
- SSN—33 percent
- LHA, LHD, LSD, LPD—32 percent
- AO, AOE, AE, AFS—33 percent
- TAO, TAOE, TAE, TAFS—44 percent.

In general, an MSC ship spends about one-third more time at sea than a comparable military-manned ship.

Other performance measures

Since MSC-manned auxiliary ships conduct replenishment operations in much the same way as USN-manned ships, but with smaller crews, we also examined other parameters for possible adverse effects of undermanning or overwork on the MSC ships.

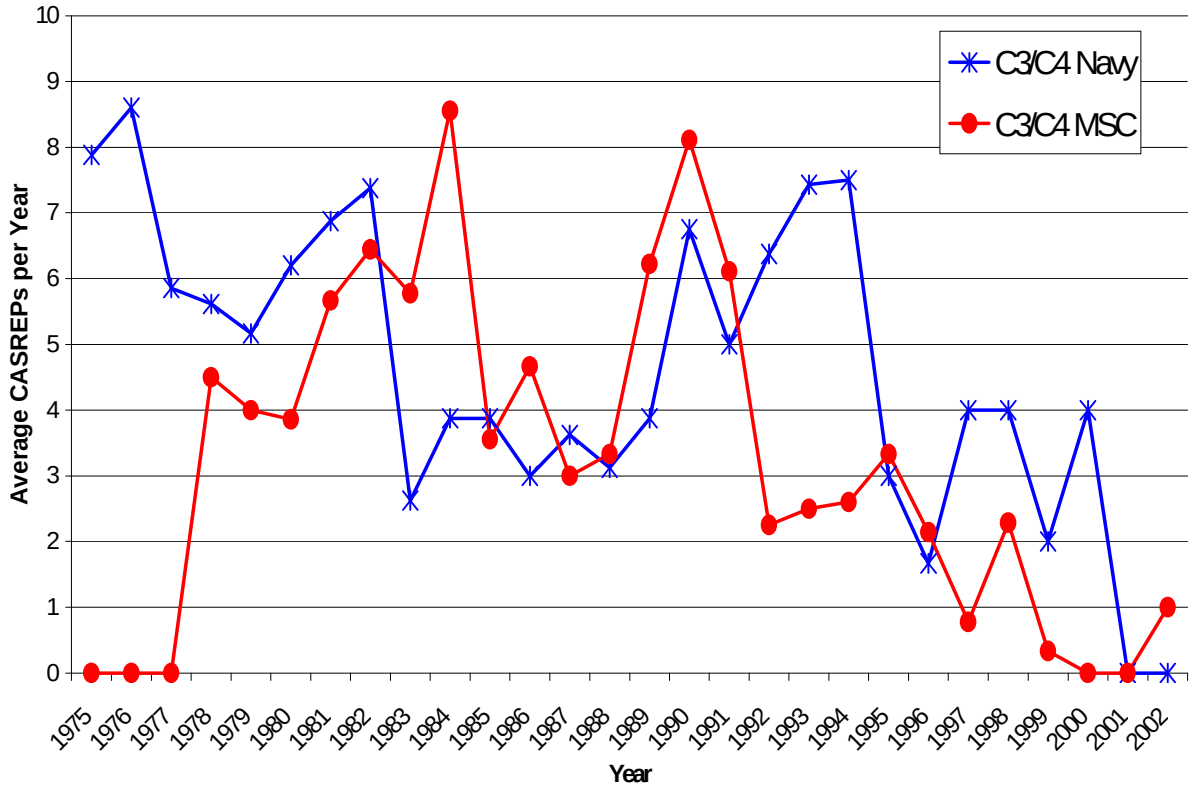
The specific metrics we examined for USN and MSC auxiliaries were mission-degrading casualties (an indication of readiness), shipboard injuries, fires, groundings, collisions, and oil spills.

Readiness

Figure 1 summarizes CASREP data on AE, AFS, AO, and AOE auxiliaries while they were operated by the USN and compares CASREP

data for those same ships when later operated by MSC. To ensure an apples-to-apples comparison, the graph excludes USN auxiliaries that were not subsequently operated by MSC, and also excludes MSC auxiliaries that were not previously operated by the USN.

Figure 1. Mission-Degrading CASREPs Navy and MSC Auxiliaries[a]



a. For ship types AE, T-AE, AFS, T-AFS, AO, T-AO, AOE, and T-AOE. Excludes all CASREPs for missile, gun, and countermeasure systems.

The ships operated by MSC during the later years of this data set were all previously operated by the USN during the earlier years. Despite the fact that the ships were older when operated by MSC, the data show fewer mission-degrading CASREPs per MSC ship than for those same ships when operated by the USN.

Specifically, for all years, MSC averaged 4.2 C3 and C4 CASREPs per ship per year, compared with an average of 5.5 per ship per year for

the USN. For the last 10 years, the MSC average was 1.8 per ship per year compared to 4.9 for the USN.

Injuries

One could argue that there is a greater strain on smaller crews. To perform the workload, they would take greater risks, resulting in injuries and accidents. We examined available data on mishaps for USN- and MSC-manned auxiliary ships. The Navy Safety Center provided data on the number of mishaps per year—injuries, collisions, groundings, and fires. Although data were provided for 1970 through 2003, indications of some mishaps' severity were only included for 1980 to 2003. Our comparison, therefore, focuses on the 1980-2003 data.

Injuries are subdivided by severity into four categories, ranging from A (most severe) to D (least severe). Table 5 provides the numbers and rates of injuries for both USN- and MSC-manned auxiliary ships, for all four severity categories, from 1980 through 2003.

Over the 1980-2003 period, the USN-manned ships recorded nearly twice as many injuries as the MSC-manned ships—2,317 for the USN-manned ships versus 1,277 for the MSC-manned ships—but there were also more USN-manned ships operating during this period. Taking ship-years into account had the effect of shrinking the apparent difference between the two types of ships. Per ship-year, the USN-manned ships averaged 3.57 injuries, and the MSC-manned ships averaged 2.55 injuries.

Table 5. Injuries[a] on board USN-manned and MSC-manned auxiliary ships, 1980-2003

	USN injuries		MSC injuries	
	Total	Per ship-year	Total	Per ship-year
Total	2,317	3.57	1,277	2.55
Category A	51	0.08	12	0.02
Category B	45	0.07	5	0.01
Category C	1,614	2.49	1,148	2.30
Category D	607	0.94	112	0.22

a. The categories are: A (fatality or permanent total disability), B (permanent partial disability), C (loss of work beyond that day on which the injury occurred), and D (loss of work on that day or no loss of work).

For each severity category, the USN-manned ships averaged more injuries per ship-year than the MSC-manned ships, but the differences were more pronounced for the more serious classes of injuries. USN-manned ships averaged four times as many Category A injuries per ship-year and seven times as many Category B injuries per ship-year as MSC-manned ships. Most of the injuries were less serious, falling into Category C or D.

We note that the data for the more serious classes of injuries are likely to be more accurate than those for the less serious injuries. An injury (or fatality) of Category A or B severity is most certainly always reported; with the less serious injury classes, there's more room for subjectivity. Workers may exaggerate Category C injuries to obtain time off from work. Or, Category D injuries may go unreported because reporting them is perceived as not being worth the trouble.[3]

Collisions, groundings, and fires

Table 6 compares the numbers and rates of collisions, groundings, and fires for USN and MSC auxiliaries during the 1980-2003 period.

Table 6. Collisions, groundings, and fires on board USN- and MSC-manned auxiliary ships, 1980-2003[a]

	USN incidents		MSC incidents	
	Total	Per ship-year	Total	Per ship-year
Collisions	54	0.02	43	0.017
Groundings	8	0.0025	16	0.0056
Fires	199	0.31	31	0.06

a. Collisions/groundings are adjusted for MSC's 33 percent higher time at sea per year.

3. Some might argue that injuries per ship-year, rather than injuries per person, is an unfair metric for comparing USN and MSC ships because USN ships have crews that are usually twice as large as comparable MSC ships. For the two most serious injury categories (where the data are most accurate), however, the USN rate is far more than twice the MSC rate, indicating that factors beyond crew size alone are affecting the number of injuries on these ships.

USN-manned ships reported more collisions (though the difference is negligible when normalized for ship-years), while the MSC-manned ships reported more groundings (but the sample size is very small for groundings). Therefore, we believe that the differences between collision rates and grounding rates for MSC and the USN are negligible. Only for fires is the difference in rates per ship-year significant. USN-manned ships averaged five times as many fires per ship-year as MSC-manned ships.

Oil spills

We reviewed summary data from NAVSEA on oil spills for all Navy and all MSC ships.[4] The data included the number of incidents (spills), the total gallons spilled,[5] and the number of ships involved. Data were available for FY98 through FY03.

Results are shown in figures 2, 3, and 4. MSC ships had fewer incidents per ship and experienced fewer gallons spilled per ship in all years. Gallons per incident were roughly similar between MSC and the Navy, except for the year 2000 for the Navy. During 2000, the grounding and loss of USS *Lamoure County* in Chile, and a tugboat puncture of a cargo tank in AOE-1, in New Jersey, spilled over 130,000 gallons of ship propulsion fuel.

The causes of most oil spills are categorized as either personnel error or equipment error, but spills sometimes involve both (improper personnel reaction to an equipment malfunction), or are beyond the control of the spilling ship (as when the tug punctured the cargo tank on the AOE-1 mentioned above). Moreover, the data do not account for the greater complexity of combatants, which have a greater amount of cross-connect piping and valves for shifting fluids between different tanks as a damage control feature and, therefore, are more amenable to personnel failure.

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4. The oil spill data do not differentiate between ship types, such as combatants or auxiliaries, within the USN. At MSC, both civil-service and contractor-operated ships are included.

5. This number should not be considered the amount of oil; it is the amount of liquid, which may be composed of either a high percentage or a low percentage of oil.

Figure 2. Oil spill incidents per ship

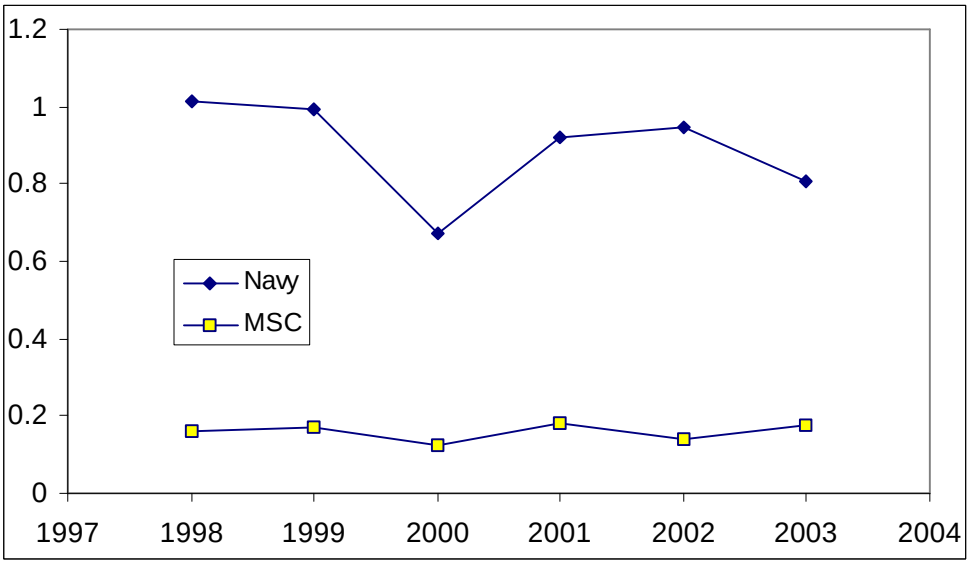


Figure 3. Gallons per incident

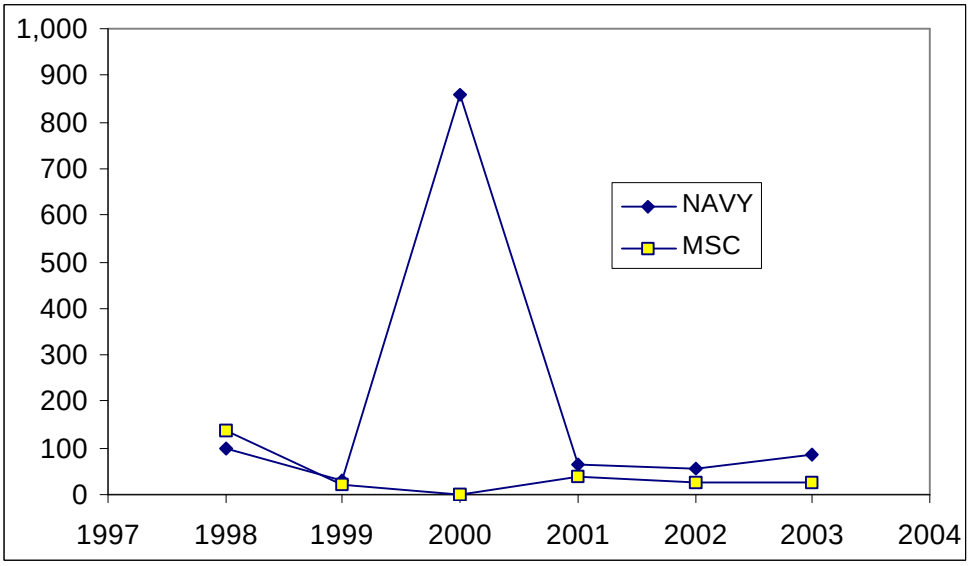
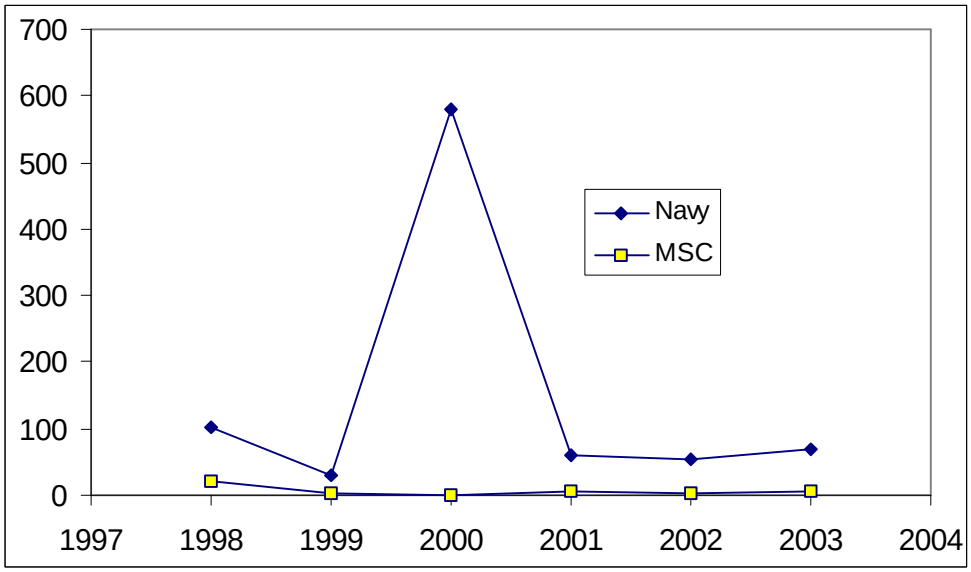


Figure 4. Gallons per ship



Despite MSC ships' smaller crews and longer periods at sea,[6] one can say that the MSC ships have had no more frequent or serious oil spills per ship per year than the USN ships. In fact, for the years reviewed, the MSC record is slightly better than the record for USN ships in all categories.

6. MSC ships are at sea about 33 percent more per year than USN ships. See bulleted list on page 12.

The mariner workforce

Military Sealift Command's Naval Fleet Auxiliary Force (NFAF) fleet is made up of 37 ships, including fast combat support ships (T-AOEs), fleet replenishment oilers (T-AOs), combat stores ships (T-AFSs), ammunition ships (T-AEs), and fleet ocean tugs (T-ATFs), plus two hospital ships (T-AHs) that are kept in a reduced operating status.[7] NFAF ships deliver supplies to USN ships at sea, conduct towing and salvage operations, and serve as floating medical facilities.

MSC mariners

The NFAF ships are government-owned ships manned by civil service merchant marine mariners (CIVMARs). As of 30 June 2004, there were 4,133 CIVMARs in the MSC workforce. Except for about 60-65 CIVMARs who are assigned to shore positions primarily to assist in training, liaison, or personnel placement, all of the CIVMARs are in specific ship billets, on leave, in training, attending to other administrative matters, or en route to/awaiting a new ship assignment.[8] CIVMARs do not have a sea-shore rotation program.

CIVMARs are either “unlicensed” or “licensed” by the United States Coast Guard (USCG). In general, those who are unlicensed perform MSC shipboard functions similar to those held by enlisted ranks in the U.S. Navy, and licensed MSC mariners perform functions similar to USN officers.[9]

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7. The San-Diego-based hospital ship USNS *Mercy* was recently activated for duty in the Indian Ocean for the tsunami relief effort.

8. For many years, the MSC budget has included funds for an additional 25 percent above the ship-required manning levels to provide for personnel on training or leave or otherwise between ship assignments. This has recently been increased to 26 percent.

9. Notable exceptions are mariner supply officers, pursers, medical officers, and chief stewards, who are considered part of the officer corps on merchant ships but do not require USCG licenses.

CIVMARs are compensated under the Wage Marine (WM) pay scale, a unique civil service pay scale used only by MSC and the research ship crews of the National Oceanic and Atmospheric Administration (NOAA). As in all civil service pay systems, WM pay is adjusted annually for comparability with "prevailing rates" in industry (for MSC mariners, the maritime industry). In addition, WM work rules and procedures mirror those in the maritime industry, subject to the constraints of civil service regulations and law. CIVMARs are paid overtime for work in excess of 40 hours per week, and "premium" pay is also provided for unusually dirty or hazardous work. A comprehensive review of annual pay for all CIVMARs was completed in 2001 [3]. That review indicated that the average annual pay for all CIVMARs was about $60,000, including premium pay and about 25-45 hours of overtime every 2 weeks, depending on rating, ship type, and mission [4]. In addition, food and lodging are provided to CIVMARs at no cost while they are aboard ship.

Unlike USN military personnel, MSC mariners do not have a mandatory retirement age. However, they must be in good health and must pass a physical once every 5 years if under age 50,[10] once every 2 years if between the ages of 50 and 60, and annually if over 60 years of age. The average age of all MSC mariners is about 46.

MSC employees earn annual leave at the same rate as other civil service employees:

- 13 days per year for the first 3 years of service[11]
- 20 days per year for those with more than 3 but less than 15 years of service
- 26 days per year for those with 15 or more years of service.

10. For those under 50, MSC complies with DOT regulations requiring that anyone who might operate a forklift must have a physical every 3 years and that explosive handlers have physicals every 2 years.

11. Prior government service can be counted. For example, a newly hired CIVMAR with more than 3 years of prior service at any other U.S. government job (including military active duty) would be entitled to 20 days of leave per year.

In addition, they can earn 1 day of "shore leave" for every 15 days at sea, per month.[12]

Because of the limited leave available for new mariners, or perhaps due to personal preference, it would not be unusual for mariners to be at sea nearly 10 months per year during their first 3 years with MSC. Because mariners are at sea a considerable amount of time, some observers speculate that few mariners are married, but this is not the case. Although MSC does not maintain records indicating the marital status of its mariner workforce, a recent CNA study [5] used mariner payroll tax exemption data to conclude that about 47 percent of the unlicensed mariners are married, compared with about 49 percent for Navy enlisted.

MSC recruiting and training

Unlike their military counterparts, CIVMARs must be U.S. citizens. They also must have U.S. Coast Guard "documentation"[13] and a valid passport before they can be considered for employment.

MSC recruits from the population at large (including private-sector merchant marines), from former Navy personnel, from high schools (including adult maritime technology schools) for unlicensed mariners, and from maritime academies for licensed mariners. About a third of MSC mariners are former USN enlisted personnel (figure 5).

Once employed, entry-level MSC mariners receive about 4 days of indoctrination training[14] at the Afloat Personnel Management Center, Virginia Beach; 5 days of Standards of Training, Certification, and Watchkeeping (STCW)[15] training (required by the USCG); and

12. This provides about 24 days of additional leave per year. In 2004, the Navy proposed legislation that would increase shore leave by 50 percent, to 36 days per year, but it has been disapproved by OMB.

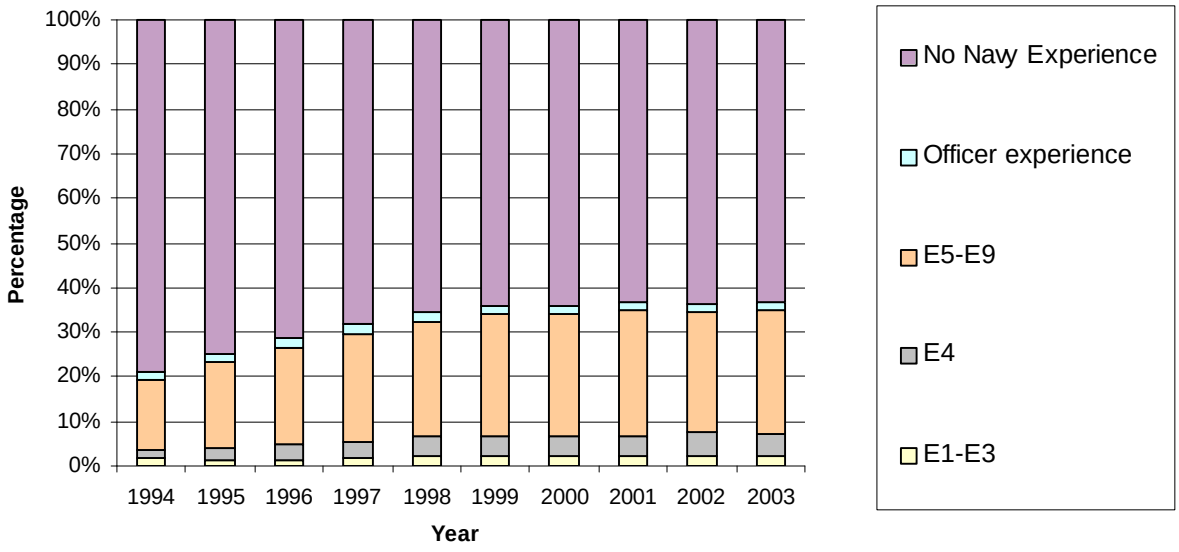
13. USCG documentation is granted after fingerprinting and background checks using FBI and other national crime data bases.

14. This training includes civil service regulations, EEO, pay system, health and life insurance benefits, and sick leave and annual leave procedures.

12 days of MSC-unique training before their first ship assignment. The MSC-unique required training is:

- Basic Fire Fighting (3 days)
- Basic Chemical, Biological, Radiological Defense (1 day)
- Damage Control (2 days)
- Environmental Programs (1/2 day)
- Helicopter Fire Fighting (1 day)
- Naval Occupational Safety & Health (2 days)
- Ordnance Hazard Awareness (2 days)
- Anti-Terrorist Brief (1/2 day).

Figure 5. CIVMAR Navy experience



15. STCW training includes Basic Fire Fighting, Personal Safety and Social Responsibility, First Aid, Personal Survival (including swimming), and Rating Forming Part of a Navigational Watch.

Additional training is available based on position and / or ship assignment. Courses are administered through Navy sources, unions, maritime academies, or commercial vendors. In some cases, CIVMARs may choose to pay for their own training and receive it while on personal leave or leave without pay, in order to qualify for a higher rating or to improve their chances for promotion. Some of the courses available follow:

- Advanced Fire Fighting
- Anti Terrorism Officers Course
- Air Conditioning & Refrigeration
- Bridge Resource Management
- Variety of Computer Classes
- Electronics
- Food Service Management
- Gas Free Engineering
- Global Maritime Distress & Safety Systems
- LAN Administration
- Lifeboatman
- Material Handling Equipment
- Ordnance Handling Equipment
- Proficiency in Survival Craft
- Pump Maintenance
- Small Arms
- Supply Management
- UNREP Training.

Personnel assignment processes

MSC

After their initial orientation training, new CIVMARs are assigned to ships to fill vacancies that have been created by other MSC mariners' resignations, retirements, leave, illness, death, training, or discipline, or they are assigned to a ship newly acquired by MSC.[16] Although MSC does not normally rotate shipboard personnel after any specific period, rotation takes place by default because a mariner on leave is replaced by another mariner with similar qualifications and, after completing leave, is assigned to a different ship.[17]

The process is not without shortcomings, however. The MSC Afloat Personnel Management Center (APMC) has found it necessary to maintain a pool of paid mariners on each coast who are between assignments or awaiting training, physicals, or disciplinary hearings. Although MSC strives to minimize the size of these pools, they sometimes contain as many as 100 or more mariners on full base pay, plus lodging and subsistence in some cases. As shown in table 7, the rotation causes relatively short durations aboard ship. During the 11-year period for which we have data, the average mariner served on seven to eight ships an average of 61 to 67 weeks each.

Nevertheless, this process enables MSC to man ships at minimum levels without extra personnel on board to accommodate vacancies, because vacant essential positions are filled as expeditiously as

16. On ships that are new to MSC, such key positions as Master, chief engineer, first mate, and 1st assistant engineer are normally manned with highly experienced mariners.

17. There are exceptions. To maintain continuity, ship Masters are often replaced temporarily by other Masters who rotate from ship to ship as temporary replacements. Also, a ship can get a particular mariner back after his absence if they want him back and if they have not required a replacement during his absence----that is, if the employee's position can remain unfilled or his duties can be handled by some other crew member with proper qualifications.

possible[18] with *qualified* personnel—ready to stand watch immediately upon arrival.

Table 7. CIVMAR ship experience profile, 1993-2003 (572 weeks)[a]

	Ave. # ships	Median # ships	Max # ships	Ave. # wks per ship	Ave. total wks, all ships	Ave. % time on ships
Officers	8	8	18	61	385	69%
Unlicensed	7.4	7	16	67	398	71%

a. Max # ships is high because some mariners specialize in rotating to temporarily vacant positions for short periods.

Commercial

In the commercial hiring and ship assignment process, unemployed mariners congregate in a union hall and volunteer for jobs posted by shipping companies. They are selected in order of seniority and time since last sailing, and serve at sea under contract for about 3 months, after which their contract ends and they are entitled to as much as 3 months paid leave. When their leave ends (or earlier, if they desire), they are subjected to the hiring hall process before sailing again unless they happen to work for a company with a steady workload that hires mostly permanent employees. This process tends to cause some mariners to sail for many different shipping companies during their careers, but some private-sector mariners frequently return to the same ship after leave, continuing the on-again, off-again cycle for many years with the same company.

18. MSC gives priority to ships that deploy and to ships that have dropped to 95 percent of allowance. Still, some ships do "sail short" as a result of various circumstances, but they never sail with less than the minimum number of key positions required by the USCG. Emergent situations may prompt a waiver request.

Although the private-sector mariners are technically unemployed between contracts (except for those who become permanent company employees), they continue to receive pay and benefits from their respective unions. At retirement,[19] they receive annuities from their unions rather than their former employers, who have made pension plan payments to the unions on behalf of the mariners they employ. While the nearly 1 day of paid leave for 1 day of work is attractive to many commercial mariners, they are not assured of being rehired after each leave period and consequently can suffer through periods of prolonged unemployment—especially during economic downturns. By contrast, MSC is able to offer permanent federal employment and job security for those who perform satisfactorily and remain physically qualified, and MSC emphasizes this in its recruiting ads (see appendix A).

19. 20 years "shipping" normally entitles the commercial mariner to pension benefits but the majority of mariners "ship" for 25 years.

Differences between the USN and MSC/ commercial model that affect manning

Age and experience

USN workforce experience profiles

The Navy's experience profile is based on policies that were derived at a time when there was a strong emphasis on “youth and vigor” in the armed forces and when military technology and culture required skills and knowledge that were unique to the military. Furthermore, past population and educational patterns were such that relatively large pools of young men who stopped their education at high school were available to recruit.

Two policies are the main forces driving the Navy’s workforce to be more junior than even the least experienced civilian workforce:[20]

1. *Closed-loop entry:* Since military accession policies allow virtually no lateral entry, almost everyone enters with no military experience. This, coupled with existing attrition and reenlistment rates, means that a very high proportion of the service is in the earliest years of service (YOS).[21]

2. *Cliff-vested retirement:* The military retirement system grants full retirement at 20 YOS with no vesting before that point. This means there is a cliff in the experience distribution with very few staying beyond 20 years. Of these, all must leave at 30 years.

20. See appendix B for a more detailed comparison of USN and industry workforce profiles.

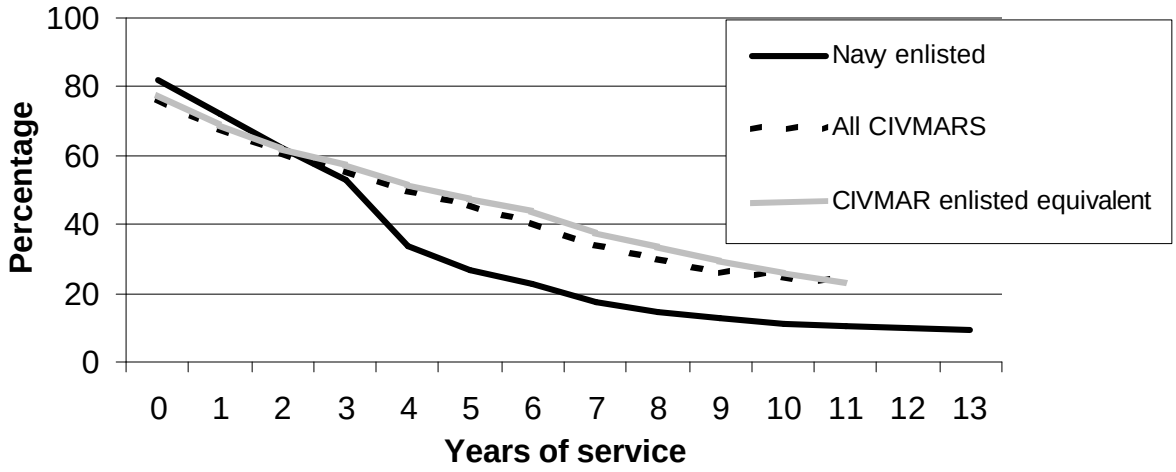
21. About 5 percent of new entrants to the Navy have had prior military service.

MSC CIVMAR workforce

By contrast, the MSC CIVMAR workforce is older and more experienced because:

- MSC hiring practice permits "lateral entry" to hire seasoned merchant mariners for positions above entry-level positions. Therefore, unlike the USN, newly arriving personnel are not necessarily young or inexperienced.
- New MSC personnel tend to stay longer after being hired. As figure 6 shows, only 27 percent of USN enlisted remain in the Navy after 5 years—compared with nearly 50 percent of CIVMARs remaining in MSC after 5 years.
- MSC mariners have no mandatory retirement age.

Figure 6. Average of survival percentages for Navy and MSC accessions, 1990 to 2002[a]



a. Sources: Navy Enlisted Master Record (EMR) and Navy Civilian Personnel Data System (NCPDS).

Time aboard ships and crew turnover

The amount of time that USN personnel are assigned to ships during their first 5 years of service (65 percent for enlisted, 61 percent for officers) is nearly comparable to MSC personnel, but the percentage of time assigned to ships declines for USN personnel as their years of service increase. As shown in figures 7 and 8, USN officers and enlisted after 20 years of service have been assigned to ships only about 41 percent of the time.[22] This means that as USN personnel become more skilled and experienced, the time they are called on to apply their skills aboard ship diminishes. MSC CIVMARs, however, maintain a generally constant 70 percent of their time assigned to ships regardless of years of service. This also means that, as MSC personnel rotate, they are more likely than USN personnel to be replaced with people who have the necessary experience.

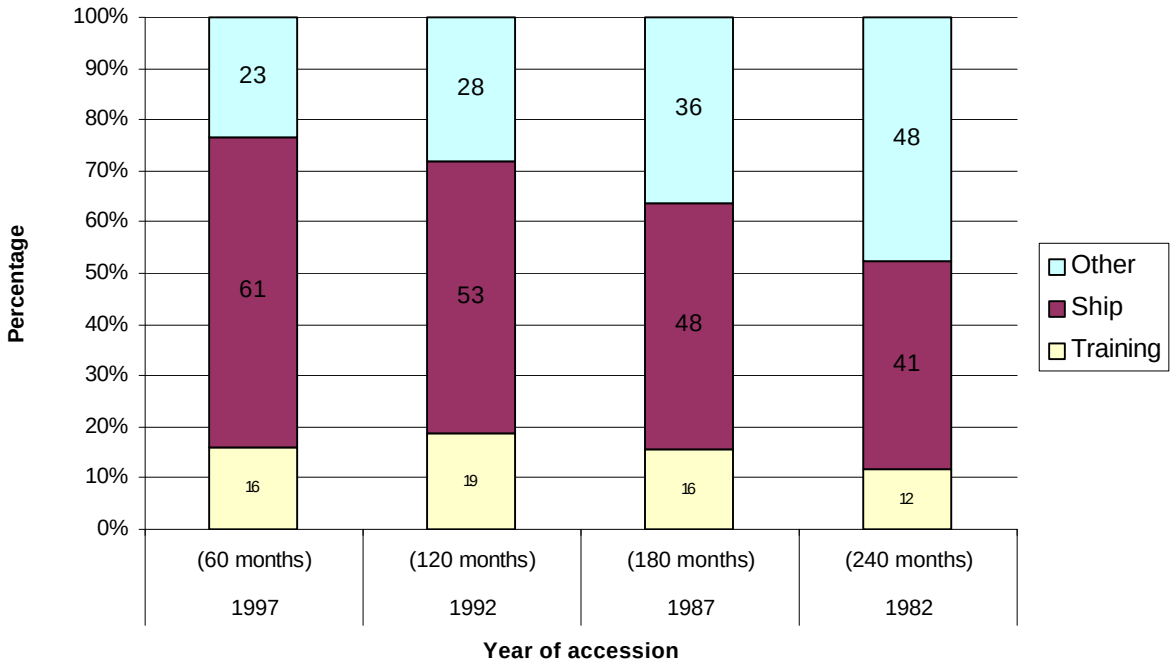
Studies have quantified the adverse effect of turnover and the benefits of experience. One study [6] examined how experience can affect downtime for deployed squadrons and found that:

- Adding two experienced E-4 or E-5 maintainers to a squadron reduces the average downtime due to maintenance per incident by 8 percent. Adding two *nonexperienced*[23] E-4 or E-5 maintainers to a squadron reduces the average downtime due to maintenance per incident by only 3 percent.
- Adding one experienced E-6, E-7, or E-8 maintainer to a squadron reduces the average downtime due to maintenance per incident by 5 percent. Adding one *nonexperienced* E-6, E-7, or E-8 maintainer to a squadron reduces the average downtime due to maintenance per incident by only 2 percent.

22. There is little difference between officers and enlisted, and there is little difference between SWOs, submarine officers, or those who have served on both.

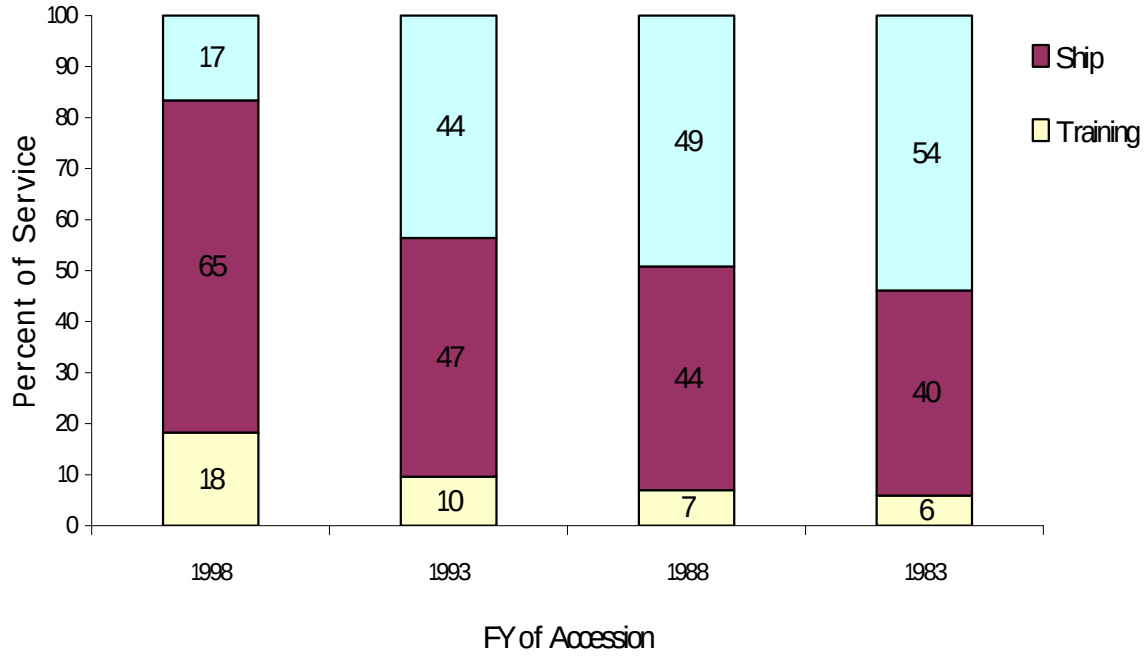
23. Reference [6] states that "for a maintainer to be considered experienced, he must have both the correct NEC *and* prior experience within the past 8 years assigned to a unit consisting of the same aircraft he is working on now."

Figure 7. Ship or training time for Surface Warfare Officers in Navy at end of FY 2002[a]



a. Source: Navy Officer Master File (OMF), NPC Pers-341.

Figure 8. Ship or training time for enlisteds in Navy at end of FY 2003[a]



a. Source: Navy Enlisted Master Record (EMR), NPC Pers-341.

Another study [7] found that, if turnover on ships could be decreased by 10 percent, readiness would rise by about 1.2 percent. Or, holding readiness constant, a 10-percent reduction in turnover could allow a decrease in ship manning by about 1.43 percent. We calculated the savings due to a 1.43-percent manning decrease for surface ships (table 8) and found a reduction of about 1,416 enlisted billets per year, for a savings of over $152 million per year.

Table 8. Decreasing ship manning by 1.43 percent

Type	Number	Manning	1.43 percent	Sea Billets saved
CVN-69	9	3200	45.76	412
CVN-65	1	3350	47.905	48
CV-67	1	2930	41.899	42
CV-63	1	2930	41.899	42
CG-52	22	340	4.86	107
CG-47	3	312	4.46	15
DDG-51	41	344	4.92	202
DD-963	7	319	4.56	32
FFG-7	30	232	3.32	100
LHD	7	1123	16.06	112
LHA	5	930	13.30	66
LPD-17	4	361	5.16	21
LPD-4	11	420	6.01	66
LSD-49	4	413	5.91	24
LSD-41	8	413	5.91	47
AS-39	2	600	8.58	17
AOE-1	4	600	8.58	34
MCM	14	84	1.20	17
MHC	12	52	0.74	9
				1,416

Time at sea

Earlier we summarized the average time that MSC CIVMARs and their military counterparts are assigned to ships during their careers. However, duty aboard a ship at sea is profoundly different from duty aboard a ship in port or in a long-term maintenance availability in a

ship yard. Although both assignments can be arduous, they are different. The Coast Guard considers at-sea experience more important in determining useful experience and only counts at-sea time as credit toward advancement (a license upgrade). For example, to become a 2nd assistant engineer (AE), mariners must not only pass a demanding licensing test but also first serve 1 year *at sea* as a 3rd AE. Similarly, a mariner must serve 1 year at sea as a 2nd AE before rising to 1st AE, and 1 year at-sea as a 1st AE before qualifying for chief engineer.

Recall that military officers or enlisteds with 20 years' service have about 41 percent of their time (98 months) assigned to a ship, as opposed to 70 percent (168 months) for a typical CIVMAR, and that USN ships are under way about 33 percent of the time compared with 44 percent of the time for MSC ships. From these data, one can conclude that the actual at-sea time for a sailor or officer with 20 YOS is about 32 months (33 percent of 98) versus about 74 months for the CIVMAR (44 percent of 168) with 20 YOS.

Although this is a large difference, the difference between USN and MSC mariners' time at-sea is actually understated because the military data for time aboard ship include time for off-ship leave and training taken while assigned to a ship UIC, whereas the MSC data do not. Also, the USN seldom "decrews" ships when USN ships undergo major maintenance periods ashore, whereas MSC usually partially decrews their ships during maintenance availabilities of a month or more—keeping only about 20 to 25 officers and a few senior non-officers. The more decrewing occurs, the more time at sea is incurred by the crews, as they are transferred to other ships at sea.

Number of ranks and ratings

There are essentially three layers of management on USN ships (officers, noncommissioned officers, and enlisted) contrasted with two levels in the MSC / private sector (officer and non-officer).[24] MSC and

24. On new USN ships, such as LCS and DDX, there is likely to be a much higher percentage of senior enlisteds, so there may be almost a defacto two-level hierarchy on those ships—CPOs and officers—more like the MSC / commercial model.

the private sector have a relatively flat non-officer workforce, with only two to three different pay levels, and only four levels of officers compared to the five or six different officer ranks commonly found on USN ships. Moreover, there is no layering among the non-officers; they all report to an officer, not to other non-officers.

Redundant NECs

In the Navy system of manning, a large number of less experienced and narrowly trained enlisteds are used, and they are often supplemented by apprentices for training purposes. In some cases, rather than train individuals for more than one system, extra maintenance personnel are added instead. To quantify the impact of this policy, we asked the Naval Surface Warfare Center, Carderock (NSWCC) to examine manning on DDGs, using its unique Manpower Analysis and Prediction System (MAPS). The author of that report [8] notes:

> There are five ratings on this ship class, in which NEC's actually cause a possible inflation of requirements. The most significant of these is the Electronics Technician (ET) rating in CE division of the Combat Systems Department.

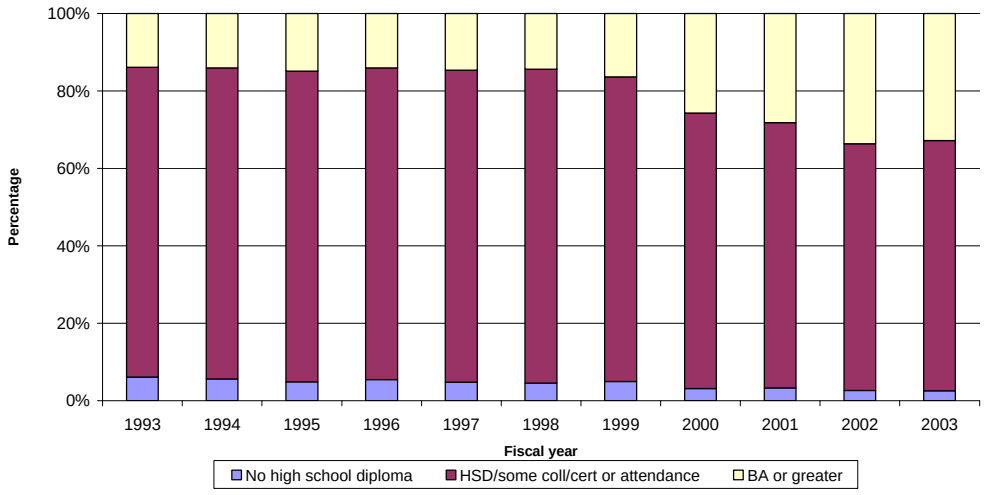
This is due to a Navy NEC assignment policy "to assign to two separate billets, NEC's for significant equipment or systems. This ensures redundancy in case of loss of a repairman for a vital equipment." But that redundancy does come at a cost. Reference [8] concludes with the following:

> If system NEC's were only assigned to one billet, a savings of six billets could be realized. The savings would be over forty million dollars annually for the DDG 51 ship class.

Education

Although the level of education of MSC officers has been increasing over the past decade, only a little more than a third of MSC licensed CIVMARs have college degrees, and about 3 percent do not have high school diplomas (figure 9). In the Navy, 98 percent of officers have college degrees, and virtually all have high school diplomas.

Figure 9. Licensed MSC CIVMAR education



Nevertheless, the CIVMAR technical workforce, especially the officers, appear to be better qualified technically than their nonnuclear USN counterparts. This is largely a consequence of the more focused education and practical training of the civilian mariners, driven primarily by USCG licensing standards.

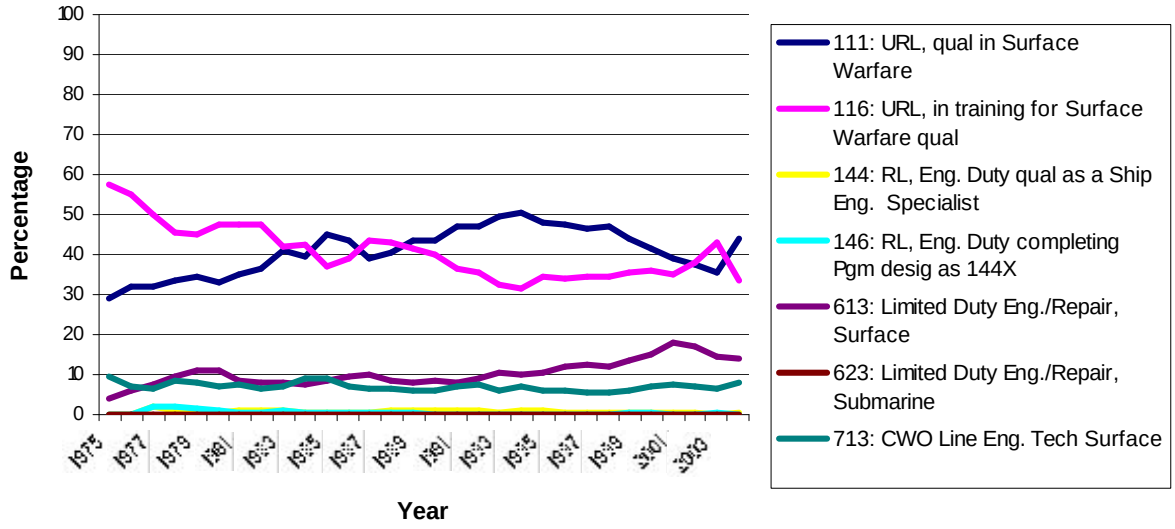
Technical education and training

Nearly all USN officers must have degrees, but engineering department officers (on USN nonnuclear ships) need not have either engineering degrees or even an interest in or aptitude for engineering. "Unrestricted line" officers can become division officers in engineering departments—even chief engineer of a combatant or large auxiliary—with comparatively little engineering training or experience.

Figure 10 gives a sense of the experience of officers in engineering departments: 34 percent of officers in USN combatant engineering departments are in training for warfare qualification. But they are not truly qualified to run their divisions, and they are a teaching burden to the more experienced crew members, thus increasing workload and contributing to larger crews. An additional 44 percent of the

officers in nonnuclear engineering departments, most of whom are engineering department heads, are "qualified" SWOs.[25] However, these are also unlikely to be either graduate engineers or truly qualified operating engineers because only about 24 percent of SWOs have engineering degrees (figure 11) and, according to detailers we have consulted, no effort is made to place SWOs with engineering degrees into engineering departments. For the large majority of SWO Department Heads that do not have engineering degrees, their only formal training is the 6-week Department Head course received at the Surface Warfare Officer School (SWOS). The U.S. Navy is unique in placing such inexperienced personnel in positions of responsibility in ship engineering departments.

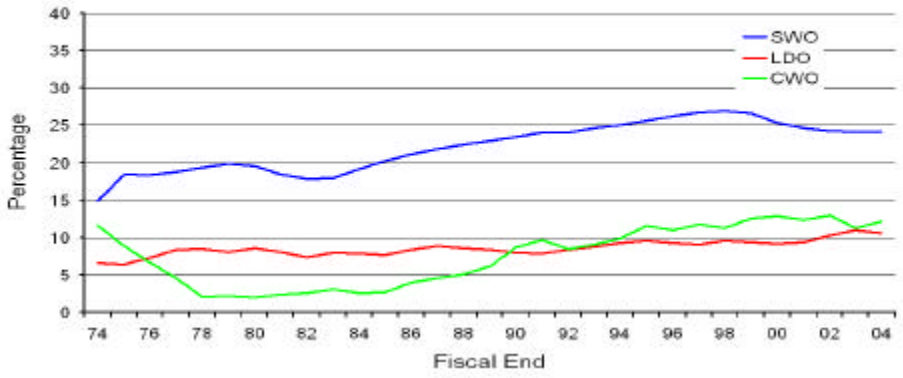
Figure 10. Distribution of officers in nonnuclear ship engineering departments[a]



a. Ships include: CG, CV, DD, DDG, FF, FFG, LCC, LHA, LHD, LPD, LSD, MCM, MHC

25. The remaining 22 percent of nonnuclear ship engineering department officers are LDOs and Warrant Officers, generally far more experienced and more capable in engineering plant operations than most SWOs.

Figure 11. Percentage of officer degrees that are engineering degrees[a]



a. Excludes those with unrecorded degrees

By contrast, the standard at MSC, NOAA, and commercial shipping companies is for strict compliance with USCG licensing requirements or equivalent international standards. These requirements mandate passing rigorous examinations and having extensive at-sea time in progressively demanding ship engineering positions.

Many of the licensed merchant marine engineers who have degrees are graduates of either the U.S. Merchant Marine Military Academy, Kings Point, NY, or the six state maritime academies.[26] The curricula at the maritime academies meet the requirements for engineering accreditation but also include many hands-on laboratory sessions across a number of semesters. In these sessions, they disassemble and repair pumps, motors, and other main propulsion and auxiliary machines in various ships and craft kept by the academies for that

26. The state academies are (1) California Maritime Academy California State University, Vallejo, CA; (2) Great Lakes Maritime Academy, Northwestern Michigan College, Traverse City, MI; (3) Maine Maritime Academy, Castine, ME; (4) Massachusetts Maritime Academy, Buzzards Bay, MA; (5) New York Maritime Academy, State University of New York, Fort Schuyler, NY; and (6) Texas Maritime Academy, Texas A&M University, Galveston, TX.

purpose. They also produce essential components using machinist mills and lathes, and learn to perform a number of welding tasks using a variety of welding techniques. In addition, during their 4 years, all engineering students spend a number of sea terms under way directly under the tutelage of seasoned marine engineers in school ships and commercial ships both operating and repairing propulsion and auxiliary machinery[27]—*before* being licensed.

The Surface Warfare Officer School provides survey courses in warfighting, seamanship, and engineering subjects but do not equip junior officers with mechanical skills or the in-depth ship operation and maintenance knowledge of the professional mariner. In fact, the junior USN naval officer, especially the ROTC graduate, has little time at sea and even less formal technical training when assigned to his first ship, even though his first tour may be as a division officer in the ship's engineering department.

Before 2004, new officers reported to the SWOS division officer (DIVO) course in Newport, RI, to gain some of this training before their first sea tour. Now they arrive aboard ship with no SWOS training, but while on board during the first 12-15 months they receive OJT—supplemented by Computer Based Training (CBT) from an SWOS CD—and examinations proctored by a more senior officer aboard ship. After they complete the instructional requirements, assume responsibilities of a division officer, and earn their fleet officer of the deck underway letter, they report to SWOS for a 3-week "advanced proficiency" course, via PC-based simulators and classroom training, which includes only about 14 hours of engineering familiarization. Following this course, the officers are sent back to their ships ready for

27. The curricula of most nonmaritime engineering colleges focus on theory and design of machinery, equipment, and systems, but not necessarily the operation and repair of shipboard machinery and equipment. However, there is currently no USN incentive to adjust the various curricula at the Naval Academy, the NROTC universities, or the Coast Guard Academy to permit the attainment of more pertinent skills because both Navy officers and Coast Guard officers go to sea in ships where the senior enlisted, warrant officers, and limited duty officers perform virtually all of the shipboard maintenance on the machinery.

their SWO qualification board—the final step toward becoming a designated Surface Warfare Officer. After 18 to 24 months as a DIVO on their first ship, they are usually transferred to a second ship for an additional DIVO tour, typically on a ship class and in a division different from their first tour.

Although this relatively new approach enables the SWO student to ask informed questions while at the SWO School, and get more out of the school experience, it places inexperienced and poorly trained junior officers in responsible positions as division officers, subjects them to the inconsistencies of OJT, and burdens the ships with training duties. This is particularly onerous when new graduates with non-engineering degrees and no technical aptitude are placed in billets where technical expertise is important.

Unrestricted line officers (URLs) as engineering officers

The use of unrestricted line officers in engineering billets aboard ship has been USN policy since about 1976, when using Engineering Duty Officers (EDOs, or "EDs") on most USN nonnuclear surface ships (other than carriers) was discontinued.

According to the report[28] leading to the change, the main reason was that "EDs have turned away from their role as technical experts and as a result, their capability and effectiveness have declined" and that "URLs have also turned away from technical matters and their knowledge of the details of maintenance and operation of their ships has declined." The report observed that "the idea that Naval officers should be technically oriented professionals who know the details of their ships was overtaken by the notion that Naval officers should be managers." The recommended solution was not to improve the technical capability of the engineering community, but to replace many EDO billets (including most ship engineering billets) with URL billets and to "make more engineering experience available to URL officers."

28. See appendix C for background on the decision to transition shipboard engineering billets from EDOs to URLs.

Today, in USN surface ships, junior officers who are not extensively trained technically are assigned to the engineering department not for what they contribute, but primarily to gain experience to better prepare them for potential command. In addition, rather than being mentored by their superiors, as is the case in most hierarchical organizations, they are usually more extensively mentored by subordinates. In a thesis on this subject [9], one naval officer noted that

> such situations are commonplace: the officer with immediate responsibility for the equipment has no background or experience, and the officer(s) to whom he would normally turn for guidance is similarly unqualified....Our officers are simply not appropriately trained for these tasks and, as a result, are insufficiently competent to perform them.

Since this thesis was prepared, the amount of technical training for SWOs has decreased. As a consequence, many officers in technical billets on USN ships:

- Can be a training burden to more experienced crew members, which increases crew workload and contributes to larger crews.
- Are limited in their ability to teach or guide subordinates in technical areas or to contribute to solving technical problems.
- Spend considerable time standing watch on the bridge and in other departments, rather than dedicating all of their time to operation and maintenance of the engineering plant.

Moreover, much of this “training time” is wasted because only about a third of junior officers actually progress to engineering department head, where some of it could be put to good use, and still fewer officers progress beyond that.

When contrasted with commercial and MSC ships and most other navies, it appears that the USN policy, at best, contributes to overmanning of USN non-nuclear surface ships because of the burden it places on other, more experienced crew members. At worst, it can result in marginal or ineffective engineering aboard ship, which is probably not what Navy leadership had in mind in 1976 when they referred to the idea that “Naval officers should be technically oriented professionals who know the details of their ships.”

Officer specialization

The MSC/commercial model (and the model of virtually all foreign navies) is built around engineering specialization for shipboard operation, using two career paths for officers:[29]

- One path that specializes in engineering and culminates aboard ship in the position of Chief Engineer, and
- One path that specializes in the nonengineering aspects of ship operation and culminates aboard ship in the position of Commanding Officer.

In this construct, shipboard officers in the engineering departments do not aspire to ship command or stand watches on the bridge, and their time at sea focuses nearly 100 percent on the proper operation and maintenance of the engineering plant.[30]

To qualify as a Chief Engineer, one must first hold progressively challenging positions as 3rd assistant, 2nd assistant, and 1st assistant engineer, must spend a minimum of 1 year at sea in each, and must pass a USCG examination to qualify for each promotion. Similarly, those choosing the deck officer ("command") path to ship Master must first serve as 3rd officer, 2nd officer, and 1st officer for a minimum of 1 year at sea in each and must pass a USCG examination to qualify for each promotion.

In MSC/commercial practice, the second most influential officer aboard ship is the Chief Engineer. Engineering officers at every level

29. There are also supply and medical officers aboard MSC and commercial ships, but they are not part of the command structure and do not require USCG licenses.

30. The foreign Navy approach to engineering personnel is closer to the MSC/commercial model than the USN model. Junior officers assigned to the engineering department are either graduate engineers or have technical aptitude and receive extensive technical training. The more senior officers in the engineering departments are highly qualified and are able to provide knowledgeable engineering guidance and leadership to their subordinates and confident, experienced counsel to the CO for technical matters (see appendixes D and E).

are placed into engineering billets aboard ship based on their technical qualifications and the minimum technical needs of the ship. In the USN system, many naval officers are placed into engineering billets aboard ship without significant technical qualifications to gain broad experience for future, higher level billets aboard ship as Executive Officer or Commanding Officer or, ultimately, as the Chief of Naval Operations.

Officer hands-on maintenance

Another fundamental difference in the MSC and commercial manning construct is that MSC/commercial officers are expected to perform maintenance and repair work that, in the Navy, is the purview of senior enlisted personnel. This is either a cause or an effect of the fact that licensed marine engineers are competent to repair shipboard machinery and equipment whereas most USN naval officers are not. Coupled with the selectively narrow training of Navy enlisted, this directly contributes to comparatively larger manning requirements on Navy ships.

Watchstanding practice

Still another difference relates to watchstanding practice aboard MSC ships and USN ships. Table 9 shows the watchstanding routine on a Military Sealift Command, commercial, and Royal Fleet Auxiliary (RFA) ships.

MSC/Commercial/RFA ships

On these ships, most of the crew are watchstanders. Watchstanders rotate in three sections through six periods a day, always having the same watch every day and every night. When not on watch, the person's time is his own, which avoids both sleep deprivation and body clock disruption. Individual watchstanders do perform I-Level maintenance on an overtime compensation basis,[31] but in general they get 6 to 7 hours' sleep every 24 hours.

31. MSC mariners typically work about 17 hours of overtime per week (depending on rating and ship mission).

Table 9. Typical six-section watch rotation in MSC/RFA/ commercial ships

Six Rotation (no dog) (a)	Watchstanders Standard 1 in 3 Watch System Day 1	Day 2	Day 3	Day Workers
0000-0400	A	A	A	
0400-0800	B	B	B	
0800-1200	C	C	C	4
1200-1600	A	A	A	3
1600-2000	B	B	B	1
2000-2400	C	C	C	
Work (incl watch)	8	8	8	8
Free Time (b)	16	16	16	16
Uninterrupted Period	7	7	7	12

a. "No dog" means that the evening watch is not broken into two 2-hour segments, and the on-watch personnel eat their evening meal by being relieved for about a half hour by the people standing the next (2000 to 2400) watch.
b. "Free time" refers to time for meals, sleep, and other personal activities.

USN

In the U.S. Navy, watchstanders on surface ships rotate in three sections through five 4-hour watch periods, and two 2-hour watch periods a day.[32] Since the preponderance of people serving in U.S. Navy ships are not watchstanders, the work routine of the ship is organized for the non-watchstanders, or day workers. Reveille typically goes at 0600 and the mid-watch can sleep only until 0630. When not on watch in the daytime, watchstanders are expected to join their shipmates in normal maintenance work and training evolutions. In addition, that individual is required to participate in work and training during the morning, before going back on watch in the afternoon (table 10).

The combination of rotating through seven watch periods in a day and being included in the normal workforce when not on watch affects the watchstanders in two ways. First, they are severely sleep

32. In U.S. submarines, the three sections usually stand watch for 6-hour periods.

deprived; second, their body clock is significantly disrupted, such that the U.S. Navy sailor can expect 6.5 continuous hours of sleep only once every three nights, with a 4-hour and a 2.5-hour continuous sleep on the nights between. What is most debilitating is that, on the night with only 2.5 hours sleep, there are only another 1.5 hours out of the 8.5 hours of "free" time in which the sailor can nap without interruption—for a total of 4 hours of sleep in that 24-hour period. This is because the other 7 hours of free time, that day, occur during meal hours or when water is available for his/her personal needs. Compared with the MSC model, the U.S. Navy sailor misses 8 hours of sleep every three nights—which in itself is the equivalent of more than another night's sleep.

Table 10. U.S. Navy watch rotation

	Watchstander			Day
Seven Rotation	**Standard 1 in 3 Watch System**			**Workers**
(dog evening) (a)	**Day 1**	**Day 2**	**Day 3**	
0000-0400	A	B	C	
0400-0800	B	C	A	0.5
0800-1200	C	A	B	3
1200-1600	A	B	C	3
1600-1800	B	C	A	1
1800-2000	C	A	B	1.5
2000-2400	A	B	C	
Work	15.5	10	12	9
Free Time (b)	8.5	14	12	15
Uninterupted Period	2.5	6.5	4	8

a. "Dog evening" refers to the practice of splitting the 4-hour evening watch (1600 to 2000) into two 2-hour segments, permitting watchstanders to eat the evening meal. The 1800 to 2000 group eats before going on watch, and the 1600 to 1800 group eats following watch.
b. "Free time" refers to time for meals, sleep, and other personal activities.

To compensate for this, commanding officers often are under pressure to qualify more watchstanders, to expand the number of watchstanders, and to move to a four-section or even a five-section rotation, if possible. Because the U.S. Navy does not relax its daytime work

standards for watchstanders, and still expects watchstanders to contribute to maintenance and participate in the training evolutions, the actual effect of expanding the number of watch sections is that body clocks are further disrupted. A Coast Guard report [10] on the effects of such watch cycles on crew endurance is unambiguous. It states that for the individual, going to 1 in 4 or 1 in 5 is "like crossing back and forth over 5 time zones every day!" The Coast Guard report advises:

- Avoid the use of frequently rotating watch/work schedules "at all costs."
- If you must use rotating schedules, make sure that personnel remain on the same schedule for at least 2 weeks and that they rotate forward (e.g., from mid-0400 to 0400-0800) rather than backward (e.g., from 0400-0800 to mid-0400).
- Avoid allowing personnel to work more than 12 hours in a given 24-hour day. Count the 24 hours beginning from crew members' wake-up time from their normal (longest) sleep period (not naps).
- Remember that every time the schedule changes it will take about **3 days** for the body clock to readjust. The longer crew members stay on the same schedule, the better adapted they will be.

During our discussions with foreign navies (appendix D), we found that the Dutch Navy has reached the same conclusions as the USCG, that constantly rotating watches can result in persistent fatigue symptoms. Accordingly, the Dutch Navy rotates watches only once every 2 or 3 weeks, synchronizing changes in watch schedules with appropriate in-port periods.

While the Navy has been operating with larger crews, sleep deprivation has been masked because of the numerous backups available. However, as crews become smaller with fewer watchstanders that represent *a greater proportion of the crew*, sleep deprivation needs to be addressed as a major issue.

Numbers of personnel on watch

Another major difference, until recently, has been the numbers of people on watch in USN ships. In the last year or two, however, the U.S. Navy has made great strides in downsizing the bridge watch staff on surface warships. Some of these improvements originated with the Smart Ship program, but most of the credit goes to the Optimum Ship Manning Experiments conducted by the Surface Force Commander, who has significantly downsized bridge watch enlisted staffs with or without a Smart-Ship-equipped bridge.

Table 11 compares MSC practice with the older method of U.S. Navy ship bridge watch assignments, and new warship manning practice as documented in current ship manning documents. As shown in the table, USN bridge manning levels have been vastly improved but are still slightly higher than typical MSC levels. And as shown in table 22 in appendix D, new USN bridge manning levels are also still higher than some foreign navies, who have reduced their bridge watch assignments down to MSC-like levels.

Table 11. MSC vs. U.S. Navy bridge watchstanders

	MSC method	**AS-39 (USN old method)**	**FFG (USN new method)**	**DDG-51[a] (USN new method)**	**CG-52[b] (USN new method)**
Bridge Watch	Mate	OOD JOOD QMOW BMOW	OOD JOOD Bridge Spec.	OOD JOOD Bridge Spec.	OOD JOOD Bridge Spec.
	Helmsman	Helmsman EOT(JV Talker)	Control Console	Control Console	Control Console
	Utilityman	Messenger JL Talker	JL Talker		
		Lookout Stbd Lookout Port			
	Lookout Fwd	Lookout Aft	Lookout Aft	Lookout Aft	Lookout Aft
Signal Bridge		Supervisor Recorder			

a. Type I, Type II, and Type IIA.
b. Smart Ship and Non-Smart Ship.

But improvements could also be made to the USN watchstanding practice in engine rooms. For example, on the AOE-6 class, the Navy system provides for six people to be on watch in the engineering spaces when the ship is under way. These watch stations rotate on a three-section basis, through seven watch periods a day. The supervisor of each of the six men on watch at any time is a senior chief or Master chief petty officer. He is backed up by a second class petty officer. None of the ship's officers perform the engineering officer of the watch function.

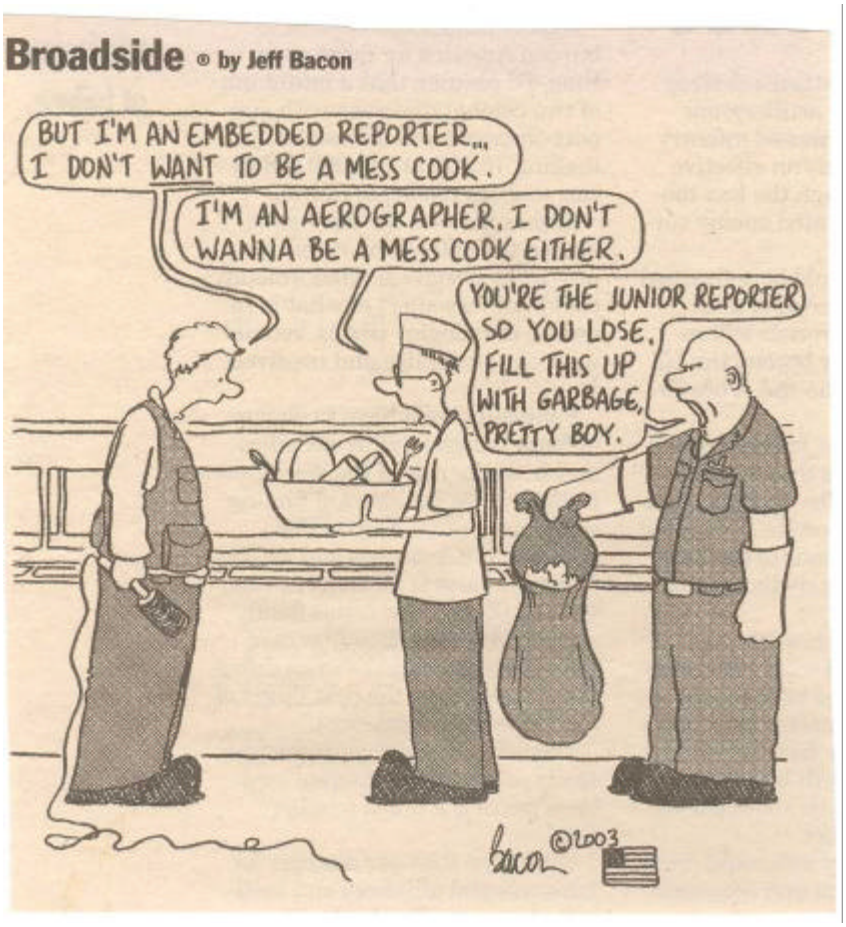
By contrast, the MSC system provides for five people to be on watch in the same engineering space, either under way or in port. These watch stations rotate on a three-section basis, through six watch periods a day. The supervisor of each of the five men on watch at any time is a senior 3rd Assistant Engineer, and he is backed up by a more junior 3rd Assistant Engineer, plus the equivalent of a CPO and two others.

Efficient use of trained personnel

Figure 12 is a lighthearted look at another difference between MSC and the U.S. Navy—how the Navy wastes trained personnel. MSC assigns personnel only to positions for which they have been trained, whereas the U.S. Navy commonly uses personnel trained in other specialties for menial tasks not requiring specialized training. For example, the Navy typically assigns galley and laundry tasks to trained enlisted personnel for as many as 3 to 4 months after their first arrival aboard ship, which has a number of consequences that adversely affect efficient manning:

- It is demotivating and reduces morale
  - — of those who have recently completed A-School but are not given the opportunity to apply their newly gained skills
  - — of the departments that have to relinquish their trained personnel for galley/laundry duty.

Figure 12. How the Navy wastes trained personnel[a]



a. By Jeff Bacon, Copyright @ 2004, Navy Times, Springfield, VA

- It requires ship supply department personnel to continuously train new "conscripts" from other departments as they rotate through the galley/laundry every 3 to 4 months.
- It causes a significant loss of the technical expertise gained during A-School training. Numerous studies have shown that a break from training or performance results in decrements in task proficiency (known as "skill decay"). The longer the period of not using new skills, the greater the skill decay [11].
  - — One study examined 20 Antisubmarine Warfare Operators (AWs) and their loss of capabilities after only 25 days of non-utilization of skills and knowledge learned during a basic acoustic analysis course [12]. In that study, the AWs' total knowledge dropped from 85 percent to 72 percent, and their classification accuracy performance dropped from 85 percent correct to 74 percent correct.
  - — In other studies, researchers have measured the loss of newly acquired skills or knowledge after not using them for periods of 90 to 180 days. Although the studies had different metrics that measured the "level of performance," each study did find a lower level of performance 90 to 180 days after no use when compared with the level of performance right before the period of no use. Specifically, after 90 to 180 days of no use, the performance level of the average participant was found to be lower than 92 percent of all participants' performance levels immediately before the period of no use [13]—the equivalent of transforming satisfactory performers to bottom-of-the-class performers.

Some have argued that the Navy would not be able to keep personnel if they were permanently assigned to perform menial tasks, but MSC has had few problems with their approach. For example, of the 586 Steward Utilitymen aboard MSC ships in March 2005, nearly 25 percent had been in that rating for 4 or more years (despite the fact that, as civilians, they were free to resign at any time at the end of a voyage). But just as there were many that were content to stay with these menial tasks, others used these entry level positions to advance. For example, for the 12 months ending March 2005, roughly 16 percent of steward utilitymen got promoted to higher-paying ratings. Overall,

the average annual attrition rate for MSC steward utilitymen over the past 10 years was only 21 percent, *including* those who advanced to higher jobs within MSC.

Manning philosophy

Differences in culture and manning philosophies have an effect on MSC and USN manning. At MSC and in the private sector, there is an emphasis on minimizing shipboard manning to reduce costs—and this culture is evident not only at the higher levels of management, as it is in the USN, but also aboard ship. One ship's Master told us, "One man too few is better than one man too many," and another said, "The more personnel you have, the more opportunity there is for idleness and mischief." We have not observed similar philosophies aboard USN ships, where nearly all that we spoke to cited a lack of capable personnel, overwork, and, frequently, constant fatigue.

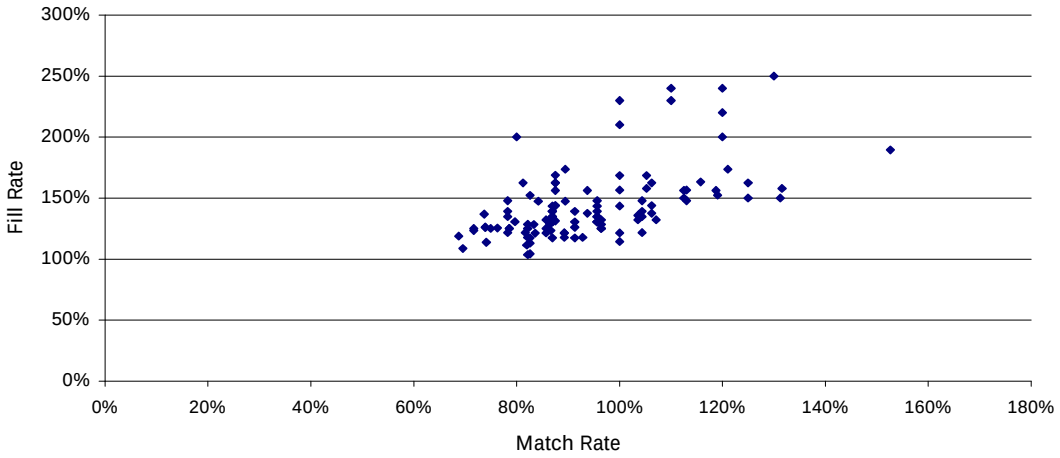
In general, when MSC plans manning, the expectation is that significantly fewer but more experienced people can get the job done. Following are examples of how differences in manning philosophy can affect ship manning levels.

Excess Surface Warfare Officers

In December 2004, the SWO community had 1,125 more junior officers than jobs for them to fill because they are expected to be needed for department head billets in about 2011. These excess officers cause overmanning on USN surface ships and cost the USN more than $150 million in 2004 (based on Military Composite Standard Pay and Reimbursement Rates, Department of the Navy, FY 2004).

As shown in figure 13, all of the 115 USN surface ships tabulated are currently manned at over 100 percent of authorized levels, and 9 ships have more than twice as many officers than were authorized. Despite manning by as much as 50 to 100 percent over authorized billets on some ships, however, the USN still falls short in placing the proper designations or paygrades aboard them, achieving only a 70- to 80-percent match rate.

Figure 13. Surface ship officer fill rate vs. match rate[a]

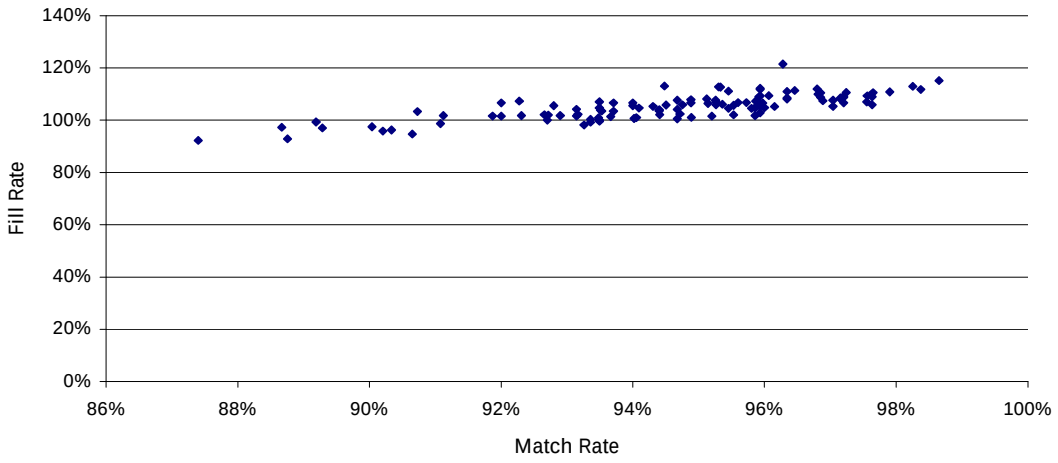


a. Surface ship classes FFG, CG, DDG, LHA, LHD, LSD, as of February 2005. Excludes 8 DDGs: FITZGERALD (changed home port), LABOON/GONZALEZ (Sea Swap Program), and CH HOON, NITZE, J. WILLIAMS, MOMSEN, HALSEY (new construction). AOEs are excluded because data not representative due to transition to MSC.
Fill rate = officers onboard divided by authorized billets.
Match rate = officers with correct designator and pay grade (allowing for one up and one down detailing) divided by authorized billets.
Data source: Director, Distribution Management, Allocation, Resources and Procedures Division (PERS-45).

Excess enlisted manning levels

Surface ship manning levels are much closer to authorized levels for enlisted personnel than they are for officers, with a more logical correlation between fill and match than for officers and relatively few ships with fill rates higher than 110 percent or lower than 90 percent. The manning pattern is indicative of a detailing system that is consistent but, with a skew toward overmanning, not necessarily efficient. Because of the large numbers of ships, even relatively small overages per ship can be costly. For example, for the 115 ships summarized by figure 14, there is a total overmanning of 1,768 and undermanning of 134. The net difference of 1,634 is only about 5 percent of the total number of authorized billets for these ships but represents an annual cost to the Navy of over $83 million (assuming Military Composite Standard Pay and Reimbursement Rate for E-4).

Figure 14. Surface ship enlisted fill rate vs. match rate[a]



a. Surface ship classes FFG, CG, DDG, LHA, LHD, LSD, as of February 2005. Excludes 8 DDGs: FITZGERALD (changed home port), LABOON/GONZALEZ (Sea Swap Program), and CH HOON, NITZE, J. WILLIAMS, MOMSEN, HALSEY (new construction). AOEs are excluded because data not representative due to transition to MSC.
Fill rate = enlisted onboard divided by authorized billets.
Match rate = enlisted with correct rating control number divided by authorized billets.
Data source: Director, Distribution Management, Allocation, Resources and Procedures Division (PERS-45).

Comparison of engineering departments

The next sections compare in detail the staffing of the engineering departments of former Navy ships when manned by the Navy and when the same class of ship is manned by MSC CIVMARs.

Table 12 summarizes the before and after staffing of most of the ships that have been transferred to MSC operations.[33] Also included is the one command ship currently operating with a CIVMAR-manned engineering department.

As can be seen in table 12, the CIVMAR staffing of the engineering departments is roughly one-third the size of the Navy construct. Also the MSC manning is always more than 50 percent officers and CPOs, whereas the Navy staffing process provides for fewer officers and nearly 90 percent juniors (E-6 and below).

33. None of the current MSC oilers or any of the three AFS-8 class ships were ever operated by the U.S. Navy, so we exclude them from the table.

Table 12. Staffing of engineering department on large ships converted to CIVMAR manning[a]

Ship type	Staffing	Navy manning	MSC manning
AE-26	Officer	5	8
	CPO	6	10
	Other	99	19
	Total	**110**	**37**
AFS-1	Officer	5	9
	CPO	7	7
	Other	103	17
	Total	**115**	**33**
AOE-6	Officer	5	12
	CPO	8	14
	Other	110	17
	Total	**123**	**43**
AGF-11	Officer	6	11
	CPO	8	14
	Other	111	19
	Total	**125**	**44**

a. "Other" designates E-6 and below on Navy-manned ships, and junior unlicensed on MSC-manned ships.

Table 13 displays the staffing comparisons for the salvage ships that are now being converted to civilian manning. Here the proportion of experienced people is even more pronounced. For the Navy, 12 percent are seniors and 88 percent are juniors; for the MSC, 62 percent are seniors and 38 percent are juniors.

Table 13. Staffing of the engineering department of salvage ships

Ship type	Staffing	Navy manning	MSC manning
ARS-51	Officer	2	5
	CPO	3	0
	Other	39	3
	Total	44	8

A similar pattern is apparent in English ships. The Royal Navy, and the Royal Fleet Auxiliary (the British equivalent to the Military Sealift Command), both operate new LPDs. The ships are not classed alike but they are very similar in size, scantlings, and propulsion. Table 14 shows the engineering department staffing comparison for those ships. What is different here is that both have about the same proportion (about 50 percent) of seniors. But the Royal Navy seems to rely more on its senior petty officers, whereas the RFA seems to expect more engineering and maintenance work from its officers.

Table 14. Staffing of British LPDs

Ship type	Staffing	RN manning	RFA manning
LPD	Officer	3	6
	CPO	15	1
	Other	21	7
	Total	39	14

AOE-6 class engineering operations

Another example is the AOE-6 class, a 100,000-shaft-horsepower, 4-turbine, 2-shaft ship with a propulsion plant similar to those of all the large surface combatants of the Navy. MSC operates that class of ship with an engineering department that is about one-third as large as the Navy crew. We note the following differences.

Organization-level maintenance on propulsion and auxiliary machinery

According to the USN and MSC manning documents, for organizational-level maintenance of the propulsion and auxiliary machinery, the Navy crew employs 72 people, while the MSC crew employs 15. The Navy crew comprises 5 CPOs and 67 others (no officers). The people performing maintenance on propulsion and auxiliary machinery in the MSC crew consist of the 1st Assistant Engineer, two 2nd Assistant Engineers, and two 3rd Assistant Engineers, all licensed officers. There are also 2 CPO pumpmen and 8 others, for a total of 15 people.

On the MSC ship, these day working maintenance people and the six watchstanding officers, three watchstanding CPO, and six watchstanding others perform intermediate-level maintenance actions both under way and in port, mostly on an overtime basis. The Navy staffs a separate entity, the Ship Intermediate Maintenance Activity (SIMA), with more experienced petty officers to accomplish the intermediate-level maintenance, which is always done in port.

Organization-level maintenance of electronic equipment

The MSC engineering department includes the electronic repair personnel, whereas in the Navy construct such technicians are assigned to the operations department. Here we have included the electronic technicians in the engineering comparison. The Navy construct requires nine electronic technicians, seven of whom are juniors. The MSC crew has two electronic technicians, both senior, skilled people. With minor exceptions, the electronic equipment was not changed when MSC manned the ship. What is different is that the 11 subskills required (as represented by required NECs) of the electronic technicians are spread across nine people in the Navy construct but only two people in the MSC construct.

Refrigeration Repair

The MSC crew has two refrigeration repairmen, and the Navy crew has three.

Electricians

The MSC crew has 3 electricians. Not including the 12 electricians dedicated to deck machinery repair, the Navy crew has 7 more electricians and 6 telephone repairmen to maintain the same power generation and internal communications distribution machinery and equipment.

Deck Machinery Repair

The AOE is an UNREP ship with many winches, plus a number of STREAM “send” rigs with massive hydraulic sliding blocks. Keeping these critical machines operating is a significant challenge. The Navy crew employs 25 electricians and machinists under the direction of a Chief Electricians Mate to keep all these machines in good working

order. The MSC crew employs 4 machinists under the supervision of a 2nd Assistant Engineer to accomplish the same work. Here the difference is in the approach to the problem. The Navy assigns a repairman to each replenishment rig team, and employs most of these 26 people in watching the machinery in operation, during a replenishment. MSC assigns no repairmen to replenishment teams. Instead, the 5 individuals are employed in repairing the machinery when not in use. Reportedly, there is rarely a casualty to this deck machinery when in operation on MSC-manned ships.

Battle damage response and fire fighting

USN Ship Manning Document policy assumes that a crew must be able to "fight the ship" (continue to carry out its mission) while performing damage control and fighting an onboard fire, even though USN experience over the past half century (and MSC/private sector practice) has been to cease operations until fires and/or damage are contained. A vestige of World War II experience, this policy leads to increased crew size.

Moreover, there is a belief among many in the Navy that a larger crew is always better than a smaller crew for battle damage control and fire fighting, and that smaller MSC crews are not as effective as larger USN crews in fighting fires and responding to battle damage. To address this issue, we examined the training for military and civilian crews, and found them to be comparable. We also explored the motivation of civilian crews compared with military crews, and our interviews led us to conclude that both will fight fires and conduct damage control aboard a ship at sea with probably equal tenacity, if for no other reason than that their lives depend on it. For the same reason, we expect that MSC and USN crews would also be relatively equal in avoiding abandoning their ship until they were convinced it couldn't be saved. We also know that a smaller crew is likely to sustain fewer injuries and fatalities than a larger crew merely because there are fewer on board to be injured when incurring battle damage or fighting fires.

We found the "more is better" manning philosophy to be most prevalent when applied to damage control and fire fighting on a

combatant, but organization and training were also thought to be very important. The Royal Navy lost 6 ships during the Falkland War in the early 1980s, and 11 more were seriously damaged [14]. They are very attuned to the need for a strong damage control and fire-fighting capability, yet they recognize that there must be upper limits to crew size—and their combatant crew sizes are not unusually large. Instead, they provide damage control training and live fire-fighting training for the entire crew once every 2 years, compared with once every 5 years for both MSC and the USN (appendix G, figure 26).

Compensation and personnel policy reform

Should Navy's profile more resemble civilian's?

We have seen that the current Navy enlisted workforce is much more junior than comparable civilian workforces. In particular, the Navy has relatively more very junior people and almost no people with more than 20 years' experience. In the future, however, changes in technology, demographics, and educational patterns may make it necessary for the Navy to pursue reforms that will make a more experienced force feasible.

Both supply and demand factors may lead to significant changes. On the labor supply side, the American population is getting older and young people will become a smaller proportion of the workforce. At the same time, the level of postsecondary education is expected to increase, and there are ways that the Navy can benefit from bringing more college recruits into the enlisted ranks.[34] Recruiting lateral entrants with more job experience is also a possibility.

On the demand side, future organizational and platform innovations will reduce but not eliminate the requirements for low-skilled labor, and will increase requirements for highly skilled and more experienced enlisted personnel. Although future ship acquisitions will start to change manning requirements by the end of the decade, changes in strategies for organizing and manning current platforms, such as those discussed in the rest of this document, should have an earlier impact.

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34. For a discussion of available educational statistics, their shortcomings, and what can be inferred about likely future trends, see [15]. For a discussion of the extent to which the Navy needs college recruits to fill enlisted accession requirements and how it can benefit from college recruits, see [16].

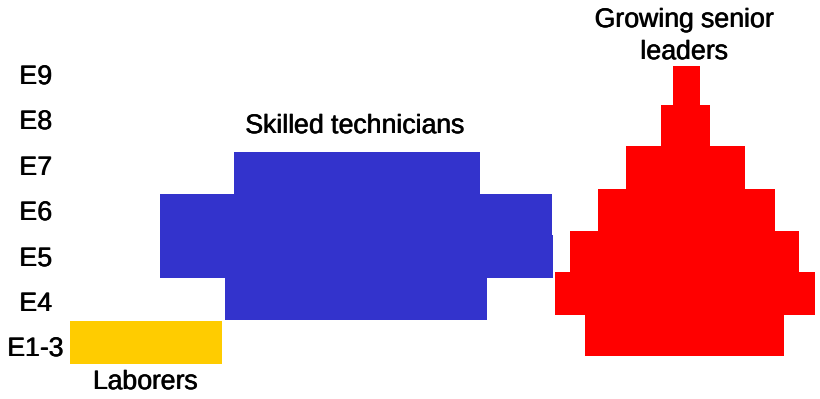
Future requirements

We can think of the manpower requirements for the future Navy as coming from three distinct functions, as shown in figure 15:[35]

- There will be a small remaining requirement for unskilled labor. Even the most advanced designs for ships, submarines and squadrons use some unskilled labor and, as we have noted earlier, making skilled workers do routine work can lead to dissatisfaction and reduced effectiveness. The next section contains further discussion of unskilled sailors, sometimes referred to as general detail sailors (or GENDETs).
- There will be a larger requirement for skilled, experienced technicians. We've primarily extended the E-6 and E-7 grades to be consistent with industry's relatively greater use of technicians with 20 or more years of experience. An important point to keep in mind is that now paygrades E-1 through E-9 are ranks and imply command authority. In a Navy with more technical jobs, however, advancement might sometimes mean gaining technical skill or experience but not necessarily command authority. Breaking or loosening this distinction will become an important issue. In some occupations, the Navy will need some proportion of highly skilled and highly paid technicians who do not necessarily have much military experience, high rank, or command authority.
- There will be a continuing need for a pyramidal ladder to gain military experience and grow senior leaders. This requirement is not much changed from today's, except that we assume that more people enter at somewhat higher paygrades due to the possibility of lateral entry.

35. Reference [17] looks at major acquisition programs and Human Systems Integration literature and provides a synthesis of expert opinion on manpower requirements for future naval platforms.

Figure 15. Different functions drive different requirements



A role for GENDETs

One difference in how ships' personnel can be organized is whether some sailors are assigned specifically to do unskilled tasks or these tasks are divided up and rotated among the rest of the crew. Especially with the future high-tech, minimally manned ships, it's tempting to conclude that automation will progress to a point where GENDETs won't be needed. However, even the most advanced technologies still require some unskilled labor, and recruiting unskilled labor is a low-cost option that has quite a few benefits for the Navy.

Since FY98, GENDETs have ranged from 19 to 25 percent of the Navy's enlisted accessions. It's a low-cost entry program: the average GENDET costs only $6,000 to recruit and $7,000 to train, compared with $16,000 and $27,000, respectively, for all Navy accessions.[36] So, overall, compared with average A-school recruit costs, it costs only 30 percent as much to bring in and train someone to do unskilled labor.

36. Average recruiting and training costs for all recruits are FY02 estimates from reference [18]. The comparable GENDET recruit cost was computed using quality distribution of GENDET recruits (FY99-03 average) and average costs of recruits in each quality cell. The GENDET training cost was estimated by using an average training cost of $83/day (mostly student salaries) multiplied by 9 weeks of bootcamp plus 3 weeks of apprentice training.

And, as we have noted, there is the additional benefit of avoiding the atrophy of skills that otherwise occurs if A-school graduates do not apply their skills soon after being trained.

Given this, how do the GENDETs fare once they're in the Navy? First, it is true that their attrition rates are slightly higher than those of recruits who are promised a training school, but the difference isn't great and can mostly be explained by differences in AFQT scores. For accessions who entered the Navy in FY01, 29 percent of GENDETs had left within 24 months compared with 25 percent of school-guarantee recruits.

The Navy does provide good career opportunities for the GENDETs who stay. More than half of those who start as GENDETs end up earning a rating during their first term, and fully 91 percent of the GENDETs who make it all the way to the end of their first term have earned a rating. For those who do earn a rating, the average time it takes is about 2 years, and they then have high reenlistment rates. So, the Navy is not just using these young people as a source of unskilled labor; it is providing them with a way to learn about the Navy and choose a career path. Furthermore, having GENDETs do the unskilled work prevents dissatisfaction arising from assigning these chores to skilled crew members.

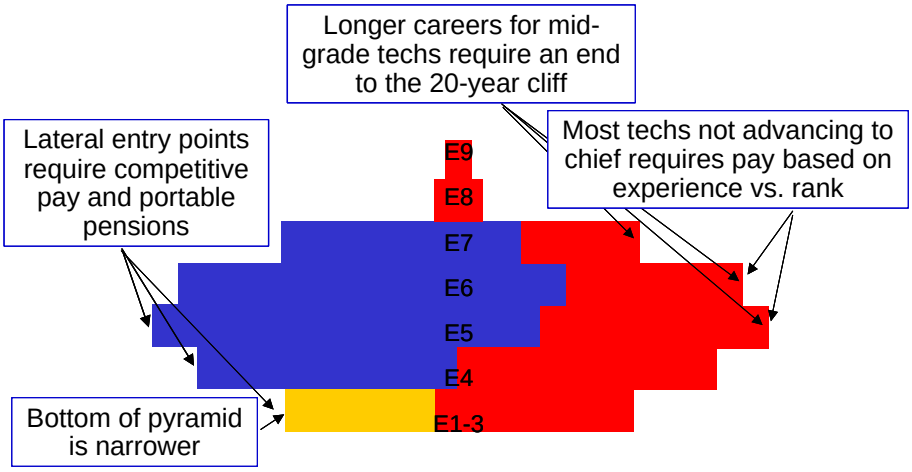
Moving from pyramids to ovals

Combining the need for unskilled labor, technicians, and future leaders would form a requirements profile for the entire enlisted force that looks something like that shown in figure 16. If this is the target profile for the future force, both increased lateral entry and changes in the length of at least some military careers are essential. These changes, in turn, require transforming the compensation system, especially entry and retirement pay, and pay advances tied to skill, experience, and performance rather than rank.

Oval force profiles, if optimal for some occupations or functions, cannot be sustained with the current personnel management and compensation systems. Most notably, significant levels of lateral entry would be required. Longer career lengths, for all or only for technical

specialties, would also be required, especially without the current up-or-out restrictions.

Figure 16. The end of the manpower pyramid?

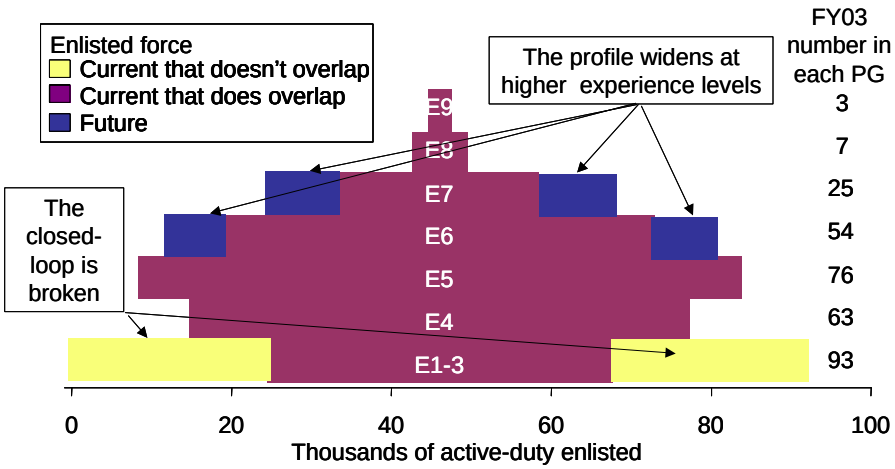


Comparing current and future requirements

Figure 17 shows the FY03 actual Navy enlisted personnel inventory by paygrade and compares it with our notional forecast of what future manpower requirements might be. The scale across the bottom gives thousands of active-duty enlisted in FY03, and the numbers on the far right are the inventories by paygrade (e.g., there were 93,000 E-1s through E-3s). The yellow and maroon bars show the FY03 inventory.

We have no idea what the absolute size of the future Navy will be, so all we can do is compare relative sizes of different paygrades. If we assume that the number of E-4s is the same, how would the number of E-1s through E-3s, E-5s, etc., compare? We chose to set E-4s equal as a benchmark and show in maroon the future requirements that overlap with the current. Given this, we see that the current force has many more E-1 through E-3s (the segments shown in yellow) than the future force. The other difference is that the future requirements have relatively more E-6s and E-7s, shown in blue.

Figure 17. Current paygrade inventory vs. notional future requirements



Workforce profile alternatives for the future

Earlier, we saw that the Navy's current workforce experience profile is much more junior than comparable civilian workforces, and we have argued that the Navy should move toward a more experienced workforce. (Also see appendix B.) If the Navy does choose to reshape its experience profile, it will have to work with both extremes: breaking the closed-loop accession policy and holding on to people beyond the 20-year retirement point. This will require many changes, including compensation reforms and personnel policy changes.

Compensation reform

The "right" answers to the design of a compensation system depend on the skills and experience levels that the pay and benefits are meant to attract and retain. The old pyramidal force profile, with many personnel at low paygrades and progressively fewer at higher grades, required a different personnel and compensation system than a force profile that has a larger proportion of personnel with moderate or extensive levels of experience.

Oval force profiles cannot be sustained with the current personnel management and compensation systems. Some areas that will have to

be changed to support significant levels of lateral entry and longer career lengths would be:

- Entry pay for technically skilled recruits must be competitive at all levels. This is relatively easy at the first-term E-1 vs. E-3 level, but it gets more complicated for officers and at higher levels of experience.
- Reforming the defined-benefit, 20-year cliff vested retirement system.
- Greater flexibility will also be key—more variation in pay and policies by occupation, experience, performance and function.

These changes in the compensation system would have several purposes. First, the intention is to break the paradigm of bringing in accessions only at the bottom of the system. The new model would be a more varied pattern of accessions, where lateral entry and in-and-out paths are also possible. The second purpose of compensation reform would be to allow more variation in pay and career length among different kinds of personnel, based on function or occupation or skills.

The military retirement system

The military retirement system differs from most private or government pensions. Typical retirement plans have defined contribution rather than defined benefit plans, have earlier vesting, don't start paying benefits at 20 years of service, and are less generous [19].[37]

As of 2000, almost all medium to large companies offered some form of defined contribution retirement plan.[38] The most prevalent of

37. Reference [19] uses data from studies by the Hay Group, Hewitt Associates, Watson Wyatt, and the Profit Sharing/401(k) Council of America (PSCA).

38. A *defined contribution plan* consists of individual accounts for participating employees. The account can contain both employer and employee contributions, depending on the plan's terms. Participants are entitled to their vested account balance. A *defined benefit plan* specifies participants' benefit entitlements. The benefit is usually determined by a formula based on a percentage of compensation times years of service.

these, offered by 80 percent of medium to large employers, is a Thrift Savings Plan (TSP), which is essentially an employee savings account that can be drawn on once retirement age is reached.[39] Employee contributions are at least partially matched by over 90 percent of large companies.

Since many companies offer a combination of defined contribution and defined benefit plans, over 50 percent of medium to large firms still had some form of defined benefit plan in 2000. Only 1 percent, however, offered a defined benefit plan only.

In the private sector, the Employee Retirement Income Security Act (ERISA) requires employers to vest employees in their retirement system within 5 to 7 years. Once employees are vested, they may take their account balances with them when they leave their current employer. Many view this portability as a positive feature of defined contribution plans, particularly as job mobility has increased over time. In contrast, the military retirement system has no vesting until 20 years and then offers a uniquely generous payout to people who can be as young as 38 or 40 in the case of enlisted members who joined directly from high school.

The 20-year cliff vesting has two disadvantages. The most obvious is that it creates a strong incentive, which most people follow, to leave at 20 years of service, even for people the Navy would like to keep. Another disadvantage is that, once people reach a certain career point, they begin to count on staying to 20 years; separating them means they are losing a valuable part of their expected total lifetime compensation. Cliff-vesting creates an implicit contract that reduces the Navy's flexibility to separate poor performers and slows advancements and reduces morale for more productive personnel.

39. 401(k) plans are thrift savings plans that allow employees to defer part of their compensation on a pre-tax basis into the plan. The other types of defined contribution plans, offered by the other 20 percent of medium to large companies, are profit sharing and employee stock ownership plans.

Retired pay reform

Although retirement reform is a perennial and difficult issue, we believe its importance merits diligent effort and that progress is both essential and feasible. The Navy experience profile cannot be made substantially more senior without retaining more people beyond 20 years of service. Although adopting incentive pays and changing up-or-out policies will make some difference, the 20-year retirement cliff is clearly the major driver of the upper end of the experience profile.

Furthermore, the current military retirement system may have little appeal to the kind of skilled and experienced sailor we are discussing in this paper, with the ability and desire to move in and out of the Navy. A portable and vested defined contribution retirement plan may be more attractive to these individuals.

One direction toward retirement reform is relatively easily. Active duty military members currently have access to a defined contribution retirement plan through the recent extension of the Federal Employees' Thrift Savings Plan (TSP) to active duty military members. Reform proposals to allow servicemembers to contribute more to TSP should be supported. Furthermore, the Navy should support putting any additional retirement money into matching contributions for TSP rather than the defined benefit plan.

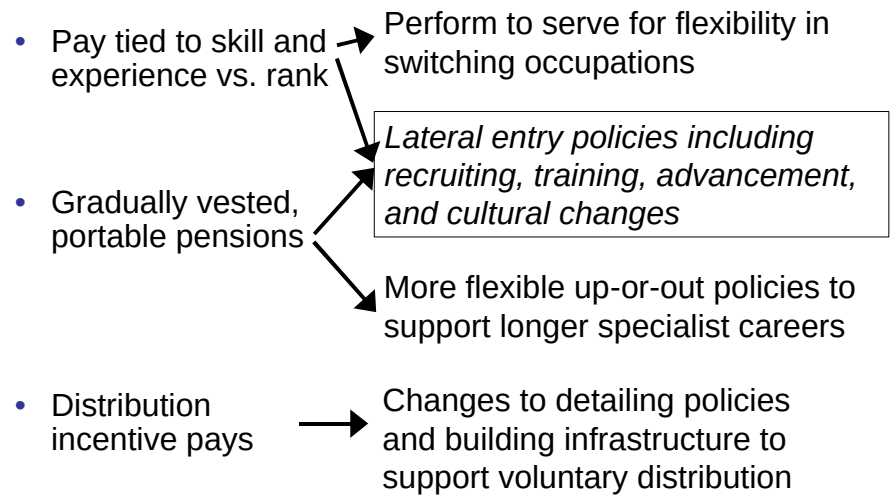
A more sweeping retirement reform proposal has been advanced by RAND researchers and supported by the Ninth Quadrennial Review of Military Compensation [20]. Asch, Johnson, and Warner [21] note several reasons for the unique structure of the military retirement benefit. It has typically served both as a deferred compensation incentive to encourage retention and as a separation device. (Both functions are needed, particularly for as long as the military personnel system allows virtually no lateral entry.) As such, they recommend an old-age benefit that is either defined benefit or defined contribution in structure, coupled with a system of separation bonuses that could vary by occupation.

Personnel policy reforms

In addition to the changes to the compensation system, major changes in Navy and DOD personnel policies also would be required. Some of the policy changes, and their relation to compensation changes, are shown in figure 18.

There is little previous analytic work to support quantitative estimates for such major departures from traditional systems. Analysis has yielded more insights in some areas (lateral entry, retirement reform) than others (separate career tracks for technicians and leaders), but the military services are just beginning to design and implement some of these changes. Pilot programs, and authority to rapidly adjust pays to emerging results for Navy-wide compensation reform, will be critical to successful transformation.

Figure 18. Compensation reforms go hand in hand with policy changes



If pay is increasingly tied to occupation, experience, and performance, the Navy will also need policies to facilitate its ability to retain good performers and, if needed, help them switch to occupations that need more people. OPNAV N1 is currently developing and evaluating the Perform To Serve (PTS) policy that is shaping this ability.

Flexibility in up-or-out policies and specialist careers is receiving a great deal of attention as the subject of current studies and test programs. Assignment Incentive Pay (AIP) and the associated computerized Job Advertising and Selection System (JASS) are starting points on the compensation, policy, and infrastructure changes that are needed to accomplish sailor choice. Relatively more research has been done and is under way in the area of lateral entry, which is discussed below.

Lateral entry policies

Flattening out the left-hand side of the experience profile requires breaking the Navy's closed-loop accession policy—in other words, bringing in more lateral entries. Almost all pilot programs to date have been of early lateral entry, that is, replacing A-school training or NEC training by bringing in pretrained recruits. In general, CNA studies of these programs have recommended greater reliance on private-sector training where clear civilian counterparts exist [22].

When the Navy is providing training that is identical or very similar to training that can be obtained at a civilian institution (e.g., Information Technology (IT), basic electronics, welding, some medical specialities) it is likely that private institutions have cost and effectiveness advantages. These advantages include the ability to spread fixed costs over a larger student population, operating subsidies provided by government and industry, and efficiency gains from competition [23]. Several CNA studies have documented cost savings from private-sector training and also have shown that military performance didn't suffer. The studies included IT training, medical training, and a specific medical laboratory technician NEC [24–26]. Also, as we note in appendix D, a few foreign navies have used lateral entry successfully, aided by conscription and economic downturns.

Although theory and studies both indicate substantial cost and effectiveness advantages for private-sector training, there are still hurdles to overcome, even with early lateral entry programs. One CNA study evaluated the Navy's limited success with the Tech Prep program, a partnership to provide transition from high school to community college to the enlisted ranks [27]. Partnerships between educational institutions and employers are common. The Army has a similar one

with its College First program. The Navy also has the Direct Procurement Enlistment Program (DPEP) that "provides for Regular Navy enlistment of candidates with civilian acquired training/work experience" [28]. None of the services has pursued these options aggressively. For example, only six civilians enlisted under the DPEP in FY03 (all were MSs), and only two were recruited under the DPEP in FY04 (one MS, one HM). We do not know for certain why the DPEP is so underutilized. Some say that the program is not well publicized by Navy recruiters, and others speculate that most of the people who might be eligible already have higher paying jobs in their respective fields. As we have found in our discussions of foreign navies, however, lateral entries do increase as the economy falters—if the lateral entry option is adequately publicized.

Other programs may not have been fully resourced and supported, or enlisted recruiters may not be comfortable on college campuses and colleges may not welcome them. In some cases, more applicable to recruiting medical technicians than the Tech Prep program, the entry pay may not have been competitive.

Reference [16], cited earlier, examines how the Navy can take greater advantage of the college market. In addition, there is a new study in the CNA FY05 program to investigate the experience and productivity levels feasible from lateral entry and how cost-effective it would be.

Other questions that must be addressed regarding lateral entry include:

- How can recruiting be restructured to take advantage of the new markets?
- How will military-specific training, acculturation, and indoctrination be provided to lateral entrants? This issue becomes more difficult the later in the career you allow people to enter. For example, if an enlisted sailor enters after 2 years of college instead of high school, it's not a problem. But if a network administrator enters after 2 years of college and 6 years of work experience, it becomes tricky.
- How to separate pay, experience, and command authority.

- Creating mechanisms that would support people moving in and out of the Navy.

The entire system of bringing in fresh young recruits and providing all training in-house is so much a part of military culture that a range of cultural issues would have to be addressed.

Conclusions and recommendations

Some naval officers that we spoke with thought that MSC was able to man ships with smaller crews because they did not maintain their ships as well as the Navy, or they thought that, unlike the Navy, contractors did all their maintenance. Others suggested that MSC auxiliary Ship crews were smaller only because they were called on to do less than USN auxiliaries, not because they were necessarily more efficient. And many believed that MSC ships were able to stay at sea for longer periods of time because hardly any of the mariners were married, compared with USN crews, and that MSC only appeared to be less expensive. It was thought that, when overtime is factored in, the smaller MSC crews would be more costly than the larger USN crews.

None of these opinions and beliefs turned out to be true. We found that the percentage of MSC crews that are married is just slightly less than that of USN crews, that MSC ships have a state of readiness at least as good as that of comparable USN ships, that MSC crews perform more maintenance aboard ship, without contractor assistance, than do USN ship crews, and that the performance and safety records of MSC civilian-manned auxiliary ships are as good as if not better than USN auxiliaries. Even when civilian overtime is factored in, the smaller MSC crews are less costly per year than the larger USN crews when all military personnel costs are considered, such as health care and retirement.

In recent years, the USN has made considerable progress in reducing ship manning, most notably through Smart Ship and the Optimum Manning Experiments (OME), and in reducing overall personnel requirements with the Sea Swap program. All of these advances contain elements that mimic long-standing MSC and commercial practice: Smart Ship expands the use of automation and low maintenance materials/coatings, OME reduces bridge manning and strives to move some functions (such as supply and financial) off ship, and Sea Swap rotates crews, not ships, to increase the amount of time ships

remain on-line. But more can be done, as evidenced by the experience of MSC and the private sector.

With the DDX and LCS, the Navy plans to design and build future ships that will apply still more lessons learned from MSC manning practice, but these new ships will be manned by Navy crews that will have gained most of their experience in ships that exist today. Therefore manning innovations should first be applied to the "legacy" fleet, to prepare today's crews technically and culturally for the next generation of minimally manned ships.

As a blueprint to aid the USN in applying MSC principles to reduce the size of crews in legacy ships, and to better prepare for the DDX and LCS, we offer the following recommendations:

Improve engineering capability

Since the U.S. Navy converted most nonnuclear surface combatant engineering billets to URL billets in 1976, ships have become more complex and crews are becoming smaller, mandating that all crew members must be capable when arriving onboard—especially engineering division officers and department heads. Also since 1976, officers are required to serve in Joint Duty billets to qualify for flag selection, which subtracts roughly 3 more years from the total time available for an officer to become proficient in all shipboard departments and command. Therefore, the Navy should reconsider its long-standing policy that makes every SWO a generalist who is expected to be effective at running engineering ship departments and divisions without formal engineering training or education, based primarily on OJT gained during relatively short periods of time at sea. Instead, the policy should be that all officers assigned to the engineering department must be technically trained as operating engineers, meeting standards similar to USCG licensing requirements for 3rd assistant, 2nd assistant, 1st assistant, and chief engineer.

Further, reduced crew sizes on such ships as the LCS and DDX are more likely to be successful if the current Navy culture of officer reliance on subordinates for engineering expertise is replaced with a culture similar to the MSC/commercial model, where officers are not

only technically competent but are expected to physically perform some maintenance as well as to oversee it. This paradigm shift should not wait for the introduction of LCS and DDX but should start as soon possible on legacy ships.

Change officer career management policies

Once a SWO gains the necessary training and experience to effectively operate and maintain ship engineering plants, it would be most cost-effective for that officer to continue to specialize in the engineering area and to spend more time at sea over a 20-year career. We recommend, therefore, that the Navy adopt a two-track career path system for naval SWOs, similar to those used by MSC and the private sector and virtually all navies of the industrialized world. In those systems, engineering expertise is valued and rewarded, and it is not difficult to find those who aspire to the position of Chief Engineer rather than CO.[40] Engineering department officers might be SWOs, LDOs, Warrant Officers, or EDOs, or perhaps a special class of officers drawn from all four communities, but the main objective would be for all officers responsible for at-sea ship engineering to be technically trained and competent when they arrive on ship, with a hands-on culture.

An earlier CNA study [29] addressed this issue in broader terms, noting that the expanding number of "must-have" tours for generalist officers requires longer careers and that a generalist model is likely to cost more than a specialist model without lengthened careers. We recognize that moving toward increased technical specialization, with or without lengthened careers, would be a major change for the sur-

40. Some officers have opined that recruiting new SWOs would be harder with a two-track system. We believe that the experience of the private sector and MSC and most other navies proves otherwise, especially if recruits at the outset are selected with the promise of gaining operating engineer status, and if chief engineer pay is commensurate with that of commanding officers. Others think many SWOs would resign if not given an opportunity for command. This could be avoided if these officers were grandfathered into the new system with assurances of command opportunities during the transition period.

face warfare and other communities. But it need not be perceived as a negative change if other changes are made at the same time to smooth the transition. For example, if those in the engineering track were no longer being simultaneously groomed for command, their total time at sea in engineering billets could increase (improving their technical expertise and the operation/maintenance of the engineering plants) without necessarily increasing total time at sea. Those in the command track would spend more time at sea in Weapons and OPS departments, improving their warfighting skills without necessarily extending time at sea. Eliminating most engineering track officers from contention for command could improve promotion opportunities for those who remain in the command track, or promotion opportunities for department heads could be fine-tuned to remain the same as they are now by extending the duration of XO and/or CO tours—an improvement that studies show could improve ship performance.

Total training time need not increase for those in the technical track because their postgraduate school experience, now common for SWOs after 4 years aboard ship, could be refocused to a more technical education. We think that all of these changes need to be examined in detail, and that this is a good time to start because the LCS and DDX are on the horizon, with designs that anticipate very small crews. For LCS/DDX crews to be effective, they must have technically strong and experienced officers with a history of operating with smaller crews on legacy ships.

Extend at-sea tours

Our studies show that reducing the turnover rate aboard ships can improve readiness or, if readiness is held constant, a reduced turnover rate can improve average experience levels, thereby allowing reduced manning. Our data also show that USN surface (and submarine) officers and enlisted spend, on average, about 8 years of their first 20 years on "sea duty" and less than 3 years of their first 20 years "actually at sea" (time deployed plus other underway time). If officers and enlisted (especially those with 10 to 20 years of service) spent more time at sea, the Navy could gain more benefit from their experience and ships could be manned at lower levels, closer to the private-sector model.

Increasing at-sea time need not have an adverse effect on quality of life if more emphasis were placed on reducing total time away from home. The RN measures "separation time" as total time away from homeport *plus total time on duty while in homeport*, which it tries to keep to a maximum of 660 days over a 3-year period. Although USN ships are in port 67 percent of the time, the Navy culture is to keep officers and crew on board and working, well beyond 40 hours per week. A policy of allowing more time off ship while in port, to compensate for increased at-sea time, should be examined.

Use trained personnel efficiently

We observed that the Navy, unlike the private sector, assigns menial galley and laundry tasks to technically trained enlisted personnel for as many as 3 to 4 months after their first arrival aboard ship, a practice that reduces morale and productivity and degrades technical proficiency.

The impact of this policy is twofold: (1) It deprives the Navy of the use of the sailor's technical skills for the 3 to 4 months he/she is diverted to menial tasks, and (2) it causes a deterioration of capability when the sailor finally applies the newly learned skills after the 3- to 4-month hiatus.

This is a costly practice that should end. For example, 3,144 fresh A-school graduates were newly assigned to surface combatants and amphibious ships in 2004. Skill decay due to extraneous food service and laundry assignments could be costing the Navy as much as $30 million per year.

There are ways to avoid or mitigate these inefficiencies while providing mess cook and laundry services. First and foremost, individuals assigned to these duties should not have previously been technically trained for other functions. As at MSC, NOAA, and in the private sector, they could be:

- Entry-level individuals aspiring to become culinary specialists
- Entry-level individuals who aspire to other duties in other departments

- Individuals who have no further aspirations.

Or they could be individuals seeking these billets through the new auction-based assignment program being introduced in the Navy.

If it is determined that rotation of all junior personnel into these billets should be continued despite having newly acquired technical skills, rotation should be limited to cycles of a few days or a week so that their technical skills do not atrophy. This is the practice of the Dutch Navy.

Improve watchstanding practice

We have described differences between USN watchstanding practice and those of MSC, the private sector, and foreign navies, and have observed that the USN practice of frequently rotating watches is the least desirable from the standpoint of sleep deprivation. While we cannot state that improved watchstanding practice on USN ships would necessarily lead to smaller crews, we are confident that smaller crews on USN ships must be accompanied by improvements in watchstanding practice. Therefore, we recommend that USN policies be redesigned to minimize frequent watch rotations and associated unnecessary sleep deprivation and interruption, thereby increasing safety and performance.

Implement phased reforms using pilot programs

Some of our recommendations, such as those related to changing officer career progression, technical training, and lateral entry and retirement policies, require detailed further analysis by USN teams to identify and quantify specific pros and cons and to establish guidelines for implementation. Others, such as changes to watchstanding practice and operation of legacy ships with crew sizes approaching MSC standards, are best implemented by first using actual trial periods aboard a few ships, and then phasing in application to additional selected legacy ships, followed by new construction ships, such as LCS and DDX. We describe three possible pilot programs in detail in appendix F (for submarine tenders and FFGs), and in appendix G, for a DDG. In the appendix F programs, we propose two ASs or two

FFGs operating for an extended period: one of each class with MSC manning and the second with Navy manning to the same levels as the comparable MSC ship, after the Navy crew had first observed operations on the appropriate MSC ship for an extended period. In the appendix G program, a DDG is manned with a USN crew sized approximately to MSC standards, after most of the USN crew is first exposed to MSC procedures and routine aboard a T-AOE. These pilot programs will enable the Navy to:

- Verify Navy capability to operate Navy ships with crews reduced to sizes generally comparable to the MSC/commercial construct
- Identify standard Navy operational, reporting, and administrative procedures and requirements that require changes to enable reduced size crews
- Form the basis for transition to reduced-size crews on:
  - Other legacy ships
  - LCS and other new construction ships.

Initiate recruiting, compensation, and retirement reforms

We think that the combination of the need for unskilled labor, technically skilled officers and technicians, and future leaders requires the workforce profile of the future to have a larger portion of personnel with moderate or extensive levels of experience—more of an oval-shaped workforce profile, like that of MSC and the private sector—than the Navy's current pyramid-shaped profile.

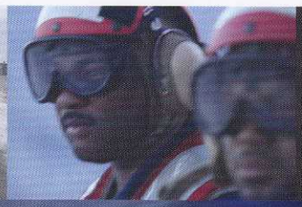
This workforce of the future will be most effective if

- Lateral entry and in-and-out paths are possible.
- The compensation system provides pay tied to skills and experience rather than only rank.
- Gradually vested, portable pensions are provided.

We recognize that these are major changes requiring, in some cases, far more analyses than we have offered here. But, as noted in the body

of the report, a number of studies are already under way in many of these areas. We recommend that the USN continue to pursue these issues to truly achieve a more optimal workforce.

Appendix A: MSC recruiting advertisement



Federal Employment
Job Security
Steady Pay

"Never have to worry about my paycheck at MSC. Job's too important."

Make the move to MSC.

If you're an experienced merchant mariner with the drive to excel, consider a career as a civilian mariner with Military Sealift Command. As an MSC CIVMAR, you'll fill an important role in our national defense–serving onboard a growing fleet of 39 ships that provide all the goods and services to keep the Navy at sea. We offer Federal benefits with steady pay, career advancement opportunities, and job security unheard of in the commercial maritime industry. To take the next step, call our toll-free number or visit our Web site. Act now and take command of your career.

MILITARY SEALIFT COMMAND

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www.sealiftcommand.com/PM

CALL 1-888-891-4577

Military Sealift Command is an equal opportunity employer and a drug-free workplace.

Appendix B: USN and industry workforce profiles

In the main text, we compared USN and MSC workforce profiles. In this appendix, we compare the USN profile with a broader range of the civilian workforce and address possible alternatives.

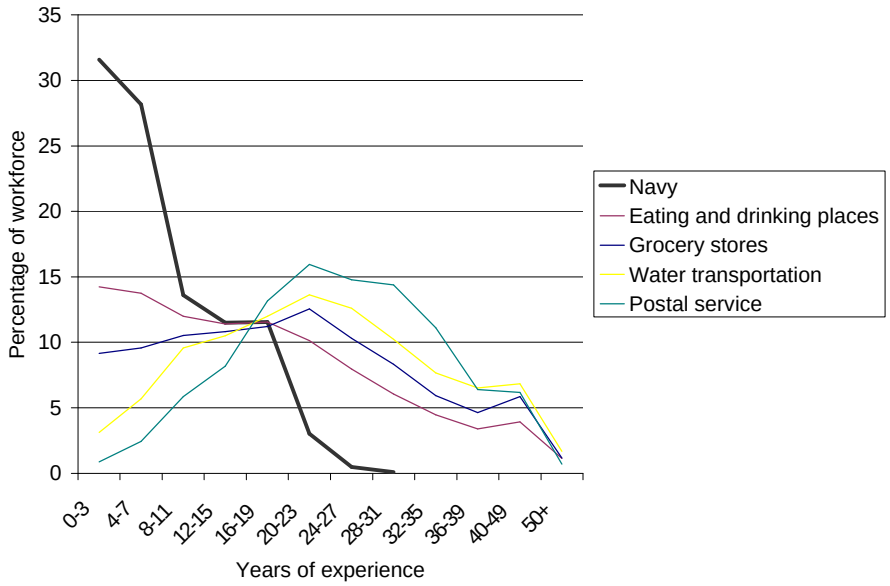
Comparing Navy enlisted to civilians

Figures 19 through 23 illustrate differences in experience levels between the Navy and civilian employers. The annex that follows this appendix explains differences between Navy and civilian data that complicate comparisons of experience measures. The most important difference is this: for civilian workers, we can only proxy work experience by total years since leaving school; for the Navy, years of experience equals the length of active-duty military service. The Navy measure, then, will always be equal to or lower than the civilian because it doesn't include employment in other industries or time not working. In spite of these differences, however, there are points where the Navy and civilian profiles differ so markedly that some conclusions can be drawn.

Many very junior and almost no very senior sailors

Figure 19 shows the percentage of the workforce with various experience levels from 0-3 years up to 50 or more. We started by comparing Navy enlisted nonstudents to ten industries chosen to reflect industries similar to Navy branches, a range of experience and skill mixes, and both public and private civilian employment. Here we show four of the ten industries that span the range of experience variation.

Figure 19. Workforce experience profiles for Navy enlisted nonstudents and selected civilian workforces[a]



a. The Navy profile is based on Enisted Master Record (EMR) data for all enlisted ratings from 1995 to 2002, excluding anyone in a student accounting code, and shows the percentage of the enlisted workforce with the given years of service. The civilian profiles are based on CPS data from 1995 to 2002 and show the percentage of the workforce in that industry with the given number of years since leaving school. The numbers are not strictly comparable since one shows years in the military while the other can include years in other industries, in military service, or unemployed.

The most striking differences in figure 19 are:

- A very high proportion of Navy enlisted are in their first 8, and especially first 4, years of service.[41] Even if the non-Navy profiles were made more junior to reflect reasonable assumptions about time spent in other industries or out of the labor force, the Navy would still have a higher proportion of very junior people.

41. Years of experience 0-3 includes up to 3 years and 11 months of experience and thus can be called the first 4 years.

- Less than 4 percent of Navy enlisted personnel have more than 20 years of experience and none have more than 30. This again contrasts so sharply with all non-Navy profiles that it would not be erased by downward adjustments for time spent in other employment or not working.

Experience levels across comparable industries

Figures 20 through 23 compare the proportion of the workforce at a particular experience level across the Navy and all ten chosen industries. Figure 20 looks at the most junior workers: those with up to 4 years of experience. This is one of the two most dramatic differences caused by the closed-loop personnel system and cliff-vested retirement. Thirty-two percent of the Navy's enlisted force, excluding people still in training, has under 4 years of military experience. In the industries, however, from 1 to 14 percent of the workforces have under 4 years' experience since leaving school.

Figure 20. Percentage of workforce with up to 4 years' experience

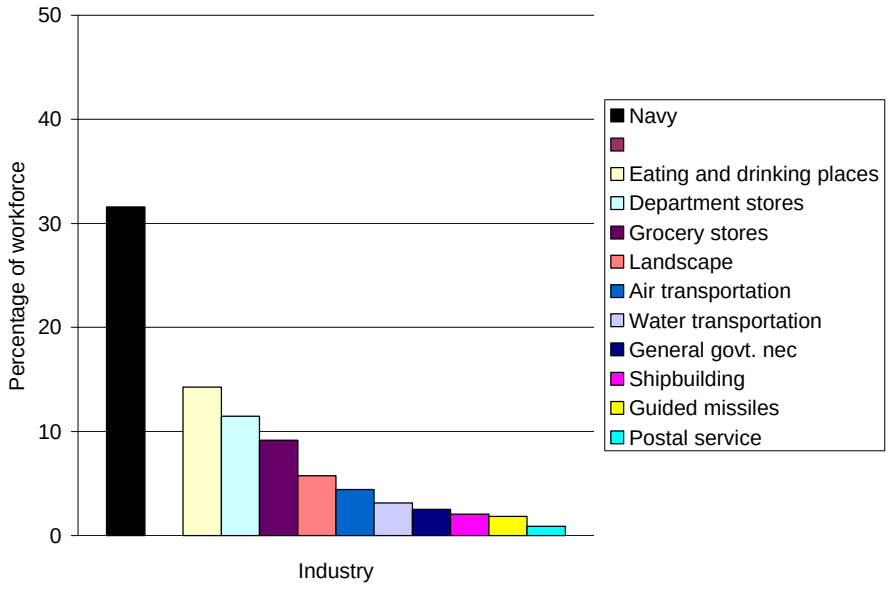
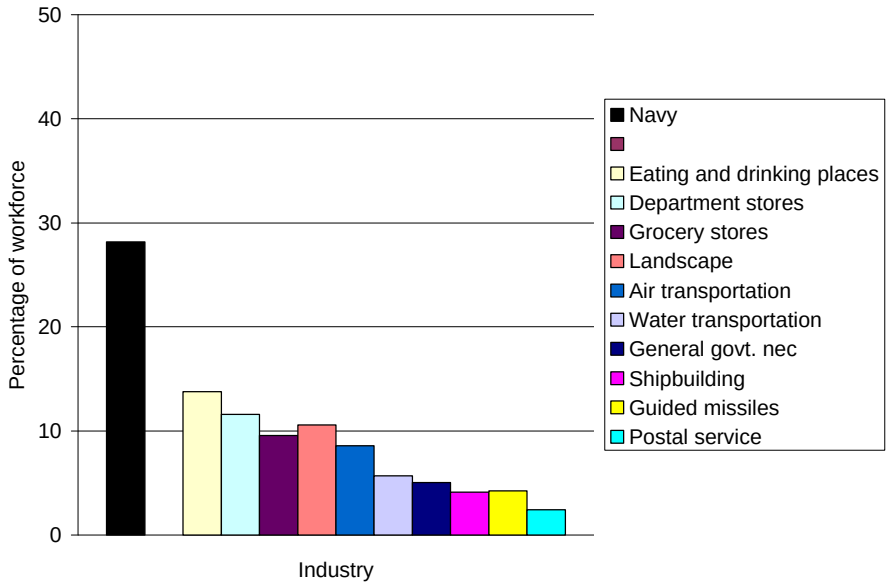


Figure 21 shows that, even by 4 up to 8 years of experience, the Navy has a significantly higher proportion of junior people.

Figure 21. Percentage of workforce with 4-7 years' experience



In figure 22, we look at the mid-experience range—everyone with at least 8 and up to 20 years of experience. Here the Navy is within the range for other industries; however, if experience only within an industry were considered and time out of the workforce were subtracted from the CPS data, the picture might change somewhat. Still, the general conclusion would remain that the big differences in experience mixes are that the military has many more very junior people and many fewer people over 20 years.

Figure 23 shows the dramatic difference at the high end of the experience profile. Under 4 percent of the Navy enlisted force has over 20 years' military experience, whereas from 37 to 70 percent of the CPS industries' workforces have been working for 20 or more years. For most of the industries this percentage is near or above 50 percent.

Figure 22. Percentage of workforce with 8-19 years experience

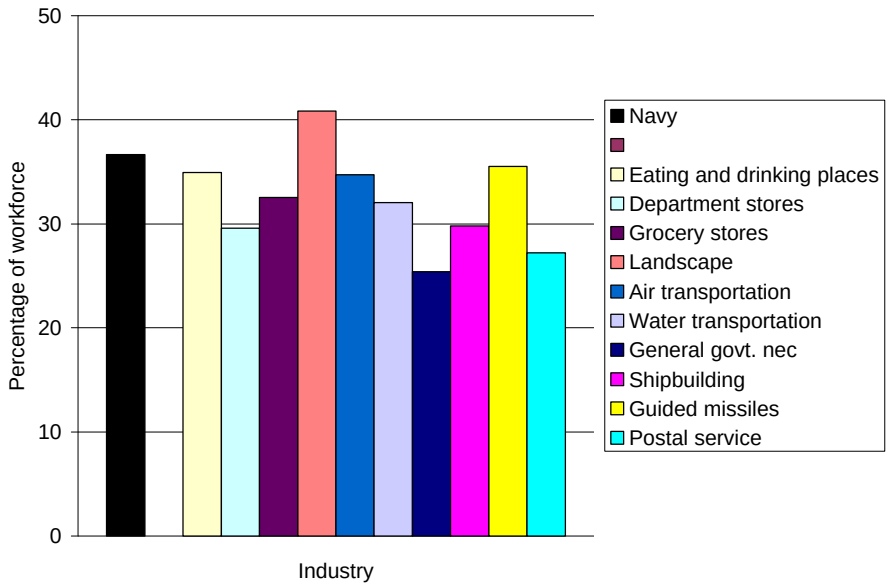
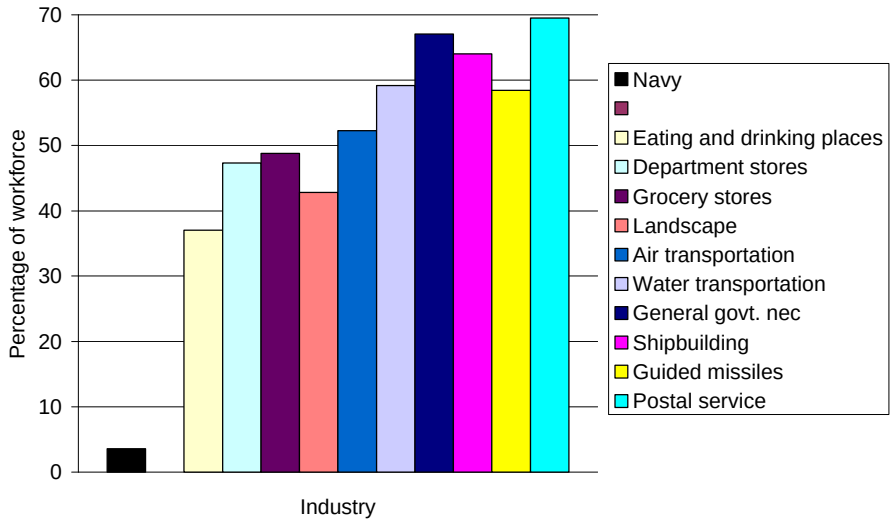


Figure 23. Percentage of workforce with 20 or more years experience



Comparing different civilian workforces

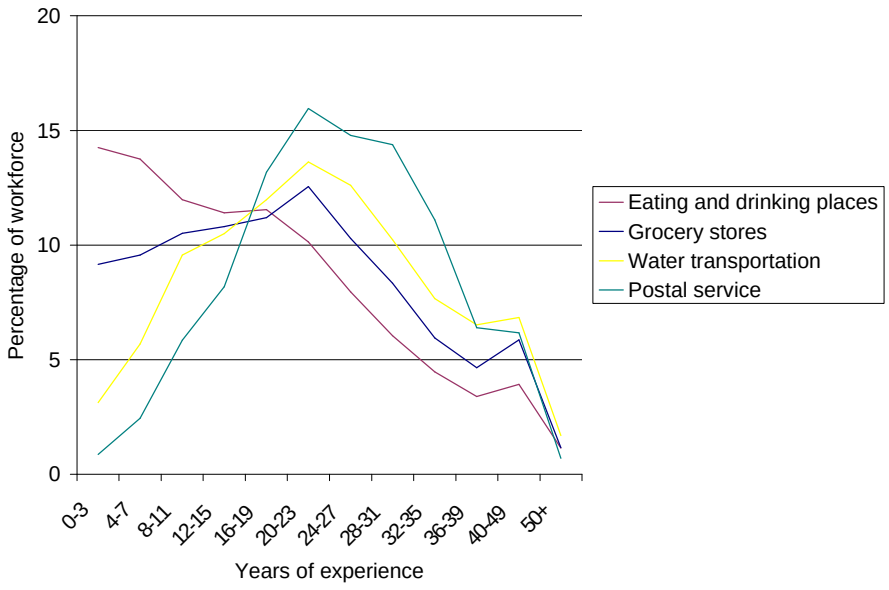
Figure 24 expands the scale of figure 19 and omits the Navy line so that differences between civilian workforces are easier to see. The chart illustrates the range of experience profiles across the CPS industry classifications we examined:

- Only eating and drinking places follow the pattern of numbers of workers falling as years of experience increase. And even here the pattern is much less pronounced than in the military, starting out with 14 percent at 0-3 years, falling slightly to 12 percent at 16-19 years, then declining at a faster rate to 3 percent by 36-39 years.
- Grocery stores have a fairly even distribution of 9-12 percent of workers in each 4-year interval from 0 to 28 years, after which there is a smooth decline down to 5 percent in the 36-39 year interval.
- In the more senior workforces, water transportation[42] and postal service, the proportion of workers rises over the first 24 years of experience. Since this is the number of years after leaving school, it must be rising due to lateral entry—people leaving other industries and entering these. Nevertheless, it does indicate a workforce that is older and more experienced, even if some of the experience was gained in other industries.

These differences across workforces vary both by required skill mixes and by industry structure, such as private vs. public employment and degree of unionism. In contrast, experience profiles in the Navy don't vary much from one rating to another. So Navy experience profiles are not only more junior by design than even the most junior civilian workforces, they are also less variable and adaptable to different experience requirements in different skills.

42. This index includes CIVMARs but also includes numerous ashore and inland waterway personnel, such as managers and administrators, dockhands, stevedores, secretaries, and ticket and reservation agents.

Figure 24. Experience profiles across four civilian workforces



Appendix B annex: Data differences and limitations

In the main text, the section titled "MSC and USN comparability" illustrates differences in experience levels between the Navy and civilian employers. There are critical differences, however, between Navy and civilian data, the most important being how to define years of experience.[43] For the Navy, years of experience equals the length of

43. Our Navy data come from personnel inventories in the Enlisted Master Record (EMR) and are averages of March 1995, 1999, 2002, and 2003. Each record in the EMR contains a Length of Service (LOS) variable that gives that individual's total length of active-duty military service. Any breaks in service or unauthorized absences are subtracted, and Reserve duty during breaks in service is not counted. However, a small number of recruits are active-duty veterans of other services, and this time is counted in length of service. Students were excluded from the EMR data using the accounting category code.

    The best data source for civilian employees is the Department of Labor's Current Population Survey (CPS), which does not have a direct measure of years that people work in a particular industry, or even of total years of full-time work. Instead, we must infer years of work experience from the number of years since leaving school by subtracting the date that a person completed school from the date of the survey. Although most people spend most post-school years working, if someone has been out of the workforce, this won't be reflected in our civilian profiles.

    The Bureau of Labor Statistics reports results from its Current Population Survey (CPS) by industry. We looked at ten CPS industry classifications, chosen to reflect industries similar to Navy branches, a range of experience and skill mixes, and both public and private civilian employment. The ten industries we chose, by their 3-digit CPS designators, are 020–Landscape and Horticultural Services, 360–Ship and Boat Building and Repairing, 362–Guided Missiles, Space Vehicles, and Parts, 412–U.S. Postal Service, 420–Water Transportation, 421–Air Transportation, 591–Department Stores, 601–Grocery Stores, 641–Eating and Drinking Places, and 901–General Government, N.E.C.

active-duty military service. For civilian workers, however, years of experience is measured by total years since leaving school. Navy and civilian experience measures, then, differ for two main reasons, both of which mean that the Navy experience measure will be lower:

- On one hand, Navy experience is military experience only. If someone worked in another industry before joining the Navy, or had a break in service with some private employment, this is not reflected. On the other hand, civilian experience counts any employment, not just employment in a particular industry.
- Navy experience counts years actually on active duty, while civilian is total time since leaving school and includes time not in the labor force. We do exclude students from the Navy measure to make it more comparable to time since leaving school. Taking students out lowers the proportion of Navy enlisted with very low years of service, but this proportion remains high relative to civilian workforces.

Another important thing to realize is that both sources of data are cross-sectional, showing all Navy enlisted nonstudents or the CPS survey sample at a certain point in time. The data are not longitudinal and do not track individuals across time and across jobs. From these data, we can say that the average individual in an industry has a certain number of years of experience, but we can't tell the average amount of time that individuals stay in one job or in one industry. These numbers will differ because of differences in entry cohort size and differences in movement from one type of job to another within industry.

Furthermore, even the Navy data just show total military service, not tenure in one particular job. Any quicker rotation from job to job within the military than in the private sector is not captured.

Appendix C: Background on the transition of shipboard engineering billets from Engineering Duty Officers to URL Officers

The use of unrestricted line (URL) officers in engineering positions aboard ship has been USN policy since about 1976, when using Engineering Duty Officers (EDOs, or EDs) on most USN surface ships was discontinued to create more URL billets.

In a letter dated 12 July 1976, the CNO "cited a need to improve the Navy's capabilities in the design, acquisition and maintenance of ships and shipboard systems," noting that "EDs have long been associated with these matters in both technical and managerial positions." He ordered "a comprehensive review of the fundamental requirements for engineering officers and a clear determination of the role of those officers in the Navy."

The resulting report[44] stated that:

> The fundamental discontent is with the Navy's continuing problems in areas largely within the purview of EDs....since the Navy currently has major problems with cost growth in shipbuilding programs and with claims disputes with shipbuilders. Additionally, the readiness of ships and combat systems, adequacy of logistics support, and costs and duration of ship overhauls are other current issues.

The report indicated a perception among naval officers and civilians that "EDs have turned away from their role as technical experts and as a result, their capability and effectiveness have declined" and that "URLs have also turned away from technical matters and their knowl-

44. "Report of Study Group To Determine Navy Requirements for Engineering Duty Officers and the Actions To Satisfy Those Requirements," Aug 1976, chaired by Vice Admiral C. R. Bryan.

edge of the details of maintenance and operation of their ships has declined." According to the report, "The idea that Naval officers should be technically oriented professionals who know the details of their ships was overtaken by the notion that Naval officers should be managers."

The report's major conclusions included the following:

3. The Navy needs an ED community of highly trained, experienced, professional naval engineers to technically direct the design, acquisition, and maintenance of ships and combat systems.
4. EDs should provide increased technical leadership and direction of design, acquisition, and maintenance of ship combat systems.
5. EDs should contribute to technical leadership and direction of Navy and DOD command and control, large area surveillance, and telecommunications systems.
6. EDs should have sufficient capability in financial management and contracting to carry out their assigned responsibilities.
7. There is a need for URL subspecialists in the design, acquisition, and maintenance of ships and combat systems to provide operational experience and that degree of direct technical contribution appropriate to their subspecialty.
8. Many of the current ED billets at sea should be redesignated for URL officers to make more engineering experience available to them. ED billets should be limited to those required for:
   - — Basic sea experience
   - — Tender (AD/AS/AR) repair officers
   - — Some carrier main propulsion assistants.

Although the EDO's capability as shipboard operating engineers was not questioned by the report, the operating billets were the ones that were sacrificed to enable URLs to gain more technical experience and for EDOs to continue in shore engineering functions, such as acquisition and maintenance planning.

Appendix D: USN and other navies compared

During the course of this study, we discussed many issues with the Naval Attachés of a number of foreign embassies in Washington, DC, and, at the invitation of the Embassy of the United Kingdom, we spent a few days with the Royal Navy's Second Sea Lord organization at Portsmouth, England. (The Second Sea Lord functions are similar to those of our Chief of Naval Personnel.) While in Portsmouth, we also visited the Royal Fleet Auxiliary, the English agency that is most like our Military Sealift Command.

Some of the results from those discussions follow.

Differences between USN and ship rosters of other navies

We were most interested in the issues that generate manpower requirements in U.S. Navy ships and how they are handled in other modern navies. (Appendix E lists the interview questions posed to foreign navies.) As indicated in table 15, there are many billets in U.S. ships that do not exist in the roster of the ships of other navies. We were surprised to find that the Royal Navy embarked a full-time physical training instructor for each of its ships; other than that, however, the other navies are consistent in using a collateral duty system similar to the process used on ships of the U.S. Navy before 1973.

Are foreign Navy operations sufficiently similar to USN operations to provide adequate manning benchmarks for the USN surface ship Navy? Many are. The British, Germans, and Dutch have a seagoing culture and a long history of operation of technically advanced surface combatants. The British have relatively long deployments to the Falklands and to the Middle East, and the Dutch continue to deploy to former Dutch colonies in the Caribbean periodically and for NATO excercises, as do the British, Germans, French, and others. For these reasons, we think some lessons can be learned from these navies that have application to USN operation.

Table 15. Enlisted billets that do not occur in the roster of the ships of other navies[a]

Country	United States	Japan	France	United Kingdom	Germany	Nether-lands
Command Master Chief	Full-time billet	Collateral duty	Collateral duty	Collateral duty	Collateral duty	Collateral duty
Alcohol Counselor	Full-time billet	Collateral duty	Collateral duty	Collateral duty	Collateral duty	Collateral duty
Career Counselor	Full-time billet	Collateral duty	Collateral duty	Collateral duty	Collateral duty	Collateral duty
Master-at-Arms	Full-time billet	Collateral duty	Full-time billet	Collateral duty	Collateral duty	Collateral duty
Religious Program Coordinator	Full-time billet	Collateral duty	None	Collateral duty	Collateral duty	Collateral duty
Legal Clerk	Full-time billet	Collateral duty	Collateral duty	Collateral duty	Collateral duty	Collateral duty
Physical Trainer	None	Collateral duty	Collateral duty	Full-time billet	Collateral duty	Collateral duty

a. According to NAVMAC, U.S. "full-time billet" designation applies to surface ships with crews larger than 250; these functions are collateral duty on submarines and smaller ships, such as minesweepers and patrol craft

Ship service functions

We were also interested in how other navies handled the assignments of food service and laundry, to see if they sent newly reporting technically schooled graduates to laundry and mess cooking functions, as is the USN practice. Also, since most other navies do not have a shipserviceman function, we examined who did the laundry and how they provided for the grooming and health and comfort items for the crew (see table 16).

In general, we found that foreign navies did rotate personnel from other ship departments into the galley/scullery to share in clean-up responsibilities, similar to USN practice. But a major difference is that the other navies either do not use technically trained personnel for this purpose or they rotate personnel in and out of the galley on a short-term (sometimes daily) basis, to ensure that technical skills don't atrophy.

Table 16. Ship service assignments

Country	United States	Japan	France	United Kingdom	Germany	Nether-lands
Food Service	Junior enlisted, regardless of source, serve 3 to 4 months as mess-cooks serving food, and clean-ing mess-decks and galley.	Mess-cooks like U.S	Dedicated personnel start as apprentice cooks Juniors rotate on compart-ment clean-ing.	Communal Party 4- to 6-month assignments for juniors. After 4 years' schooling, highly trained Artificers[a] do not serve.	Officers eat cafeteria style. Juniors rotate on food ser-vice and compart-ment clean-ing, daily.	Stewards serve all ranks, Officers and CPO, restaurant style; ratings and petty officers buffet style. Ratings and petty officers rotate food service and cafeteria cleaning every 2 weeks.
Laundry	Ship Service-men aug-mented by junior enlisted on additional duty similar to mess cooks.	Individual does own	Dedicated people recruited specifically for the job.	Civilian contractors, usually foreign national, either Hong Kong Chinese or Gurkha.	2-3 short-term con-scripts (with less than 6 months of service remaining)	2-3 people recruited specifically for the job, serve about 4 years then leave the service.
Hair Grooming	Ship Service-man rating.	Cut each other's hair, on a cash basis.	Dedicated on large ships and volunteer on small ships.	Cut each other's hair, on a cash basis.	Cut each other's hair or go ashore.	Ashore.
Ships Store	Ship Service-man rating with Supply Officer man-aging the stock and accounts.	Ship Service-man rating with Supply Officer man-aging the stock and accounts.	Specialist rating with Supply Officer man-aging the stock and accounts.	Civilian contractor from the Navy and Armed Forces Insti-tute, similar to NEX.	Ship's store operated by volunteers with Supply Officer man-aging the stock and accounts.	Ship's store operated by volunteers with Supply Officer man-aging the stock and accounts.

a. RN term for technical specialists schooled for 4 years before fleet assignments.

As shown in table 16, there were more differences between foreign navies and the USN with regard to laundry services. Rather than rotate technically trained personnel for laundry duty, as the USN does, most foreign navies permit crews to do their own laundry (an option that is becoming increasingly popular with USN crews) or they employ personnel especially recruited for that duty.

Shipboard engineering officers

We found that the Royal Navy system of separate branches for officers was typical of the other navies. In general, the Royal Navy breaks down its shipboard officers into three branches: weapons, logistics, and engineering. There is also a small weapons engineering branch. Officers in the weapons branch are in the command succession and can rise to the position of First Sea Lord,[45] whereas supply officers in the logistics branch and engineers in either the engineering branch or the weapons engineering branch are not. Also, at the grade of senior Lieutenant Commander, Royal Navy officers enter another career phase, which is not branch specific,[46] that prepares them for higher level joint and combined assignments and for duty in the various procurement agencies of the Ministry of Defense.

Nearly all engineering officers in Royal Navy ships are Marine Engineers. Typically, after about a year at the Naval Academy, at Dartmouth, officers are commissioned. Those volunteers with appropriate qualifications are sent to national universities for degrees in engineering. These degreed engineers specialize in either Marine Engineering, Weapons Engineering, or Aeronautic Engineering. Marine Engineers serve in increasingly challenging positions within the engineering departments of the ships and in engineering branch assignments ashore relating to fleet and dockyard maintenance. They also serve at higher grades in the procurement agencies.

45. CNO equivalent.

46. The Royal Navy just recently adopted this significant change in career paths for officers.

Port engineers

We asked each navy if it used a port engineer system for continuity, as the U.S. surface Navy has done since 1987. In general, the navies said they had found such a system unnecessary since they employ responsible professional engineers in the crew of the ships (see table 17).[47]

Table 17. Comparison of shipboard Engineering Officers in the various navies

Country	United States	Japan	France	United Kingdom	Germany	Nether-lands
Ship Engineers	SWO/LDO	Engineer Branch, Specialization starts at Lt. Successful career engineers, can become COs.	Engineer Branch	Engineer Branch	Engineer Branch	Engineer Branch

Sleep deprivation and watchstanding

We asked the various navies how they handled sleep deprivation and body clock disruption in their ships.

The Royal Navy does dog the evening watch but relaxes the necessity for watchstanders to participate in all other maintenance and training evolutions. For example, in Royal Navy warships, reveille goes at 0700, and the prior mid-watch can sleep in *until the midday meal.* Also the ongoing mid-watch has the afternoon off. (Comparatively, in most USN ships, reveille typically goes at 0600 and the mid-watch can sleep in only until 0630. When not on watch, during the daytime, watchstanders are expected to join their shipmates in normal maintenance work and training evolutions. In addition, they are required to

47. We note, however, that MSC and the private sector do use port engineers even though they also have professionals aboard ship, and have found the practice beneficial.

participate in work and training during the morning, before going back on watch in the afternoon.)

Our research found that the concept of dogging the evening watch originates with the Royal Navy of the Napoleonic Wars, at the beginning of the 19th century. In those days, warships were crewed to man gun barrages on both sides of the ships and to man the yards in order to trim the sails and improve propulsion and maneuver when engaged with an enemy. Thus, there were enough people in the crew to man the yards when not engaged, on a two-section basis. Typically, they rotated 4 hours on and topside and 4 hours off and below. To increase the chances for the below watch to have more time in their hammocks on successive nights, the evening watch was "dogged" and each group spent more time below, during darkness, on successive nights.[48]

On a three-section rotation, dogging the watch still permits the watch to rotate; however, it affects the individual's body clock in ways that do not occur on a port and starboard watch rotation.

Table 18 displays the system in the Royal Navy. There is sufficient sleep for the individual, but, because they are rotating three sections through seven watch periods in a day, there is some body clock disruption for watchstanders. Fortunately, they have de-coupled the workday for watchstanders, and a Royal Navy sailor can expect 7 to 8 hours continuous sleep every night.

Vesting and retirement options

We found that the other navies vested individuals in the retirement system differently than is customary in the U.S. Navy, and they also held on to their talent much longer by delaying retirement to a much later stage in life than is done in the U.S. Navy. Table 19 summarizes our findings.

48. Samuel Leech, *A Voice from the Main Deck*, Naval Institute Press, 1999 (originally published 1843).

Table 18. Royal Navy watchstander rotation with dogged evening watches[a]

	Watchstanders			Day
Seven Rotation	**Standard 1 in 3 Watch System**			**Workers**
(dog evening)	**Day 1**	**Day 2**	**Day 3**	
0000-0400	A	B	C	
0400-0800	B	C	A	
0800-1200	C	A	B	3
1200-1600	A	B	C	3
1600-1800	B	C	A	1
1800-2000	C	A	B	
2000-2400	A	B	C	
Work (incl. watch)	12	10	10	7
Free Time a.	12	14	14	17
Max Uninterupted	7	8	8	10

a. Free time in this table is non-work or non-watch time for meals, sleep, and other personal activities.

Table 19. Career personnel retirement in other navies

Country	United States	Japan	France	United Kingdom	Germany	Nether-lands
Entry into Retirement System	Upon entry into service	At E-4 become per-manent em-ployee with benefits	Upon entry into service	Age 22	If 9-month conscript and extend for 23 months	Upon entry into service Officers upon com-missioning
Retirement from Service	20 to 30 years service Age 37 +	CPO -54. Lcdr and Cdr - 55. Capt -56. Adm - 60.	1st step 15 yr. 2nd step 25 yr. 40 yr. for full right pen-sion + Com-bat veterans get addition-al bonus CDR52-54 Capt56-58 ADM60-62	Career en-listed 22 yr., (up to age 50). Lcdr -50. Cdr - 52. Capt.-55.	Enlisted and LDO Lcdr - 54. (no line Lcdr retire) Cdr - 58. Capt - 60. Adm - 61.	CPO -52. up to Lt - 55. Lcdr and up-58. Flag ranks: ages 60-62 being considered.

If a U.S. Navy sailor enlists at age 17, he can retire at age 37. A passed-over Commander can retire at age 42; a Captain must retire after 30 years at age 52. Comparatively, the other navies hold on to their enlisted for as much as another 15 to 17 years, and their officers for an additional 10 to 18 years.

Lateral entry of skilled personnel

All the navies we talked to, except the German and French Navies, found our questions about lateral entry unusual because they recruit only from the bottom.[49] The German Navy gets more than 30 percent of its technically trained personnel from industry, often in reaction to conscription. These more highly trained volunteers enlist for either 23 months or 4 years beyond their 9-month conscript service and enter the service at ranks and paygrades commensurate with their experience and skill. Table 20 shows the total numbers entering the German Navy over the last 3 years and the number and proportion of those that are lateral entry, plus the rank at accession.

Table 20. German Navy lateral entries

	2002	2003	2004
Entries	1,500	1,617	1,330
Lateral Entries	450	634	385
Percent Lateral Entry	30.0	39.2	30.0
CPO	6	6	5
PO1	376	554	341
PO2	68	74	39

The only other Navy we talked to that had significant lateral entry was the Israeli Navy, which, like the German Navy, also got personnel through conscription pressures.

49. The Royal Navy is considering direct entry for technically skilled people at the E-7 level, on a trial basis, because of shortages at E-5 and E-6. They say they expect there will be a need for "leadership development."

The French Navy gets highly trained volunteers, not because of conscription pressures, but in reaction to the high level of unemployment in France. These skilled individuals are recruited into the service at ranks and paygrades commensurate with their skill and experience.

Both the English and French Navies recruit a small number of candidate technicians and then school them for as long as 4 years before they enter the fleet, at a rank comparable to E-5. All people entering the Royal Netherlands Navy are volunteers. A person chooses his branch before entry and then has 10 to 12 weeks' schooling followed by branch-related training. Typically, a person spends about a year ashore in a training status before joining a ship (see table 21).

Table 21. Skilled personnel entry in other navies

Country	United States	Japan	France[a]	United Kingdom[b]	Germany	Nether-lands
Use of Lateral Entry	Recruit E-1	Recruit E-1	Recruit E-3 Skilled technician lateral entry Mechanics receive extensive training	Recruit E-3 Artificers receive extensive training	(1) Con-scripts (2) Recruit E-3 (3) Skilled technician lateral entry	Volunteers 12 months ashore in training before first ship

a. France does not have ranks equivalent to E-1 or E-2.
b. The United Kingdom does not have ranks equivalent to E-1 or E-2.

Numbers of personnel on watch

We asked each navy its policy for manning bridge watches. Again, this question comes from watching the MSC process of supporting a bridge watch officer with two able-bodied seamen: a steersman and a lookout. In some cases, the respondents told of personal experiences when serving as exchange officers in U.S. Navy ships. They were amazed at the crowding on U.S. Navy ship bridges and, in one case,

at the perceived absurdity of keeping two bridge-wing lookouts posted in sub-zero temperatures while steaming in a Norwegian fiord, when more than a sufficient amount of personnel and radar assists were employed in the bridge.

Table 22 compares the current USN bridge watch scheme with the process used by other navies. The Japanese Navy follows the U.S. Navy very closely, but there appears to be a lag in adjusting the bridge watch staff. The other navies seem to have operated with reduced size bridge watches for a number of years. The French Navy has two officers on watch at a time, as do the U.S. and Japan. The Royal Navy, the German Navy, and the Royal Netherlands Navy are comfortable with only one officer on watch at a time. However, with only one officer on watch at a time, they always have a separate lookout. Finally, both the German and Royal Netherlands Navies rely heavily on automatic steering instead of having a dedicated helmsman.

Table 22. Bridge watchstanders

Country	United States	Japan	France	United Kingdom	Germany	Nether-lands
Bridge Watch	OOD JOOD Ship Control Console Bridge Specialist Lookout Aft	OOD JOOD QMOW BMOW Helmsman EOT(JV Talker) Messenger JL Talker Lookout Stbd (JL) Lookout Port (JL) Lookout Aft (JL)	OOD JOOD Helmsman Signal Bridge Supervisor Recorder	OOW Helmsman Lookout	OOW (Auto Steer) Lookout Signalman	OOW (Auto Steer) Lookout Signalman

Attempts at reduced manning in other navies

All the navies we talked to are attempting to produce new ships with much smaller crews. Japan is proceeding with two 16,000-ton DD(X).

In conjunction with the Italian Navy, France plans a new class of missile destroyers. Originally conceptualized as having a crew of 230, now the goal for the French ships is for a crew of 110 with a margin of 20. Also, the current French nuclear aircraft carrier has a crew of 1,256 plus an air group of 610. A follow-on conventional carrier, to be introduced in 2014, will have a crew of 700. The current 7 ships of the ASW destroyer class have crews of 220, the replacement ASW frigate (with about the same displacement) will have a crew of 100. The current assault ship has an operating crew of 240, the replacement design will be crewed by 160. Also, the French Naval Officers we talked to spoke with pride that they have redesigned the arrangements and layout of the CIC of their newest missile destroyer and now man it with 12 people where they believe the DDG-51 design requires 40 people. (The DDG-51 Flight II SMD shows 38 billets in CIC without counting the 9 billets associated with signal exploitation, during Condition I.)

The German Navy is in the design phase for its new F-125 surface combatant. It is considering a number of different concepts in manning the F-125. The navy hopes to have unmanned machinery spaces. It will have an integrated monitoring and control system linking all shipboard systems: propulsion, auxiliaries, HVAC, ship support, sensors, and weapons, including deployed weapons and sensors. The same monitoring and control system will support ship operations and also conditioned based maintenance, for all shipboard systems.

In addition, the German Navy hopes to have the capability to remotely monitor systems in unmanned sister ships alongside, in port. It intends to have the communications interfaces necessary for remote diagnosis and maintenance of all shipboard systems through land-based support units. This integrated monitoring and control system will be interfaced to service-wide administrative and management systems.

The German Navy intends to deploy fewer food service personnel on the F-125 than on legacy ships. The number of cooks can be reduced somewhat if food (not convenience food) is prepared in advance, an initiative also being explored by the USN. In addition, officers and chief petty officers will be served cafeteria style, eliminating the need for many stewards.

Appendix E: Interview questions for foreign navies

Manning policies

- How do you determine what the required manning levels of a ship should be?
- To what degree do you actually man ships to your desired levels and qualifications?
- Do you have dedicated billets for alcohol counselors, career counselors, Master-at-arms, Command Master Chiefs, religious program coordinator, legal counselors, physical training supervisors, etc.?
- Are there times when other specialists—such as a Doctor, Dentist, Chaplain, or legal advisor—are embarked?
- Do you use dedicated personnel for food preparation? If not, how is food broken out, and prepared, plus who is responsible for cleaning the galley and other cooking areas?
- Do you use dedicated personnel for food service? If not, how is food broken out, and served, plus how are the dish washing scullery / dining hall areas cleaned?
- Do you use dedicated personnel for laundry? If not, how is this accomplished?
- Do you use dedicated personnel for hair grooming? If not, how is this accomplished?
- Do your ships operate a ship's store for personal health and comfort items for the crewmembers? If so, what rating or specialist operates the store and is accountable for the merchandise?

- Do you use dedicated personnel for berthing compartment and passageway cleaning? If not, how is this cleaning accomplished?

Ship operation

- What are the duties of the watch officer underway? (1) On the bridge, (2) in the engine room, (3) in the combat information or weapons control centers.
- How many officer and rating positions or watch stations are manned on the bridge, underway? (1) During peacetime steaming conditions, (2) under wartime steaming conditions, and (3) under battle or action stations.
- How many officer and rating positions or watch stations are manned throughout the ship, underway? (1) During peacetime steaming conditions, (2) under wartime steaming conditions, and (3) under battle or action stations.
- Where are lookouts positioned, and at what hours? Do they have other duties? Do they wear earphones? How many lookout stations are manned at one time?
- Who reads flashing light, semaphore, and flag signals? Who sends visual signals?
- Do you have a watch in the after steering machinery room? Under what steaming conditions?
- Do you have a watch in the shaft alley?
- Are your ships equipped with fixed remotely controlled fire-fighting systems?
- Are your ships equipped with remotely controlled watertight closures?
- Do you have any data or studies that might help us quantify the effects of sleep deprivation or interruption due to rotating watches?

Maintenance and logistics

- The U.S. Navy organizes maintenance in three tiers: Organization level, Intermediate level, and Depot level. Are your crews trained and your ships manned to do both the first and second lines of maintenance? If not, where and how is the second line or intermediate level of maintenance accomplished?

Training

- How do your national schooling process and, if appropriate, your conscription laws affect your recruiting and training strategy?
- How do your national schooling process and, if appropriate, your conscription laws affect your sourcing of officers?
- Do you have any data on the average total time your officers and enlisted ratings spend in training over a career?
- Do you have any data on the average total time your officers and enlisted ratings spend in shipboard billets over a career?
- Do you train all crewmembers in small arms and keep them qualified? If not, what portion do you train and for how long? How frequently are they retrained or expected to requalify?
- Do you train all crewmembers in fire fighting and damage control, and keep them qualified? If not, what portion of the crew do you train and for how long? How frequently are they retrained or expected to requalify?
- Do you recruit technical ratings directly from civilian life with appropriate prior training?
- Do you cross-train ratings in more than one specialty area?
- Are your officers university graduates in the specialty that you employ them?
- Do you add additional enlisted billets to your ships for apprentice training or seasoning new recruits?

- Do you add additional senior enlisted or warrant officers to your ships to oversee the training of juniors?

Career progression

- Are your engineering officers in the command succession?
- What other types of officers serving on your ships are not in the command succession?
- Is the second in command an executive officer (as in the U.S. Navy), or is he the next most experienced officer in the command succession (as in the typical commercial manning construct)?
- How do you develop the generalist officer that might eventually move to the highest levels of command?
- Do you add otherwise unnecessary officer billets to your ships for smoothing career progression of various officer warfare specialties?
- How frequently are your personnel rotated from position to position?
- Typically, how long might a chief engineer or Commanding Officer serve aboard ship in their positions before leaving the service or being rotated out to another ship or shore billet?
- Are there opportunities and mechanisms for a highly qualified enlisted person to move into the officer ranks?
- Can you pay and place highly qualified people laterally within the naval hierarchy?
- At what ages do your career ratings retire? Do you have mandatory retirement ages? Do they vary by rank?
- At what ages do your career officers retire? Do you have mandatory retirement ages? Do they vary by rank?

Appendix F: Illustrative pilot programs for comparison testing of Navy manning using the MSC manning construct

Introduction

This appendix outlines two possible pilot programs that might be adapted to test and prove Navy manning using the MSC manning construct. The first proposed pilot program builds on an ongoing effort to civilian-man the nonrepair and customer support portions of two submarine tenders that currently have Navy manning. The second pilot program suggests adapting a portion of a conceptual program to civilian-man frigates that are employed in counterdrug operations, to test the use of an MSC manning construct in a Navy-manned frigate.

Background

Over 30 years ago in an attempt to extend the useful life of Navy Combat Logistics Force (CLF) ships, older oilers were assigned to the Military Sealift Command for operations. As this concept became acceptable, over time, all CLF ships and towing ships migrated to MSC operations. These subsequent transfers were done to reduce the operating cost of the CLF because MSC mans CLF ships with civilian mariners to levels roughly one-third to one-half as large as the previous Navy crew. All indications are that the civilian-manned CLF is as effective as the previously Navy-manned CLF.

Efforts are under way to man the ship operation portion of command ships, salvage ships, and submarine tenders with civilian mariners. This offers a unique opportunity for the Navy to test reduced crew concepts on ships with nominal disruption or cost. Ships of the same

class as MSC-manned ships could be manned and operated similarly with military crews using watchstanding, maintenance procedures, and work practices of the MSC ships. In both proposals, there are at least two ships of the same class operating for an extended period, one with MSC manning and another with Navy manning to the same levels as the MSC manned ship. This then permits the Navy to:

- Verify Navy capability to operate Navy ships with crews reduced to sizes comparable to the MSC/commercial construct
- Identify standard Navy operational, reporting, and administrative procedures and requirements that require changes to enable reduced-size crews
- Form the basis for transition to reduced-size crews on:
  - — Other legacy ships
  - — LCS and other new construction ships.

These pilots differ from other efforts, such as the Smart Ship program, which necessitates significant alterations to ship and machinery control systems, or optimal manning efforts that eliminate less essential capabilities or remove functions from a ship for more central support ashore.

The MSC manning construct

In general, MSC uses a commercial model for structuring a manning schedule for a civilian-manned Navy ship. All MSC afloat-personnel are U.S. citizens and civil service mariners. Highly trained and experienced Coast Guard licensed mates and engineers are supported by a limited number of Coast Guard documented unlicensed personnel. MSC also employs mariners to perform supply, messing, medical, administrative and electronic repair functions. On the CLF ships, a small military detachment of Navy sailors perform communications and cargo management functions. On the command ships, salvage ships, and tenders, the Navy detachment is augmented significantly with Navy specialists to perform the principal mission—whether it be command and control, salvage, or repair and support. Unlike most of the former Navy ships now manned by CIVMARs, the command ships

and probably the salvage ships and tenders will retain both their Navy status and their Navy commanding officer.

Current tender program for civilian manning

The Navy intends to shift its two submarine tenders to civilian manning, one in 2008 and the other in 2009. The manning construct will be similar to that of the command ships. The ships will retain their Navy commanding officer and their official USS status. Military personnel will provide repair, supply support, and other services, such as chaplain, medical / dental, legal, postal, and disbursing, for both customers (the submarines being repaired alongside) and the embarked military personnel. MSC civilians will perform such ship functions as navigation, communications, cargo / stores handling, rigging services, small boat operations, propulsion and electric plant operations and maintenance, plus food preparation and service, laundry / dry-cleaning, and ship supply support.

USS *Emory S. Land* (AS-39) is currently at LaMaddalena, Sardinia. During 2008, the repair department of about 390 Navy people will stay the same, but a CIVMAR force of 173 and a MilDet of another 165 Navy sailors, for a total of 338, will replace the original Navy operating crew of 581—a reduction of 42 percent. USS *Frank Cable* (AS-40) is currently at Guam. During 2009, the repair department of about 613 Navy people will stay the same, but a CIVMAR force of 157 and a MilDet of another 194 Navy sailors, for a total of 351, will replace the original Navy operating crew of 599—a reduction of 41 percent.

Both ships will receive habitability modifications costing about $11.0 million and watchstanding modifications costing about $16.0 million. The latter include upgrading the steering system, modernizing the navigation system, upgrading dumb waiters and elevators, improving the fire detection system and moving displays from Damage Control Central to the bridge and quarterdeck, installing a watertight door between the fire room and the engine room, replacing the O2N2 plant with a membrane system, and adding remote monitoring and alarm systems for machinery spaces.

Patrols of the Caribbean and western Pacific to intercept drug smugglers

For a number of years, the Navy has provided patrols to intercept Go-fast-boats smuggling drugs from Colombia and Venezuela through the Caribbean and the western Pacific. Often a Navy-manned FFG or a civilian-manned TAGOS ship serves as the platform for a USN surveillance helicopter and a small Coast-Guard-provided Law Enforcement Detachment.

Pers Tempo and Ops Tempo factors restrain the extended employment of Navy-manned ships assigned this function. Such operational restraints are not applicable to the CIVMAR-manned TAGOS ships, but only a limited number of survey ships can be assigned this role. Consequently, it may be prudent to consider civilian-manning some of the currently Navy-manned FFGs for the mission.

Key factors in constructing a Navy crew to the MSC manning construct

When considering the development of a new Navy manning process that mirrors the MSC manning construct, a number of key factors must be dealt with at the outset. For example, there are billets in the crew of a Navy ship that are there to address a variety of factors that arise when embarking a large number of young people in a ship. In the MSC manning construct, only mature crewmembers are used, and there is no necessity to have separate billets for a Command Master Chief Petty Officer, a Master of Arms, a Career Counselor, an Alcoholic Treatment Counselor, a Legal Clerk, a Religious Program Coordinator, a Physical Fitness Trainer, and so forth. Though these skills will be present in the tenders for support to the customers, they are not in the MSC manning construct and therefore are not needed for Navy personnel performing ship functions in lieu of civilian mariners. Also, because the number of Navy personnel used in testing the MSC manning construct needs to be approximately equal to the number of CIVMARs they replace, they need to be comparably trained and experienced.

In these proposals, the Navy crew has a senior Quartermaster (day worker in the tender and a watchstander in the FFG) for bridge management and care of navigation equipment and materials. In the MSC construct, that is the responsibility of the 2nd Mate, who is also a watchstander. Also, the MSC construct burdens the Purser with disbursing support to MSC CIVMARs. Here, for the Navy crew, we add a junior Supply Corps officer to assist the Administration Officer and perform the disbursing function in the Purser department.

Also in the MSC manning construct, the watchstanders stand 4-hour watches on a three-section rotation, without dogging the evening watch. Instead, for the evening meal, the ongoing 2000-2400 watch personnel relieve the 1600-2000 watch for about a half hour so the on-watch personnel can eat their evening meal. This process, coupled with the fact that the watchstanders do not have other duties when off watch and thus can sleep 6 to 7 hours before going on duty, is the standard in the MSC manning construct. We would suggest that such a routine be adapted for the Navy crew during these tests.

Pilot program for tenders

In the following, we outline a proposed Navy scheme of complement that mirrors the MSC manning construct and builds directly from the MSC manning schedule.

An implementation strategy

MSC is expected to perform the Deck (including underway and in-port watches), Engineering (including underway and in-port watches), Hotel, Food Service, Communications, Check Cashing for CIVMARs, and an independent duty corpsman type of medical support for CIVMARs. Consequently, these are the functions that are expected of a Navy crew created to mirror the MSC manning construct. It is assumed that all alterations planned for the conversion to CIVMAR manning will be complete in both tenders, prior to this test.

A proposed Navy manning scheme of complement

In the following five tables, we show an illustrative Navy manning of the ship function portion of USS *Frank Cable* (AS-40). This manning is constructed in the same manner as the MSC manning schedule intended for the second tender to convert to civilian manning.

Table 23 shows an illustrative manning of the deck function using the MSC manning construct and experienced Navy personnel.

Table 23. Deck function

Dept.	Number	Rank	Designator/ NEC	Function
Deck	1	LCDR	6110	First Lieutenant
	3	LT	6120	Watch Officer (in-port and at-sea)
	1	LTJG	6110	Rigging Supervisor (LSO)
	1	WO-5	7110	Ship's Boatswain[a]
	1	WO-2	7110	Boat Manager
	1	E-8	0120	Boatswain's Mate
	1	E-8		Senior Quartermaster
	3 (W)	E-6		Helmsmen (QM) (Aft Sentry)
	3 (W)	E-5		Lookout (Fwd Sentry
	3 (W)	E-4		Deck Watch Utility man (Messenger
	2	E-6	0171	Boat Coxswains - (Rigger)
	2	E-5	0164	Boat Coxswains - (Rigger)
	4	E-4	0170	Boat Crew - (Rigger)
	1	E-7		Cargo Team and Flight Deck (Fire Party)
	4	E-6		Cargo Team and Flight Deck (Fire Party)
	4	E-5		Cargo Team and Flight Deck (Fire Party)
Total	30			

a. The Ship's Boatswain and all more junior non-watchstanding deck personnel are employed for at least 40 hours a week in preventive maintenance work when not rigging or operating boats. Watchstanders do not work more than 8 hours in a 24-hour day. Watchstanders do work 7 days a week. Watchstanders can take liberty when not on watch. Failure to report for duty or reporting incapacitated by alcohol is cause for administrative dismissal.

Table 24 displays an illustrative manning of the Communications function using the MSC manning construct and experienced Navy personnel.

Table 24. Communications function[a]

Dept.	Number	Rank	Designator/ NEC	Function
Comms.	1	LT	6290	Communications Officer
	1	ITCS	2379	Information System Technician
	1 (W)	ITC	2379	Information System Technician
	1 (W)	ITC	2379	Information System Technician
	1 (W)	ITC	2379	EKMS Manager
	1 (W)	IT1	2379	Information System Manager
	1 (W)	IT1	2379	Information System Manager
	1 (W)	IT1	2379	Information System Manager
	1 (W)	IT2	2379	Information System Manager
	1 (W)	IT2	2379	Information System Manager
	1 (W)	IT2	2379	Information System Manager
	1 (W)	IT3	2379	Information System Manager
	1 (W)	IT3	2379	Information System Manager
	1 (W)	IT3	2379	Information System Manager
	1	ITC	2381	Advanced Network Analyst
	1	IT1	2381	Advanced Network Analyst
	1	IT1	2381	Advanced Network Analyst
	1	IT1	2380	Network Security-Vulnerability
	1	IT2	2320	GCCS-M
	1	IT2	2330	SNAP-III
	1	IT2	2335	LAN
	1	IT3	2330	SNAP-III
	1	IT3	2330	SNAP-III
Total	23			

a. Watchstanders do not work more than 8 hours in a 24-hour day. Watchstanders do work 7 days a week. Watchstanders can take liberty when not on watch. Failure to report for duty or reporting incapacitated by alcohol is cause for administrative dismissal.

Table 25 displays an illustrative manning of the engineering department using the MSC manning construct and experienced Navy personnel.

Table 25. Engineering function

Department	Number	Rank	Designator/ NEC	Function
Engineering	1	LCDR	6130	Chief Engineer
	1	LT	6130	Main Propulsion Assistant
	1	W-4	7130	Auxiliary Officer
	1	LT	1160	Electrical Officer
	3	ENS	6130	Watch Officers
	1	EMCS	4671	Electrician
	2	MM1	4223	Refrigeration Engineer
	2	MMC	4296/4295	Deck Engineer-Machinist
	2	MM1	4541	Deck Engineer-Machinist
	3	MM2	4204	Watchstanders
	1	MM2	4222	Pumpman
	1	ETC	1419	Electronic Technician
	1	ET1	1678	Electronic Technician
	1	ET1	1420//1460	Electronic Technician
	1	EM1	4671	2nd Electrician
	1	IC2	4718/4721	2nd Electrician
	1	EM2	4650	2nd Electrician
	3	MM3	---------	Watchstanders
Total	27			

Table 26 displays an illustrative manning of the food and hotel services functions using the MSC manning construct and experienced Navy personnel.

Table 27 displays an illustrative manning of the Medical and Purser functions using the MSC manning construct and experienced Navy personnel.

Table 26. Food and hotel services function

Dept.	Number	Rank	Designator/ NEC	Function
Food and Hotel Services				
	1	LCDR	3100	Supply Officer
	1	LT	6510	Chief Steward
	1	W-3	7520	Assistant Steward
	1	YN1	----	Yeoman
	2	SK1	2828	Store Keeper
	2	SK2	2829	Store Keeper
	1	MSCS	3529	Mess Manager
	1	MSC	3529	Mess Manager
	1	MSC	3527	Mess Manager
	1	MS1	3525	Mess Manager
	4	MS1	----	1st Cooks
	5	MS2	----	2nd Cooks and Bakers
	9	MS3	----	3rd cooks
	5	MSSN	----	Mess Attendant
	36	SN/FN	----	Utility men
Total	71			

Table 27. Medical and purser functions

Dept.	Number	Rank	Designator/ NEC	Function
Medical	1	LT	2100	GP Medical Officer
	1	HMCS	8425	Corpsman
	1	HM1	8432	Corpsman
	1	HM2	8482	Corpsman
Purser	1	LCDR	6410	Administrative Function
	1	ENS	3100	Disbursing Officer
Total	6			

Summary of Navy manning of a tender to the MSC manning construct

The previous five tables illustrate a potential Navy manning scheme, with 30 Navy officers and enlisted in the deck department, 23 performing the communications function, 27 in the engineering department, 71 performing the food and hotel services, and 6 performing the medical and purser functions. This totals 157 Navy personnel that would replace 157 CIVMAR personnel in USS *Frank Cable* (AS-40) for performance comparisons with the CIVMAR crew in USS *Emory S. Land* (AS-39).

A proposed implementation concept for the tenders

In general, it is assumed that each tender receive the full conversion modifications, those for both habitability and watchstanding efficiency, as recommended by MSC.

The first ship to complete modifications, the AS-39, would be embarked with an MSC crew, plus most members of the Navy crew selected for operation of the AS-40 after her conversion in 2009. It is expected that these Navy personnel would be exposed to the MSC culture and trained in MSC procedures and routine, during a period of about 6 months, before they man the AS-40.

The AS-40 reduced Navy operating crew would then operate and maintain the AS-40 for approximately 9 to 12 months using, generally, MSC watchstanding, operation, maintenance, and other procedures gained from their experience aboard the AS-39. In addition, the AS-40 crew (or a special team of observers assigned to the ship) would be responsible for documenting:

- Specific USN operating, reporting, and administrative requirements that would need to be modified or deleted for the reduced crew concept to work on other Navy-manned ships
- Total hours worked by the crew for operations, maintenance, and administration.

After completion of the AS-40 experiment, the AS-40 would be operated by MSC similar to the AS-39.

Pilot program for frigates

In the four sections that follow, we (1) propose an illustrative CIVMAR manning schedule for an FFG, (2) show a proposed MilDet manning scheme of complement, to provide a basis for later comparisons, (3) display an all Navy manning substitution[50] for the CIVMAR manning, and (4) propose an outline of an implementation strategy. It is assumed that all alterations planned for the conversion to CIVMAR manning will be complete in appropriate FFGs in the program before the comparison tests.

An illustrative CIVMAR manning schedule for an FFG employed in drug ops

Table 28 displays an illustrative manning of an FFG with CIVMAR manning of the ship operation functions. This illustrative manning proposal follows closely the 1998 MSC proposed manning of a counterdrug FFG but is created with slightly different assumptions. Here we show a need for 60 people in the CIVMAR crew, while the earlier effort showed a need for 38. That estimate assumed that the bulk of administrative and supply support would be provided by the MSC T-AGOS project office, and a commercial helicopter would be employed. Neither assumption is applicable to this illustration.

A proposed MilDet manning scheme of complement for employment with the CivMar manning of an FFG

Table 29 displays an illustrative manning of a MilDet for the CIC and communications functions in a CIVMAR-manned FFG.

50. This substitution uses experienced Navy personnel in the MSC manning construct.

Table 28. Illustrative CIVMAR manning schedule for FFG

Dept.	No.	Rank	Pay-Code	Function
Deck	1	Master	101	Ships Captain
	1	1st Officer	103	Day Worker
	1	2nd Officer	106	Watch
	2	3rd Officer	108	Watch
	1	Boatswain (10 GT+)	150	Day Worker
	6	Able Seamen	161	Watch
	3	Ordinary Seamen	163	Watch
	2	Boatswain's Mates	164	Day Worker
	2	Ordinary Seamen	165	Day Worker
Purser	1	Purser	701	Day Worker
Engine	1	Chief Engineer	301	Day Worker
	1	1st Asst. Engineer	303	Day Worker
	2	2nd Asst. Engineer	305	Day Worker
	3	3rd Asst. Engineer	308	Watch
	1	Electrician (10K GT)	322	Day Worker
	1	Reefer Engineer	323	Day Worker
	1	Deck Eng.Machinist	328	Day Worker
	3	Unlic. Jr. Engineer	331	Watch
	1	Pumpman	332	Day Worker
	3	Electronic Technician	335	Day Worker
	2	2nd Electrician	351	Day Worker
	2	Engine Utility men	357	Day Worker
	3	Engine Utility men	365	Watch
Medical	1	Medical Service Off.	901	Day Worker
Supply	1	Supply Officer	801	Day Worker
	1	Jr. Supply Officer	802	Day Worker
	1	Chief Steward	804	Day Worker
	1	Chief Cook	822	Day Worker
	1	Yeoman-Storekeeper	823	Day Worker
	2	2nd Cook	840	Day Worker
	1	3rd Cook	841	Day Worker
	1	Cook-Baker	842	Day Worker
	5	Utility men	848	Day Worker
	1	Laundryman	850	Day Worker
Total	60			

Table 29. Proposed Navy MilDet manning for CIVMAR-manned FFG

Dept.	No.	Rank	Desig/NEC	Function
CIC	1	LT	1110	OIC -- TAO
	1	LTJG	1160	Info Sys/EKMS Mgr. TAO
	1	ENS	1160	NTDS-Ops Intel, -- TAO
	1	OSC	0326	CIC Supervisor
	1	OS1	0350	CIC Supervisor
	1	OS1	0348	CIC Supervisor
	1	OS2	0342	Trac Supervisor
	1	OS2	0324	Trac Supervisor
	1	OS2	0324	Trac Supervisor
	1	OS3	0342	Surf Det/Trac
	1	OS3	0342	Surf Det/Trac
	1	OS3	0324	Surf Det/Trac
	1	OSSN	----	DRT Plot
	1	OSSN	----	DRT Plot
	1	OSSN	----	DRT Plot
	1	CTT1	1733	DCC Operator
	1	CTT2	1733	DCC Operator
	1	CTT3	----	DCC Operator
	1	ITC	2779	TST Supervisor
	1	IT1	2780/2781	TST Supervisor
	1	IT1	2379	TST Supervisor
	1	IT2	2730/2735	Comm System Manager
	1	IT2	2730/2379	Comm System Manager
	1	IT3	2720	Comm System Manager
	1	STGC	0417/0466	Console
	1	STG1	0402/0466	Console
	1	STG2	0415	Console
Total	27			

Other military personnel

In addition to the Military Detachment of 27 Navy officers and enlisted shown in table 29, the CIVMAR-manned FFG will also embark a Navy helicopter detachment of 3 officers and 26 enlisted, plus a U.S. Coast Guard Law Enforcement Detachment of 8 Coast Guard personnel. Since the Ship Manning Document for the FFG, (the document that sets the requirement for Navy manning of an

FFG) identifies only 6 people in the flight deck fire party, we have not added additional people in this plan. Instead, we expect there are enough people assigned to create appropriate fire parties as needed.

A proposed reduced all-Navy manning scheme of complement substituting for MSC personnel in an FFG

Table 30 displays an illustrative manning of the ship operating functions in an FFG using the MSC manning construct and experienced Navy personnel. The officer designators and the enlisted NECs map the skills needed to match the more focused training of the MSC crew. The rank structure provides for the experience level possible with an MSC crew.

Table 30. Illustrative Navy scheme of complement for an FFG substituting one for one for CIVMARs shown on table 28[a]

Dept.	No.	Rank	Designator/ NEC	Function
Deck	1	CDR---CO	1110	Ship's Captain
	1	LCDR--XO	1110	Day Worker
	1	LT---OPSO	1110	Watch
	2	LTJG	1110	Watch
	1	BMCS	0120	
	1	QMC	----	Watch
	2	QM2	0230	Watch
	3	QM3	0230	Watch
	3	BM3	-----	Watch
	2	BM2	0170	
	2	BM3	----	
Purser	1	WO-2	7410	
Engine	1	LT Chief Engineer	6130	Day Worker
	1	LTJG MPA	6130	Day Worker
	1	WO-2 Aux	7130	Day Worker
	1	WO-2 Electric	7130	Day Worker
	3	GSMC	4128	Watch
	1	EMC	4650	Day Worker
	1	EN2	4291	Day Worker
	1	MM1	4296	Day Worker
	3	GSM2	4128	Watch

Table 30. Illustrative Navy scheme of complement for an FFG substituting one for one for CIVMARs shown on table 28[a]

Dept.	No.	Rank	Designator/ NEC	Function
	1	GSM2	4222	Day Worker
	1	ET1	1424/1321	Day Worker
	1	ET1	1491/1503	Day Worker
	1	ET1	1428/1460	Day Worker
	2	EM2	4673	Day Worker
	2	EN3	4303	Day Worker
	3	GSE3	4129	Watch
Medical	1	HMC	8425	Day Worker
Supply	1	LT Supply Officer	3100	Day Worker
	1	ENS Disbursing	3100	Day Worker
	1	WO-2 Food Service	7520	Day Worker
	1	CS1	3527	Day Worker
	1	SK1	2831	Day Worker
	2	CS2	3527	Day Worker
	2	CS3	3527	Day Worker
	5	CSSN	----	Day Worker
	1	SH3	----	Day Worker
Total	60			

a. The BMCS and all more junior non-watchstanding deck personnel and the MPA and all more junior non-watchstanding engineering personnel are employed for at least 40 hours a week in maintenance work. Watchstanders do not work more than 8 hours in a 24-hour day. Watchstanders do work 7 days a week. Watchstanders can take liberty when not actually on watch.

A proposed implementation concept for testing the CIVMAR and Navy manning concepts in FFGs

A program for civilian manning the Navy FFGs employed in the drug interdiction patrols is in its formative stage. The number of ships that might be involved, what types of habitability modifications may be possible, and what other alterations might be required have yet to be decided. Here we propose one way for manning an FFG with civilian mariners. Our illustration assumes that a small number of Navy personnel will be employed in the CIC, though CIVMARs are employed for the other ship functions. We also assume that the Navy will continue to provide the helicopter; however, if an outsourced civilian

helicopter is used, probably fewer helicopter people will be needed, as has been the UNREP helicopter experience. Finally, we assume that the Coast Guard Law Enforcement Detachment of about eight people will also embark while on patrol.

As a pilot program to compare Navy manning sized to the MSC manning construct, at least two FFGs need to be converted. Again, the sequence as suggested for the tenders might be employed. Let the reduced Navy crew substituting for the CIVMAR crew be trained on the first ship and employed in the second ship.

Appendix G: Proposed pilot program for a U.S. Navy warship using an MSC manning construct

Introduction

Background

Since 1972, the Navy has been gradually assigning Combat Logistics Force (CLF) and other support ships to the Military Sealift Command for operations. Now a few years into the 21st century, all the CLF ships that directly support fleet units in combat are manned by civil service mariners (CIVMARs) and operated by the Military Sealift Command.

When a CLF or other support ship (e.g., a command ship or a salvage ship) is manned by CIVMARs, the crew size is reduced by two-thirds, but the essential mission of the ship does not change.

We examined the ship manning practices of MSC, foreign navies, and the private sector and then identified differences with the manning practices used for USN ships that cause larger crews. We found no evidence that smaller crews on MSC-manned ships resulted in degraded performance. In fact, CIVMAR crew performance was equal to or better than that of USN crews.

We found a number of differences between the MSC and the Navy approach to acquiring, training, assigning, and compensating shipboard personnel. In addition, we have offered a number of remedies that the Navy could consider to rectify some of these differences, including testing these remedies with pilot programs to accomplish the following:

- Verify Navy capability to operate Navy ships with crews reduced to sizes comparable to the MSC/commercial construct.

- Identify standard Navy operational, reporting, and administrative procedures and requirements that require changes to enable reduced-size crews.
- Form the basis for transition to reduced-size crews on other legacy ships, LCS, and other new construction ships.

AS and FFG class pilot programs

Two pilot programs are suggested in appendix F. Both take advantage of intended conversions that may be made in the near term for civilian manning of submarine tenders and the special program frigates used in drug interdiction operations.

DDG–51 class pilot program

In the pilot program outlined here, we suggest testing the MSC manning construct in a DDG–51 class ship, a full-capability warship. Before applying the MSC principles of ship operation, however, we suggest reducing the DDG–51 crew from the current total manning requirement of 24 officers and 272 enlisted to 15 officers and 167 to 182 enlisted, for a total manning requirement of 182 to 198.

Table 31 presents the proposed changes to the crew size and the reasons for such changes. Although one change does require a modification to the DDG–51 ROC/POE, all missions now assigned to the warship remain, and the ship is manned to perform all designed missions, under wartime conditions.

Critical to adapting the MSC manning construct are the following concepts: adapting the MSC shipboard routine, watch rotation process, emphasis on and schedule of maintenance and work accomplishment, inviolability of off-duty time of watchstanders, and concentration of general training into one afternoon a week.

Another 16 enlisted billets—not shown in table 31—may also be removed by scaling the support staff down appropriately and training a few senior petty officers to perform the duties of juniors in the same ratings.

Table 31. Potential changes to crew size for DDG–51 (flight I and II)

Action	Officer	Enlisted	Total
Ship Manpower Document (7 August 2003)	**24**	**272**	**296**
Remove career progression and social requirements billets[a] and duplicate maintenance NEC	-9	-7	280
Substitute available petty officers for nonrated at battle stations		-20	260
Man the Rep-2, Rep-3, and dressing stations with co-manning (and man DCC, Rep 5, plus five Rep-2 and four Rep-3 leaders)		-62	198
Total	**15**	**183**	**198**

a. "Career progression billets" are those added solely to provide an opportunity for shipboard experience and onboard training. "Social requirements billets" include billets not directly related to mission, such as alcohol counselor and career counselor.

Fleet readiness program

Recently, ships of the surface force have been employed in an environment of continuous readiness and continuous certification. To this end, the surface force commander has instituted a Fleet Readiness Training Program that stipulates continuous training requirements and exercise requirements for the combatant ships and assesses success in these endeavours. Part of that program requires the crew of the ship to man a number of 3- to 5-man training teams, and also requires one watch team to train another. All of this is done in conjunction with support from the Afloat Training Group.

In this application of the MSC manning construct to a warship, we have taken away the extra people who might be used to constitute shipboard training teams, and one of the objectives of the pilot is to concentrate shipwide training events into one afternoon a week. In addition, we endeavor to give the off-duty watch-stander control over his off-watch time. So, if one watch is still expected to train another, additional compensation will have to be planned for training events as well as for maintenance events.

Perhaps during the execution of the DDG–51 pilot, the role of the Afloat Training Group could be expanded to staff the shipboard training teams, as needed. Or perhaps some combination of an expanded role for the Afloat Training Group and additional compensation for crew members voluntarily employed in excess of their test working hours could be developed.

Either way, we think it is important that the MSC construct pilot DDG be tested in meeting the surge performance and certification goals of the FRP—under Navy rules, not MSC rules.

Required Operational Capabilities/Projected Operational Environment (ROC/POE) for DDG–51 class

The DDG-51 consists of the following three subclasses:

1. Flight I (DDG–51 to DDG–71)
2. Flight II (DDG–72 to DDG–78)
3. Flight IIA (DDG–79 to DDG–112).

Flight II has a few weapons and sensor modifications and varies only slightly from the flight I design. Flight IIA has two helicopter hangars and can embark ASW helicopters, which can be landed but not operated from the ships of the other two flights.

From a manning standpoint, the DDG–51 flight IIA has 274 enlisted in the crew, while the other two flights have 272 enlisted. A team of 11 cryptologists has been added to the manning mix of the flight IIA, at the sacrifice of a few junior petty officers and nonrated from various departments. All three flights have 24 officers. During peacetime steaming (condition III), the flight IIA mans 51 stations (including 3 cryptological stations), while the other two flights man 46 stations. The flight IIA also mans both a sentry and a weapons roving patrol that is not found in the battle bill of an SMD of any other warship.

The DDG–51 (all flights) operates offensively in a high-density, multithreat environment as an integral element of a Navy group. The DDG–51 strikes inland targets, plus ships, aircraft, and submarines, and protects itself and ships in company from surface, air, and underwater

threats. The DDG–51 is designed, equipped, outfitted, organized, and manned to perform all primary missions, including self-defense and the prevention and control of damage, simultaneously.

Simultaneity of mission performance

The ROC/POE demands simultaneity of primary mission performance. Preventing and Controlling Damage is 1 of the 18 functions of the mobility (MOB) mission area. Mobility is 1 of 9 primary missions of the DDG–51 class.

The Preventing and Controlling Damage function comprises five subfunctions, two of which are manning intensive. They are:

- MOB 3.1, "Controlling fire, flooding, electrical, structural, propulsion, and hull/frame casualties"
- MOB 3.2, "Counter and control chemical, biological, and radiological (CBR) contaminants/agents."

The requirement for simultaneity of performance when at battle stations is indicated by a "Full" notation in the ROC/POE, which means that the capability is to be fully achieved and that achievement is to be sustained for the duration of the manning of battle stations.

Sequential performance of missions that drive manning requirements

Sometimes simultaneity of performance is not required. In those cases, the notation of Full is modified by the letter "E," which means that the capability can be achieved by using pretrained special teams that are released from other functions and detailed to perform the necessary subfunction.

Thus, if the ROC/POE were changed to indicate "F/E" instead of "F," as a requirement under battle station manning for MOB 3.1 and MOB 3.2, trained and predesignated individuals would be released from other battle stations to fight fires or to deal with damage.

In the MSC manning construct, no attempt is made to continue with other missions when the ship is on fire or damaged. Instead, the

concentration is on extinguishing the fire. USS *Cole* DDG–67, which was hit by terrorists in Aden on 12 October 2000, was not at battle stations; manning most of those stations after the ship was hit (except for mustering purposes) was counterproductive.

For the DDG–51 class, such a change in the ROC/POE would permit a reduction of the enlisted crew of about 23 percent, from 272 to 210. This assumes that Damage Control Central, Secondary Damage Control Central, and Repair 5 are fully manned and that Repair 2, Repair 3, and the talkers and stretcher bearers of the three battle dressing stations are co-manned by people released from other battle stations.

Currently, the co-manned or Special Team concept is permitted by the ROC/POE and used in the DDG–51 Battle Bill for manning the following: (1) five machine guns and two 25-MM guns for force protection, (2) the two SRBOC[51] reloaders, (3) the ready life boat, and (4) five of nine members of the Divert Team. Also, when required, the Boarding Team is co-manned by personnel from other battle stations.

BFIMA NECs required by ROC/POE

Following the inactivation of the destroyer tenders and repair ships in the early 1990s, the Navy developed the Battle Force Intermediate Maintenance Activity (BFIMA) concept. In that concept, select technicians on each ship are given advanced journeyman training to permit them to perform Intermediate, or I-level, repair work—work that is usually done by the repair staff of a Shore Intermediate Maintenance Activity (SIMA) or by the repair department of a tender. Fourteen technical billets in each DDG are so designated by the ROC/POE and are stipulated in the Ship Manning Document.

In the MSC manning construct, Marine engineering officers, aided by off-watch personnel on an overtime basis, perform I-level repair work. The presence of the advanced skill repair technicians in the Navy manning construct permits ready adaptation of the MSC manning process in developing a reduced manning scheme for the DDG-51 class.

51. SRBOC abbreviates Super Rapid-Blooming Overhead Chaff.

CNA suggestions from this report that are incorporated in this pilot program

Billets treated as collateral duties in warships of other navies

A number of billets in the DDG–51 class SMDs are not in the crew rosters of the warships of other navies. These are all treated as collateral duties instead of primary billets in the other navies. For example, the Training Officer, the 3-M Coordinator, the Master-at-Arms, the Navy Counselor, and the Command Master Chief Petty Officer could be collateral duties rather than primary duties.

In the pursuit of a reduced manning experiment in a DDG, we would suggest that these billets by reassigned as collateral duties rather than as primary billets.

Food service attendants

We found that the Navy system of manning has a built-in inefficiency: personnel trained for technical specialties are assigned mess-deck duties for as long as 3 or 4 months. MSC, however, assigns personnel only to positions for which they have been trained. We suggest for the DDG–51 reduced manning experiment that we end the practice of assigning technically trained enlisted personnel to menial food service functions, and instead follow the MSC practice by permanently assigning nonrated personnel to this function. We have left all the assigned food service billets and suggest these and other nondesignated personnel that remain be candidates for advancement in various ratings in other departments. To this end, we suggest that sufficient replacements be assigned periodically to enrich the mix of potential strikers in other ratings.

NECs vested in single crew members rather than multiple crew members with same NEC

Compared with the MSC manning construct, in the Navy system of manning, a large number of less experienced and narrowly trained enlisted are used, and they are often supplemented by apprentices for training purposes. In some cases, rather than train people for

repairing more than two systems, extra technicians are added instead. Naval Surface Warfare Center, Carderock (NSWCC) examined manning on DDGs using its unique Manpower Analysis and Prediction System (MAPS). The author of that report [8] notes:

> There are five ratings on this ship class, in which NEC's actually cause a possible inflation in requirements. The most significant of these is the Electronic Technician (ET) rating in the CE division of the Combat Systems Department.

This is due to a Navy NEC assignment policy "to assign to two separate billets, NEC's for significant equipment or systems. This ensures redundancy in case of loss of a repairman for vital equipment." But that redundancy does come at a cost.

In addition, the SMD methodology allows the notation of only two NECs for each crew member, regardless of how many NECs the person might have. Comparatively, in the MSC manning construct, the electronic technicians are qualified on various equipment to the extent that MSC will replace a large crew of Navy Electronic Technicians with only two people who are trained and competent to repair all the sensors and radios on the ship. The redundancy is in the two. We found in the course of reviewing condition III watch assignments that only 3 of 14 ET billets were redundant.

CNA suggestions not incorporated in this pilot program

Engineering officers perform hands-on maintenance work

The MSC engineering officer, though not necessarily as educated as his Navy counterpart, is better qualified technically. This is largely a result of the more focused education and practical training of the civilian mariner, driven primarily by the USCG licensing standards.

In the MSC and commercial manning construct, shipboard engineering officers are expected to do most of the O-level maintenance and repair work on the propulsion, auxiliary, and electrical machinery, which in the Navy is the purview of senior enlisted personnel. The MSC shipboard engineers also perform a large amount of the I-level repair work that is rarely accomplished by the Navy crew, even though some I-level journeymen are present in the crew. Coupled with the

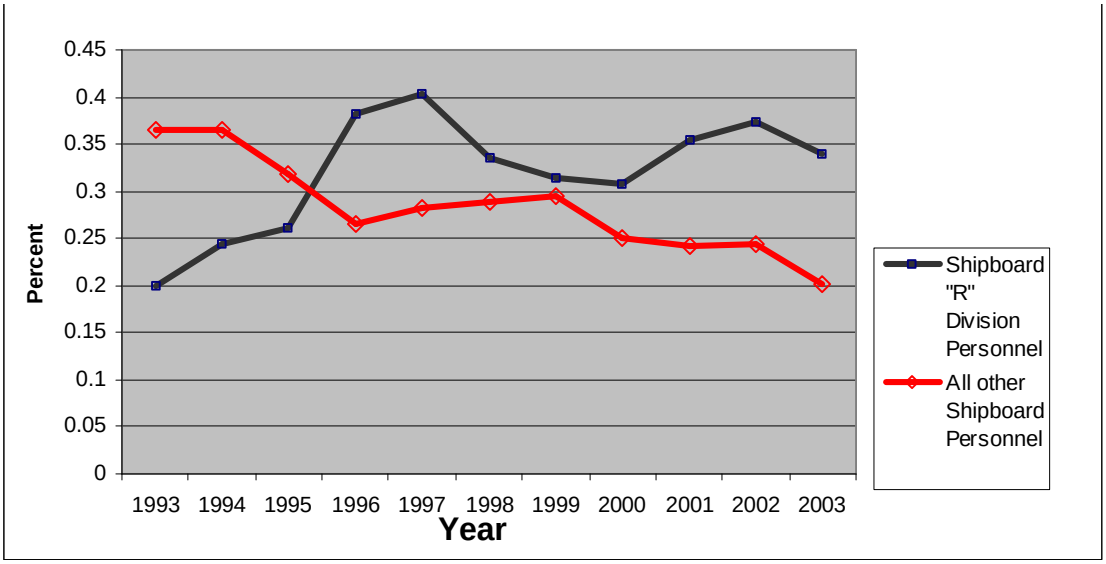
selectively narrow training of Navy enlisted personnel, this directly contributes to larger manning requirement for Navy ships.

In this pilot proposal for a reduced Navy manning of a warship, we do not require the Navy engineering officers to do hands-on maintenance; instead, we rely heavily on the BFIMA skills of some of the enlisted and the senior technical enlisted ratings, as is more common in the Navy. Perhaps, when sufficient technically skilled officers are available, the Navy could adapt the MSC machinery repair concepts.

Fire-fighting and damage control training in the Navy

To study the implications of applying civilian manning practices to USN ships, we examined the status of fire-fighting and damage control training in the Navy. Figure 25 shows the annual number of formal live fire-fighting courses taken by non-flight-deck personnel, divided by the total number of non-flight-deck afloat billets in Navy surface ships. The blue line shows the professional damage control and fire-fighting people of the R-division in each ship. The red line shows all non-flight-deck other shipboard personnel.

Figure 25. Damage control and live fire-fighting training (1993-2003)[a]

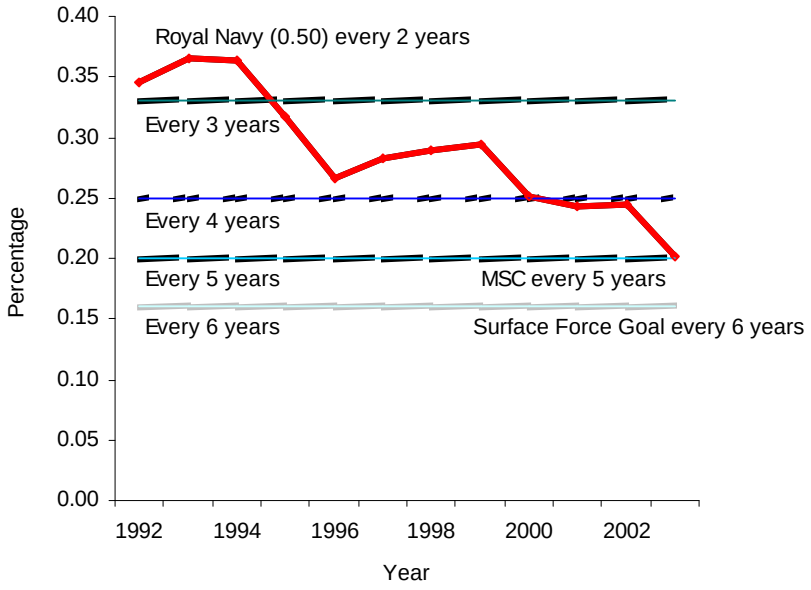


a. Total number of courses taken divided by total number of afloat billets, all classes of surface ships, excluding aviation live fire-fighting and aviation billets.

In general, the percentage of training as shown on the left scale is a rough surrogate for the frequency of retraining. A 33-percent level indicates retraining about every 3 years, a 25-percent level indicates retraining about every 4 years, and a 20-percent level implies retraining about every 5 years. This is not exact because our data are for billets, not individuals. As a result, we do not know if the same person is being retrained. With close to 100,000 billets involved for each of the 10 years, however, our approximation is close enough.

Figure 26 shows the red line from figure 25, the nonprofessional firefighter personnel, and displays the standards of training attained over the same 10-year period.

Figure 26. Comparative frequency of damage control and live fire-fighting training[a]



a. Total number of courses taken divided by total number of afloat billets; all classes of surface ships, excluding professional damage control and aviation courses and billets.

Figure 26 also shows the Royal Navy standard and the MSC standard, plus the Surface Force Goal. The Navy has been exceeding the goal and the MSC standard for most of the period, so little adjustment may

be needed to plan for nonprofessional fire fighters to perform fire-fighting and damage control functions in an emergency. It might be prudent, however, if we co-man Repair-3 and Repair-2, for the surface force commander to return to a more frequent goal for live fire-fighting retraining of non-R-division personnel.

Execution of a pilot program

In the AS and FFG pilot projects, we proposed comparing one ship manned by a small CIVMAR crew with another ship of the same class, manned by Navy Sailors according to the CIVMAR manning construct. Such a Navy/CIVMAR comparison for the DDG–51 is highly unlikely because we doubt that civilians could or should be employed in manning and operating the highly technical sensors and weapons in a modern warship under combat stresses. Therefore, the manning schedules we have developed here presume that only skilled Navy personnel will be employed in the DDG–51 class.

One salient feature of our appendix F pilot proposals was the orientation and adaptation of the Navy crews involved to the MSC culture for watch rotation, watch duration, ship control, navigation, engine operation, auxiliary monitoring, operational and intermediate maintenance action for machinery, mess service, and the like. In each case, two ships of the same class are being converted and receiving habitability and engineering modifications for MSC manning. It was a simple matter of scheduling to get the proposed downsized Navy crew to spend a significant period in the first ship modified and manned by civilians before they manned the second modified ship.

In the DDG pilot, there is no CIVMAR-manned comparable ship. Without orientation and adaptation of the Navy crews involved to the MSC culture (as described above), the pilot will fail.

Fortunately, MSC is now operating four AOE-6 class ships with about the same propulsion plant, though slightly higher rated. It might be possible to season an entire Navy crew in the AOEs for 6 to 10 months before assigning them to a DDG. The AOE-6 class was once manned by a Navy crew of 583. Today it is manned by a CIVMAR crew of 160 and a Navy military detachment of 28, for a total of 180. A portion of the downsized DDG crew of less than 200 should fit as passengers.

Battle and wartime-steaming watch stations

The Ship Manpower Document

The SMD reveals the planning involved in calculating the billets required in a modern warship. Section III of the SMD lists the manpower requirements by department and division. Each billet identified is coded by a Billet Sequence Number.

Section IV of the SMD displays the condition I and condition III watch station assignments that need to be manned to perform all the missions assigned to the ship, under each condition. This is an illustrative battle bill. Each watch station identified for condition I and condition III is coded by a watch station number.

Battle readiness

Condition I is the battle readiness status, and is colloquially called General Quarters. At that posture, all installed systems are manned and operated for maximum effectiveness. No training is attempted, and only urgent repairs are accomplished. Such evolutions as replenishment, law enforcement, or helo operations are not appropriate unless such stations are co-manned by personnel from other battle stations. The maximum expected continuous crew endurance at battle readiness is 24 hours.

Wartime / increased tension / forward deployed cruising readiness

Condition III is the wartime cruising status. Reduced defensive systems are manned to a level to counter pop-up threats. Normal underway maintenance is performed, as are support and administrative functions. In determining manpower requirements, the minimum expected crew endurance for condition III is 60 continuous days, with the opportunity for up to 8 hours of accumulated rest for each man each day.

Unfortunately, this objective leads to “sleep deprivation” for the watchstanders, and the most common remedies used, such as qualifying more watchstanders and going to 4-section and 5-section watch rotation, add to the problem by introducing “body clock disruption.”

Here the MSC construct differs by stipulating two periods per day when watchstanders can get at least 7 hours of continuous rest.

An illustrative battle bill

The tables that follow show the Watch Station Number for each watch position and the CNA-proposed Billet Sequence Number of the billet and/or person performing that duty at various locations on the DDG–51 under condition I or III.

These tables were created after the 36 billets were removed, and after relaxation of the simultaneity provisions for manning two of three repair parties and the battle dressing stations. This latter action resulted in the removal of another 62 billets.

Table 32 shows the battle station manning for the ship control function, in the pilot house on the signal bridge, at the life-buoy station, and in after steering. The far right column on table 2 shows the Primary and Secondary Navy Enlisted Classifications (P/S NEC) for each Billet Sequence Code (BSC).

Table 33 shows the relaxed-posture condition III steaming watch stations for the pilot house and the life-buoy station only because the other stations are not manned during wartime steaming. In table 33, the three-section watch rotation is indicated by the terms “Watch A, Watch B, and Watch C.” Shown in those fields on the table are the BSCs for each watchstander, including rank and rating.

Table 32. Condition I, battle readiness, ships control

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S0010	OOD		00270	LTJG	1110
S0020	JOOD		00120	LTJG	1110
S0070	Bridge Spec.	0230	00310	QM2	0230
S0050	Cont'l Console		00100	SN	9700
S0060	Cont'l Cnsl. Stby		001010	SN	9700
S0030	Navigator		000290	QMC	
S0040	Asst Nav. (Rcdr)		000300	QM1	
S0140	Bearing Rcdr.		000210	PN3	
S0120	Bearing Tkr. Stbd		000320	QM3	0230
S0130	Bearing Tkr. Port		000330	QM3	0230
S0080	BMOW		000930	BM1	
S0090	Bridge Disply.		000630	OS1	0326/0310
S0150	Lookout Port		001020	SN	9700
S0160	Lookout Stbd		001030	SN	9700
S0100	Talker (N-51)		000200	PNC	
S0110	Talker (N-80)		000230	YN1	
S0170	Lookout Aft		001040	SN	9700
S0180	Aft Steer Helm		000920	BMC	
S0190	Aft Steer Mach		002290	EN3	
S0200	Aft Steer Elect.		002390	EM3	
S0210	Signal man		000350	SM1	
S0220	Signal Recorder		000340	QMSN	
S0230	Signal Talker/log		00220	PNSN	
S0240	SRBOC Loader		Co-Manned		
S0250	SRBOC Loader		Co-Manned		

Table 33. Billet Sequence Codes for condition III, forward deployed cruising readiness, ships control

Station no.	Position	Req. NEC	Watch A	Watch B	Watch C
S0010	OOD		000270/LTJG	001200/LTJG	000430/LTJG
S0020	JOOD		000920/BMC	000290/QMC	000610/OSC
S0070	Bridge Spec.	0230	000320/QM3	000330/QM3	000340/QMSN
S0050	Control Console		001000/SN	001010/SN	001020/SN
S0170	Lookout Aft		001030/SN	001040/SN	001100/SN

Tables 34 and 35 repeat the formats of table 32 and 33 and show the watch station assignments for the operations control function.

Table 34. Condition I, battle readiness, operations control

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S0290	AW Coodinator		000120	CDR	CO Afloat
S0260	AIC Supervisor	0319	000640	OS1	0319
S0270	AIC	0318	000750	OS2	0318
S0280	Msl Syst Super		00170	LCDR	1110
S0300	USW Coordinator		000140	LCDR	1110
S0310	ASTAC	0324	000720	OS2	0324
S0320	USWCO (ATS/FCO)	0430	001670	STG1	0466
S0330	Tac Act Officer		000420	LT	1110
S0340	CIC WO		000430	LTJG	1110
S0350	Cmbt Syst Coord		001190	LT	1110
S0360	CIC Super	0326	000620	OS1	0326
S0370	GCCS-M Oper	0342	000680	OS2	0342
S0380	Own Ship Display		000800	OS3	0310
S0390	R/T Talker #1		000810	OS3	0310
S0400	R/T Talker #2		000820	OS3	0310
S0410	Phone Talker (N-51)		000240	YN2	
S0420	Phone Talker (N-80)		000890	CTTSN	
S0430	Tac Info Coodinator	0348	000660	OS2	0348
S0440	Radar Syst Control	1119	001580	FC2	1119
S0450	Identification Oper	0310	000670	OS2	0348
S0460/ 0470	EW Supervisor	1781	000830	CTTC	1781
S0480	DCC Supervisor		000850	CTT2	1733/1734
S0490	Ops Intel Analyst	3905	000900	IS1	3905/3924
S0500	Surf/Sub Wfr Coord		001200	LTJG	1110
S0510	Surf/Sub Wrf Super	0310	000610	OSC	0310
S0520	HSW Engage Planr	0334	002100	FC1	0334
S0530	Gun Cntrl Console	1120	001920	FCC	1120
S0540	ROS Cntrl Panel Op	1120	001950	FC2	1120
S0550	TDSS Supervisor		000690	OS2	0334
S0560	TDSS Operator		000780	OS3	0342
S0570	SPA 25 Operator		000790	OS2	0342

Table 35. Billet Sequence Codes for condition III, forward deployed cruising readiness, operations control

Station no.	Position	Req. NEC	Watch A	Watch B	Watch C
S0290	AW Coordinator		000420/LT	001190/LT	001170/LCDR
S0270	AIC	0318	000750/OS2	000760/OS2	000770/OS2
S0280	Msl Sys Coordinator	1143	001550/FC1	001480/FC1	001560/FC2
S0310	ASTAC	0324	000720/OS2	000730/OS2	000740/OS2
S0320	USWCO (ATS/FCO	0430	001720/STG2	001700/STG2	001710/STG2
S0330	Tac Action Officer		001800/LT	001230/ENS	001200/LTJG
S0340	CIC WO		001920/FCC	001460/FCCM	001470/FCC
S0370	Cmbt Sys Coordinator		002090/FCC	001260/ETC	000830/CTTC
S0360	CIC Supervisor	0326	000620/OS1	000630/OS1	000640/OS1
S0370	GCCS-M Oper	0342	000680/OS2	000780/OS3	000790/OS3
S0430	Tac Info Coordinator	0348	000650/OS2	000660/OS2	000670/OS2
S0440	Radar Sys Control	1119	001580/FC2	001570/FC2	001490/FC1
S0450	Identification Oper	0310	000690/OS2	000780/0S3	000790/OS3
S0460	EW Supervisor	1733 1734	000850/CTT2	000860/CTT2	000840/CTT1
S0480	DCC Supervisor		000880/CTSN	000870/CT3	000890/CTSN
S0500	Surf/Sub Wrf Coordinator		001670/STCCS	002090/FCC	002860/ENS
S0510	Surf/Sub Wrf Supervisor		000800/OS3	000810/OS3	000820/OS3
S0530	Gun Cntrl Consul	1120	001950/FC2	002000/FC3	001990/FC3

Table 36 and table 37 show the watch station assignments for the communications control function.

Table 36. Condition I, battle readiness, communications control

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S0580	TST Supervisor	2379	000480	ITC	2779
S0590	Asst TST Super	2379	000560	IT2	2379
S0600	Comm Sys Mngr		000570	IT3	2735
S0610	Sys Oper #1		000510	IT1	2379
S0620	Sys Oper #2		000550	IT2	2379
S0630	Circuit Oper		000530	IT2	2730
S0640	Talker (N26)		000590	ITSN	
S0650	Net Sec Tech	2780	000490	IT1	2781
S0660	NTCSS Sys Admin	2730	000500	IT1	2780
S0670	LAN Mngr	2735	000520	IT2	2735
S0680	Tac Syst Admin	2720	000540	IT2	2720

Table 37. Billet Sequence Codes for condition III, forward deployed cruising readiness, communications control

Station no.	Position	Req. NEC	Watch A	Watch B	Watch C
S0580	TST Supervisor	2379	000560/IT2	000510/IT1	000550/IT2
S0600	Comm Sys Mngr		000530/IT2	000490/IT1	000480/ITC
S0610	Sys Oper #1		000540/IT2	000590/ITSN	000580/IT3
S0670	LAN Mngr	2735	000570/IT3	000520/IT2	000500/IT1

Tables 38 and 39 show the watch station assignments for the combat casualty control function.

Table 38. Condition I, battle readiness, combat system casualty control[a]

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S0690	CS OOW		001180	LT	6180
S0700	CS Maint Superv	1104	001460	FCCM	1104/1321
S0720	Test/Maint Consl	1105	001500	FC1	1105
S0730	Talker (N51)		003110	MS3	3527
S0740	Talker (N80)		003120	MSSN	
S0743	Display Repair	1322	001600	FC3	1322
S0745	Computer Repair	1144	001610	FC3	1144
S0750	Electron Spt Super		001260	ETC	9608
S0760	Electronic Repair		001360	ET3	1430/1468
S0770	400 hz Rep Fwd	1143	001620	FC3	1143
S0780	400 hz Rep Aft	1143	001630	FC3	1143
S0790S	Mk 99 FCS Repair	1143	001560	FC2	1143
S0800	Electronic Repair		001270	ET1	9608
S0810	SPY-1D Repair	1119	001490	FC1	1119
S0820	Electron Rep(N26)		001340	ET3	1571/1591
S0830	Electronic Repair		001300	ET2	1571/1471
S0840	Rep (SLQ-32(V)2)	1733	000860	CTT2	1733
S0860	Mk 99 Rep (N66)	1143	001550	FC2	1143/9527
S0870	Mk 99 Rep (N66)	1143	001480	FC1	1143
S0880	UWS (N25/29)	0430	001680	STG1	0466
S0890	GFCS Repair	1120	002000	FC3	1120
S0900	Computer Opr	1144	001540	FC2	1144
S0910	Display Repair	1322	001590	FC3	1322
S0920	SPY-1D Repair	1119	001570	FC2	1119
S0930	Computer Opr	1144	001530	FC2	1144
S0940	Display Repair	1322	001520	FC2	1322
S0950	TACTAS Repair	0415	001740	STG2	0455
S0960	Electron Repair		001310	ET2	1486/1420
S0970	ET Repair (N26)		001350	ET3	1468/1430
S0980	ET Repair		001280	ET1	9605/1425
S0990	ET Repair		001290	ET2	9604/1424
S1000	Sonar Repair	0455	001690	STG2	0455
S1010	Senior Tech (N66)	1105	001470	FCC	1105
S1020	Ord Sup (N25/65)		001870	GM1	0879/0812
S1030	TSP Oper (N29)		001840	TM3	
S1040	Harpoon Repair	1169	002140	FC2	1169
S1050	Mt Captain	0879	001980	GM2	0879/0812

Table 38. Condition I, battle readiness, combat system casualty control[a] (continued)

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S1060	EP2 Panel (N66)	0879	001890	GM3	0879
S1070	GMCP Oper	1120	001990	FC3	1120
S1080	POIC (N60)	0879	001900	GM3	
S1090	Ammo Passer		000700	OS2	0334/0310
S1100	Ammo Passer		000710	OS2	0334/0310
S1110	Ammo Passer		000730	OS2	0334/0310
S1120	Ammo Passer		000740	OS2	0334/0310
S1130	Ammo Passer		000760	OS2	0318/0310
S1140	Ammo Passer		000770	OS2	0318/0310
S1150	Ammo Passer		000780	OS3	0342/0310
S1160	CIC Cntrl Panel	1121	001960	FC3	1121
S1170	Local Panel (N65)	1121	001940	FC2	1121
S1180	POIC/Loader	1121	001970	FC3	1121
S1190	Ammo Handler		003130	MSSN	
S1200	Ammo Handler		001910	GMSN	9700
S1210	Ammo Handler		001100	SN	9700
S1220	Local Panel (N65)	1121	001930	FC1	1121
S1230	POIC/Loader	1121	001980	FC3	1121
S1240	Ammo Handler		003210	SN	
S1250	Ammo Handler		003220	SN	
S1260	Ammo Handler		002080	GMSN	0981
S1270	Launch Super #1	0981	002040	GM2	0981
S1280	Launch Super #2	0981	002050	GM2	0981
S1290	Msl Monitor Fwd	0981	002060	GM3	0981
S1300	Msl Monitor Aft	0981	002070	GM3	0981
S1540	Engage Contrl Off		001230	ENS	6160
S1550	TWS Supervisor	1332	002090	FCC	1332
S1560	TWS/ADTC #1	1334	002100	FC1	1334
S1570	TWS/ADTC #2	1334	002120	FC2	1334
S1580	TWS/ADTC #3	1334	002130	FC2	1334
S1590	TWS/ADTC #4	1334	002150	FC3	1334
S1600	TER/TCR Maint	1334	002160	FC3	1334
S1610	SONAR Super	0466	001660	STGCS	0417/0466
S1620	SQS-53 Consol	0411	001780	STG3	0415
S1630	SQS-53 Consol	0455	001750	STG3	0455
S1640	SQS-28 Consol	0411	001720	STG2	0430
S1650	SIMAS/Log	0411	001730	STG2	0429

Table 38. Condition I, battle readiness, combat system casualty control[a] (continued)

Station number	Position	Req. NEC	BSC	Rate	P/S NEC
S1660	Nixie Oper		001760	STG3	0455
S1670	SQR-19 Winch		001770	STG3	0429

a. In the SMD, Condition I watch station numbers S1310 through S1460 are co-manned, small-calibre weapons, topside. Watch station numbers S0850 plus S1480 through S1530 are set aside for NEC changes only.

Table 39. Billet Sequence Codes for condition III, forward deployed cruising readiness, combat system casualty control

Station no.	Position	Req. NEC	Watch A	Watch B	Watch C
S0710	CSOOW/Super	1105	001470/FFC	001500/FC1	001510/FC1
S0750	Electronic Super		001270/ET1	001400/IC1	001280/ET1
S0900	Computer Oper	1144	001540/FC2	001530/FC2	001610/FC3
S0910	Display Repair	1322	001600/FC3	001590/FC3	001520/FC2
S1060	EP2 Panel Oper	0879	001890/GM3	001880/GM2	001870/GM1
S1280	Lnch Ctl Super #2	0981	002050/GM2	002060/GM3	002070/GM3
S1570	TWS/ADTC Oper	1334	002100/FC1	002120/FC2	0021‘30/FC2
S1610	Sonar Super	0466	001680/STG1	001690/STG2	001670/STG1
S1620	SQS-53 Cnsl Oper	0411	001780/STG3	001740/STG2	001770/STG3
S1630	SQS-53 Cnsl Oper	0455	001750/STG3	001760/STG3	001690/STG2
S1640	SQS-28 Cnsl Oper	0411	001800/STSN	001810/STSN	001820/STSN

Flight deck manning

The SMD calls for the flight deck control, the crash and salvage team, and the crew of the Ready Life Boat to be manned by augmentees, off-watch personnel, or by standing down other watches in accordance with ROC/POE instructions. The ROC/POE requires that all flight deck operations in all mission areas will be performed by off-watch

special teams or details. Also, the rescue boat is manned at condition I with augmentation by securing other battle stations and during condition III with augmentation from off-watch personnel. To include the DDG–51 flight IIA, which embarks an ASW helicopter, in our mix of candidates for the pilot, we have provided for condition I manning of the flight deck and of the crash and salvage team (see table 40). We presume that for condition III the special team approach will be used for flight quarters in the DDG–51 flight IIA.

Table 40. Condition I, battle readiness, flight deck and crash and salvage

Station no.	Position	Req. NEC	BSC	Rate	P/S NEC
S1690	Safety Officer		002020	GMC	0981
S1700	Land Sgnl Enlisted		000990	BM3	
S1710	Flt Dk Crew		000960	BM3	0170
S1720	Flt Dk Crew		000970	BM3	0170
S1730	Fuel Station Oper		002260	EN2	4340/4303
S1740	JP-5 Nozzleman		002640	GSM2	4222
S1750	Fuel Pump Oper		002320	ENFN	
S1760	Scene Leader		002520	DC2	
S1770	Hot Suitman		002920	SK2	9760
S1780	Hot Suitman		002910	SK2	9760
S1790	Hose Team Leadr		002550	DC3	
S1800	AFFF Nozzleman		000940	BM2	0120
S1810	AFFF Hose/Plug		000950	BM2	

Tables 41 and 42 show the watch station assignments for the engine control function.

Table 41. Condition I, battle readiness, engine control

Station no.	Position	Req. NEC	BSC	Rate	P/S NEC
S2160	EOOW		002180	LT	1110
S2180	PAC Oper (N83)		002590	GSCS	4206
S2190	Elect Plt Consol		002780	GSEC	4125/4206
S2200	Fwd Eng Rm Oper		002600	GSMC	4126
S2220	Prop Sys Mont		002730	GSM3	
S2230	Swbd Oper (N85)		002810	GSE3	
S2240	CRP/OD Oper		002760	FN	9760
S2250	Aft Eng Rm Oper		002670	GSM2	4126
S2270	Prop Sys Mont		002740	FN	9760
S2280	Swbd Oper (N85)		002820	GSE3	
S2290	CRP/OD Oper		002750	FN	9760
S2300	AMR Super	4398	002270	EN2	4225/4398
S2310	GT Gen Oper		002720	GSM3	
S2320	Aux Sys Monitor		002280	EN3	4398
S2330	Aux Sys Monitor		002310	ENFN	
S2340	A/C Equipment		002300	EN3	4291
S2350	OII King		002690	GSM3	
S2360	Gen Equipment		002680	GSM3	
S2370	Swbd Oper (N85)		002820	GSE3	
S2380	IVCS Repair	4712	001440	IC3	4738/4712
S2390	Gyro Oper (N-26)	9612	001330	ET3	1678/9612
S2400	Gyro Oper (N-26)	9612	001320	ET3	9612/1678
S2410	Repair-5 Officer		002220	WO3	7130
S2420	Repair-5 Leader		002240	ENC	4206
S2430	Scene Leader		002660	GSM2	4126
S2440	Team Leader		002540	DC3	
S2450	Plotter		002450	HT3	
S2460	Invst/SCBA #1		002530	DC3	
S2470	Invst/SCBA #2		002540	DC3	
S2480	Nozzle/SCBA #1		000650	OS2	0348/0310
S2490	Nozzle/SCBA #1		000790	OS3	0342/0310
S2500	Hose/SCBA #1		001370	ET3	1425/9605
S2510	Hose/SCBA #2		001380	ET3	1424/9604
S2520	Hose/SCBA #3		001390	ET3	1420/1486
S2530	Hose/SCBA #4		002830	GSE3	
S2540	Electric Repair		002380	EM3	
S2550	DMS / IC Repair		001430	IC3	4738/4746
S2560	GSE Elect Repair	4125	002790	GSE1	4125

Table 41. Condition I, battle readiness, engine control (continued)

Station no.	Position	Req. NEC	BSC	Rate	P/S NEC
S2570	Mach Rep/Relief	4125	002800	GSE2	4125
S2580	Mach Rep/Relief	4126	002620	GSM1	4126
S2590	Mach Rep/Relief	4126	002650	GSM2	4126
S2600	Mach Rep/Relief	4126	002610	GSM1	4140
S2610	Mach Rep/Relief		002710	GSM3	
S2620	Talker (N80)		002880	PC2	
S2630	Talker (N83)		002410	EMFN	
S2640	Talker (N86)		003330	DK1	2905
S2650	Utilityman		000880	CTTSN	
S2660	Utilityman		003340	DKSN	
S2670	Utilityman		002940	SKSN	
S2680	Utilityman		002400	EMFN	
S2690	Utilityman		000580	IT3	2720
S2700	Utilityman		002950	SKSN	
S2710	Utilityman		001640	FC3	1119
S2720	Utilityman		002700	GSM3	
S2730	Utilityman		002460	MR2	4402
S2740	D C Asst		002470	DCC	4811
S2750	DC Consol Oper		002510	DC2	
S2760	Supervisor		002480	DC1	4805
S2770	Plotter		002440	HT2	4955
S2780	Talker (N53)		003280	SH1	3111/3131
S2790	Talker (N80)		003290	SH2	3111/3131
S2800	Talker (N81)		003300	SH3	
S2810	Talker (N82)		003310	SHSN	3122
S2820	Talker (N83)		002940	SKSN	
S2830	Talker (N86)		002950	SKSN	
S2850	Repair-3 Leader		002890	SKC	2820/2831
S2860	Scene Leader		002360	EM1	
S2870	Team Leader		002970	PO2	HAZMAT
S2880[a]	Plotter		002990	SK2	9595
S3100	Repair-2 Officer		002850	LT	3100
S3110	Repair-2 Leader		002490	DC1	
S3120	Scene Leader		002980	BM2	9595
S3130	Team Leader		000870	CTT3	
S3140[b]	Plotter		002500	DC2	4812
S3410[c]	Medical Tech		000390	HM3	

Table 41. Condition I, battle readiness, engine control (continued)

Station no.	Position	Req. NEC	BSC	Rate	P/S NEC
S3470	Medical Tech	8425	000380	HMC	8425
S3530	Medical Tech		000400	HM3	

a. The 21 condition I watch stations, S2890 through S3090, the investigators, nozzle men, hose men, AFFF Station #2 operator, electrical repairman, sound powered phone talkers, and utility men of Repair-3 are co-manned in this construct.
b. The 26 condition I watch stations, S3150 through S3400, four more phone talkers, an IC repairman, and the aforementioned stations for Repair-3 are co-manned in Repair-2 (Secondary Damage Control Central) in this construct.
c. The 15 condition I watch stations, S3420 through S3460, plus S3480 through S3520, plus S3550 through S3580, the stretcher bearers and talkers for the three battle dressing stations, are co-manned in this construct.

Table 42. Billet Sequence Codes for condition III, forward deployed cruising readiness, engine control

Station no.	Position	Req. NEC	Watch A	Watch B	Watch C
S1610	EOOW	4206	002790/GSCS	002780/GSEC	002240/ENC
S2190	Elct Plnt Consol		002810/GSE3	002820/GSE3	002830/GSE3
S2210	Fwd Eng Rm Op		002730/GSM3	002720/GSM3	002690/GSM3
S2260	Aft Eng Rm Op		002680/GSM3	002710/GSM3	002670/GSM2
S2300	AMR Supervisor	4398	002280/EN3	002270/EN2	002290/EN3
S2350	Oil King		002650/GSM2	002660/GSM2	002620/GSM1
S2750	DCC Consol Oper		002500/DC2	002510/DC2	002490/DC1
S2840	Sounding/ Security		002530/DC3	002540/DC3	002550/DC3

Table 43 shows the condition I watch assignments for the supply support function. There are no condition III watch assignments for support control in the SMD battle bill.

Table 43. Condition I, battle readiness, support control

Station no.	Position	Req. NEC	BSC	Rate	P/S NEC
S3590	Ship's Cook		003040	MS1	3527
S3600	Ship's Cook		003080	MS2	3527
S3610	Ship's Cook		003100	MS3	3527
S3620	Stk Cntl Super		002900	SK1	2814/2829
S3630	Locate/Issue Clk		002930	SK3	2829

Additional compensation

Earlier in this paper, we advocated changes to the compensation system to provide greater flexibility for new recruits with technical skills, and to allow more variation in pay by occupation, experience, performance, and function. We believe a case can also be made for additional compensation for crews on minimally manned ships, as a substitute for additional people or (in effect) in place of the overtime commonly used in the private sector.

Funds for such additional compensation could be offset by the billets reduced in applying the MSC manning construct. Using the total cost of a Sailor methodology, removing 98 billets could yield as much as $8 million in annual savings. Since not all of that is directly captured in the budget process, we suggest that an allowance of about half that amount—roughly $4 million annually—be set aside for additional compensation funding for the DDG pilot.

About half of that, or about $2 million annually, could be credited to the Type Commander to fund the compensation of qualified shore-duty Sailors for inport night duty and appropriate duty fire parties in the DDG pilot. The other $2 million annually could then be used by the commanding officer to fund the employment of off-duty watch-standers of the crew in volunteering for such duties as maintenance or administration of training activities.

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List of figures

List of tables


CNA