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Alternative Sea Manning Concepts: Practices and Policy Implications

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Contents

Executive summary

In this paper, we examine the recent inventory of alternative sea manning initiatives and experiments that the Navy has been exploring. The initiatives fall under the broad categories of (1) rotational crewing and (2) extra manning pools and optimal manning.

Rotational crewing

Rotational crewing initiatives involve the optimal rotation of personnel to and from forward-deployed Navy ships and submarines. The primary advantage of rotational crewing is the ability that this approach gives the Navy to maximize the fleet's forward presence while adhering to the Navy's personnel tempo (PERSTEMPO) rules.[1] The Navy has used three approaches to rotational crewing:

- Blue-Gold, in which two crews are assigned to a single ship
- Horizon, which involves the use of multiple crews to support fewer ships (more crews than hulls)
- Sea Swap, which uses the same number of crews as ships.

Rotational crewing designs are not entirely compatible with the Navy's newly institutionalized deployment strategy, the Fleet Response Plan (FRP). Rotational crewing emphasizes continuous forward presence, while the FRP and fleet deployment cycle emphasize presence with a purpose and surge capability. Nonetheless, the Navy is finding an operational niche for ships manned using rotational crewing, as proven by the use of PCs, MCM-1s, and MHCs forward deployed to the Persian Gulf. These ships provide a steady, low-level background presence that supplements carrier strike groups (CSGs)

1. PERSTEMPO is measured by deployment length, the ratio of time between deployments to time deployed (turnaround ratio (TAR)), and the percentage of time in homeport over a 5-year period.

and expeditionary strike groups (ESGs). A number of issues, however, present concerns:

- The cost of rotational crewing in terms of finding offsetting shore billets to cut
- Potential impact on sea-shore ratios
- Balancing schoolhouse and shipboard training schedules, particularly under high operating tempos
- The intensity of work for both onstation and homeport crews
- The impact on Sailor retention and attrtion.

We found that reenlistment rates for crews participating in the first Sea Swap provide a mixed picture. Crew reenlistment rates were lower for the DD Sea Swap crews than comparison DD crews and virtually the same between DDG Sea Swap crews and comparison DDG crews. The reenlistment rates for the DDG crews may be more reflective of crew responses to Sea Swap since the DD crews were also decommissioning their original ships and being reassigned to new billets following the end of their deployments. The descriptive patterns for the DDGs suggest that overall Sea Swap had little impact on crew reenlistments over the longer term; however, it will be essential that the Navy monitor retention trends with any rotational crewing application or any major change in sea or shore duty attributes.

Extra manning pools and optimal manning

Three initiatives—FRP, with its need for constant levels of high readiness, optimal manning, with its streamlined crew levels, and rotational crewing, with its extra stress on crews—combine to require that the Navy have contingency personnel sources readily available to fill gaps. The Navy is examining the relative merits of creating extra manning pools to provide relief personnel to quickly fill unplanned gaps in ship billets. Sea-centric (or 130-percent) manning includes an extra 30 percent shore-based manning complement that rotates on and off the ship on a fixed schedule. These billets are manned at 130 percent of the ship's optimal manning and make up the major part of the crew. Under 130-percent manning, fully trained Sailors are placed in sea-centric, operationally oriented positions in which they can use their training, talent, and skills. They include dedicated training tours in addition to operational tours that give Sailors the opportunity to optimize their training and career objectives.

The Navy's optimal manning initiatives seem conceptually well suited to supporting both the fleet's operational requirements under the FRP and current downsizing in authorized manpower levels. The Navy has not yet tested sea-centric assignment, however. As a one-size-fits-all model, the greatest challenges to 130-percent manning are the cost of creating the 30-percent shore pools, finding shore billets to offset the increase in sea billets, and cultural barriers. Alternative approaches might target incentives to ratings with high sea-shore ratios, the use of a "just-in-time" augmentation system similar to that used by the cryptology community, or designating some shore billets as "at-risk" positions in which the incumbent agrees to provide quick relief support to fleet requirements, if needed.

The major features of the more sea-intensive force are that the Navy will have to get more sea duty out of senior E5s and E6s and find ways to quickly fill unplanned losses. This could be done in a number of ways, including modifying, fine-tuning, and/or increasing existing incentive pays. Existing and expanded incentive pays that would induce Sailors to spend more time at sea after the end of their first term or to fill unplanned losses include:

- An expanded sea pay premium targeted to those who reenlist or extend at sea. Targeting could be narrowed even more so that the pay is received only by people in certain paygrades, ratings that are undermanned at sea, and Sailors who are extending at sea beyond their projected rotation date (PRD) (or staying until PRD).
- An Assignment Incentive Pay (AIP). Such a pay could be offered to attract volunteers to fill gaps in sea billets. It would be equivalent to making all Sailors on shore duty a ready pool to fill gaps in fleet billets.

Introduction and overview

The strategic vision of the future Navy is to have a highly trained, highly agile force that can move quickly to protect and defend the vital national interests of the United States. The Fleet Response Plan [1, 2] focuses on creating a culture of readiness that maximizes the Navy's forward presence and maintains an enhanced surge capability. In recent years, the Navy has undertaken a number of alternative sea manning initiatives and experiments aimed at improving the speed and agility of Navy forces by increasing their operational availability. Through these initiatives, the Navy is developing new sea manning concepts to support the FRP. They fall under three broad categories:

- Rotational crewing
- Extra manning pools
- Optimal manning.

Rotational crewing involves the optimal rotation of personnel to and from forward-deployed Navy ships and submarines. Extra manning pools provide operational units with additional personnel to facilitate filling gapped billets and give manning relief. Optimal manning involves determining how many Sailors the Navy really needs—for today's fleet and for the fleet of the future. The general design characteristics of these initiatives focus on two areas:

1. Matching Sailors to jobs where they use and develop their occupational skills
2. Allowing Sailors to keep their skill levels high and stay in a more constant state of readiness, thus enhancing the fleet's surge capability.

In this paper, we provide information on the Navy's experiences with alternative sea manning initiatives, and we examine the impacts of alternative manning and developing operational concepts on manpower, personnel, and training processes and policies.

Background

Under the operational vision of *Sea Power 21* [3, 4], the Navy is implementing new operational concepts and organizational processes aimed at expanding the Navy's striking power, achieving information dominance, and developing new ways to fulfill its missions of sea control, power projection, strategic deterrence, strategic airlift, and forward presence. *Sea Power 21* envisions a Navy that will continue to depend heavily on its people to fulfill mission requirements. It also emphasizes the critical role of the Sailor in enabling the Navy to operate more sophisticated weapon systems, in an agile and speedy manner, to meet the challenges that will come with changes in warfighting tactics. The success of the Navy's vision for future combat effectiveness and employment is tied directly to the Navy's ability to properly shape the force and to get Sailors with the right skills to the right place at the right time.

Since September 11th, 2001, the Navy has strived to find a balance between operating efficiently and effectively while also establishing an enhanced level or "culture of readiness" [1] that meets military requirements to support the Global War on Terror (GWOT). In May 2003, the Navy announced the implementation of the newly developed FRP, which institutionalizes an enhanced surge capability and level of readiness that changes the way the Navy approaches the inter-deployment cycle [2]. Previously, the Navy focused on rotational deployments and presence. Under the FRP, naval units maintain higher levels of readiness over specified periods of their deployment cycles so that they are ready to conduct surge operations. The FRP implementation message notes the following [2]:

> Today, the fleet must be both forward deployed and also capable of surging substantial forces....To attain this substantial surge force, the FRP modifies current ship and air wing operating cycles to extend the interval between maintenance periods. Training and manpower processes must also be modified, thereby increasing the time each ship and squadron is available to surge, should surge operations be required.

The FRP emphasizes maintaining readiness levels and shifts the fleet's orientation from a focus on working up for deployment to one in which returning from deployment marks the beginning of a surge or emergency surge status, and not just the standdown period after 6 months at sea [5].

Within the construct of the Navy's strategic vision and the FRP, the Navy Personnel Command (PERS-4) has defined its goal as being able to *"create a culture of readiness"* while *"shaping the workforce of the 21st century"* through evolving and innovative assignment and distribution practices [6]. Supporting a culture of readiness requires a personnel system that is proactive vice reactive. Achieving zero personnel gaps is essential to the higher level of readiness required to sustain a substantial surge force and is integral to training and maintenance processes. The development of new manning processes will be of vital importance to maintaining U.S. naval forces at a higher level of readiness for extended periods.

Traditionally, the Navy has used large crews to operate the fleet. Today, the Navy is developing new combat capabilities and platforms that feature advancements in technology and reductions in crew size. The Navy is designing its modern warships to be run by streamlined teams of operational, engineering, and combat systems experts who are adept at handling complex systems. As manning policies and new platforms reduce crew size further, the Navy increasingly will need Sailors who are highly educated and expertly trained, and it will need those Sailors in numbers that consistently maintain 100-percent crewing across the *"emergency surge," "surge ready,"* and *"routine deployable"* stages of a ship's operational cycle.

Objective and organization of the document

In this paper, we identify the inventory of alternative sea manning initiatives and experiments that the Navy has been exploring. We present the evidence regarding how these initiatives work in practice and their relative impact on Sailors in terms of such factors as professional training, turnaround ratios (TARs), and retention. We take a critical look at various initiatives in terms of cost feasibility, the availability of shore billets to support these new manning approaches, the expected impact on sea/shore rotation, and other potential costs and consequences.

We collected information on alternative sea manning initiatives and experiments from existing Navy documents, Navy-sponsored research, and other government reports. We also conducted a series of interviews with key informants in the following commands: the Strategic Planning and Analysis Directorate (N1Z) in the Office of Deputy Chief of Naval Operations (Manpower and Personnel), the Enlisted Distribution Division (PERS-40), the Navy Manpower Analysis Center, the Surface Warfare Directorate (N76), Fleet Forces Command (FFC), Commander Naval Surface Forces Atlantic (CNSL), Commander Naval Surface Forces (CNSF), and the Center for Surface Combat Systems, Dahlgren, Virginia.

We have organized our analysis of alternative sea manning initiatives as follows. First, we take a close look at rotational crewing initiatives, including Sea Swap, since these are some of the alternative manning concepts with the longest history and the most evidence. Next, we look at other alternative manning concepts. This section includes sea-centric manning (or 130-percent manning), filling unplanned losses, and optimal manning. We also consider how rotational crewing and other alternative manning concepts fit with the Navy's new operational strategy, the FRP. Another paper in this project examines how alternative sea manning concepts (ASMCs) might affect the sea intensity of Navy careers [7]. Finally, we summarize our findings and discuss their potential implications with regard to manpower, personnel, and training policies.

Rotational crewing initiatives

In this section, we identify three basic approaches to rotational crewing. As noted earlier, rotational crewing initiatives involve the optimal rotation of personnel to and from forward-deployed Navy ships and submarines. They aim at maximizing the fleet's forward presence while adhering to the Navy's personnel guidelines regarding personnel tempo (PERSTEMPO).[2] In table 1, we outline the three major types of rotational crewing concepts that the Navy has been using. The first is the Blue-Gold concept, in which two crews are assigned to a single ship. The second is the Horizon concept, which involves the use of multiple crews to support fewer ships (more crews than hulls). The third is Sea Swap, which uses the same number of crews as ships. Under each of these concepts, after a set period of time, crews rotate completely off the ship and another crew reports on station to man the vessel. [3]

Table 1. Rotational crewing initiatives

Initiative	Approach
Blue-Gold	2 crews assigned to a single ship
Horizon concept	Multiple crews support a smaller number of ships (more crews that hulls), such as 4 crews for 3 ships or 5 crews for 3 ships
Sea Swap	Use same number of crews as ships

2. PERSTEMPO is measured by deployment length, the ratio of time between deployments to time deployed (turnaround ratio), and the percentage of time in homeport over a 5-year period.

3. The Coast Guard also practices a variant of rotational crewing that involves the gradual turnover of personnel on ships. The slower turnover of personnel allows time for the new crewmember(s) to learn from the crew that has been on station. The Coast Guard has been using rotational crewing on the four 110-ft cutters forward deployed to the North Persian Gulf: *Wrangell, Adak, Aquidneck,* and *Baranof.*

In table 2, we outline the Navy's rotational crewing initiatives, including past and ongoing experiments. These applications serve as the current source of evidence on how these initiatives work in practice. We use them to shed light on the consequences of alternative deployment and manning concepts for manpower, personnel, and training processes and policies, with particular attention to their interface with the emerging operational concepts, such as Sea Warrior and the FRP. In this section, we describe the basic design characteristics of these applications and experiments in rotational crewing and discuss general lessons concerning manpower, personnel, and training issues.

Table 2. Rotational crewing: Navy applications and experiments

Initiative	Navy applications/experiments
Blue/Gold: applications	Standard practice on Ohio-class Trident submarines and USS *Swift* (HSV-2)
	Planned for use on the Navy's new surface ship, the Littoral Combat Ship (LCS), on first two ships from Lockheed Martin, and on first two ships from General Dynamics
Horizon-like: current and planned applications	Mine Countermeasure (MCM-1) experience during the 1990s
	Current practice on MCMs, Coastal Minehunter (MHC) ships, and Patrol Coastal (PC) ships operating in the North Arabian and Persian Gulfs in support of Operation Iraqi Freedom (OIF) and Operational Enduring Freedom (OEF)
	Planned for use on the LCS, once Navy takes delivery of third ship from Lockheed Martin and of third ship from General Dynamics
Sea Swap: experiments	USS *Fletcher* (DD-992), USS *Kinkaid* (DD-965), USS *Oldendorf* (DD-972), USS *Elliot* (DD-967)
	USS *Higgins* (DDG-76), USS *Benfold* (DDG-65), USS *John Paul Jones* (DDG-53)
	USS *Gonzalez* (DDG-66), USS *Stout* (DDG-55), USS *Laboon* (DDG-58) (second sea swap ongoing)

Blue/Gold

The Blue/Gold approach to manning ships uses two crews per ship: one Blue and one Gold. Having two crews for one ship allows the Navy to lengthen a ship's deployment without increasing the length of a crew's deployment. The Blue crew sails the ship into theater while the Gold crew remains in homeport. As the Blue crew approaches the sixth month of its deployment, the Gold crew flies into theater, completes a turnover with the Blue crew, and the Blue crew flies back to homeport. The Gold crew sails the ship back to homeport after about 6 months.

Blue/Gold crewing on Trident submarines

The Navy has used the Blue/Gold crewing approach on its Trident submarines since the 1960s. Originally, to provide maximum coverage by SSBNs for strategic nuclear deterrence, the Navy forward-deployed SSBNs overseas, with each ship manned on a rotational basis by a Blue and a Gold crew. Due to advancements in missile technology, it is no longer necessary to forward deploy SSBNs, but the Navy still uses the Blue/Gold crewing concept on SSBNs to ensure that it meets current strategic requirements with fewer ships while maintaining a lower PERSTEMPO.

As applied on SSBNs, one crew operates the ship on station while the other rests, trains, and prepares to relieve the onstation crew. The onstation crew operates the submarine on patrol for 74 days and then returns to port where both crews work together for 38 days covering inspections, conducting maintenance, and turning over responsibility for the ship [8]. While one crew is at sea with the submarine, the “offcrew” remains ashore and goes through the offcrew training cycle. These crewmembers attend school, train, and hone their skills at the shore-based training centers located at the Trident bases. The cycle repeats for the anticipated 42-year service life of the submarine with occasional longer periods of scheduled maintenance, including a refit period, longer maintenance periods of 4 months at 14 and 33 years, and a 2-year period for replacement of the reactor core and additional major, long-term maintenance [9].

The Navy designed, engineered, and built Trident submarines and their bases, including the shore training infrastructure, to support the Blue/Gold crewing concept. The physical design of the Trident submarine includes large logistic hatches and removable decks to facilitate quick replacement of large pieces of equipment as well as the resupply of the submarine. The planned maintenance program for Trident submarines is tailored to keep "like-new" equipment on the submarine for each deployment. The Navy replaces equipment on a set schedule, regardless of whether the equipment needs to be replaced. The maintenance facilities (dry docks, cranes, etc.) for the Trident submarine are specially designed to support quick equipment replacement and upgrades. In addition, the Navy has built extensive onshore training facilities at Trident bases to support the offcrew's continual training and maintenance of readiness levels.

Blue/Gold crewing on HSV *Swift*

The Navy also employs the Blue/Gold crewing approach on the High-Speed Vessel *Swift* (HSV-2), an aluminum-hull catamaran being used as a mine-countermeasure and sea-basing test platform. HSV *Swift* has a crew of 40 Sailors (officer and enlisted). The Blue crew is homeported out of Ingleside, Texas. It has a parallel crew—the Gold crew—based out of Naval Amphibious Base, Little Creek, Virginia. *Swift's* crew rotates every 4 months. Depending on where the ship is located at the 4-month rotation point, the crew may swap stateside or it may swap in a friendly, forward-located port, which gives the crews an opportunity for an international port visit.

Advantages and challenges

Rotational crewing initiatives focus on maximizing ship forward presence while adhering to Navy PERSTEMPO rules. By using the Blue/Gold crewing concept on SSBNs, the Navy has met its ongoing strategic requirements *with fewer ships while maintaining a lower PERSTEMPO*. Using Blue/Gold crewing and operating with fewer ships maximizes SSBN presence while avoiding the costs associated with the procurement and maintenance of additional SSBNs that would be needed to provide the same level of presence under traditional manning constructs.

There are a number of concerns, however, that the Navy must consider before expanding its use of Blue / Gold crewing. First, the Navy's use of Blue / Gold crewing, to date, has been the special case rather than the general rule. The platforms that use Blue / Gold crewing do not adhere to the traditional surface ship interdeployment cycle. The Navy developed Trident submarines to support the Blue / Gold crewing concept, and the deployment length per crew is 74 days with a 38-day interim period for inspections, maintenance, and turnover. Their regular and extended maintenance periods do not match the typical time in maintenance for other Navy ships. Currently, HSV *Swift* is the only ship of its type that the Navy has in service. Its crew is small (only 40 members), and the crew deployment lengths are 4 months. Both *Swift* and the SSBNs are designed structurally to take advantage of plug-and-play equipment that is easily upgraded or swapped. Given these points, is it practical for the Navy to use the Blue / Gold crewing concept on other types of surface ships that have much larger crews and adhere to the traditional interdeployment cycle?

The primary advantage of the Blue / Gold crewing concept is that the amount of time a ship is deployed can increase significantly without changing the length of a crew's deployment and potentially violating the Navy's PERSTEMPO policy. The Navy adopted the current rules of PERSTEMPO in 1986. Ideally, Sailors spend no more than 6 months deployed and then get at least 2 months back in homeport for every month the unit was deployed. In addition, over any 5-year period, each unit is to spend no more than half of its time away from homeport (including time deployed, time under way when not deployed, and time away from homeport for maintenance). Operational units may break these rules only under special circumstances. The Navy may find that these rules, especially the minimum TAR of 2:1, constrain its ability to support the FRP.

A previous CNA study [10] considered the scenario in which the Blue / Gold crewing operations concept is applied to a surface ship, increasing its deployment length to almost 12 months, with each crew manning the ship for half of the time. The goal is to provide the continuous presence of one ship in the Persian Gulf, with ships homeported in San Diego. Using only one ship with a set of Blue / Gold crews quickly violates the Navy's PERSTEMPO rules because each crew would have a TAR of 1: that is, 6 months deployed, 6 months in homeport, 6 months deployed, and so on. The ship's operating tempo (OPTEMPO) would also be high. Consequently, to obtain a more reasonable PERSTEMPO for the crews and OPTEMPO for the ships requires having more ships with Blue / Gold crews.

Using four ships with four sets of Blue / Gold crews (for a total of eight crews), ship Alfa deploys for approximately 11.5 to 12 months. For the first 6 months, its Blue crew is on the ship; for the second 6 months, its Gold crew is manning the ship. The remaining three ships and their respective Blue / Gold crews are in homeport either conducting training or in maintenance availabilities. As ship Alfa approaches the end of its 12-month deployment, ship Bravo leaves port to assume forward presence responsibilities. In table 3, we show the effects on ship OPTEMPO and crew PERSTEMPO. Using four ships and eight crews results in a reasonable OPTEMPO for the ship (22.5 months at home following 11.5 months deployed), but the crew TAR is high at 3.7, which implies a PERSTEMPO that is too low. Reducing the number of ships to three and the number of crews to six results in a more reasonable TAR of 3.3, but the interdeployment phase (IDP) for the three ships decreases to only 14 months between 11.5-month deployments. To support the higher OPTEMPO, maintenance and training schedules would need to be adjusted.

Table 3. Impact of Blue/Gold crewing on OPTEMPO and PERSTEMPO[a]

To provide continuous presence in the Persian Gulf …	Number of ships	Months of IDP	Number of crews	Turn-around ratio (TAR)
Example 1 (from San Diego)	4	22.5	8	3.7
Example 2 (from San Diego)	3	14.0	6	3.3

a. Source: [10].

In practical terms, there are several differences between manning a single-mission submarine or a one-of-a-kind ship and manning an entire class of multimission ships, such as amphibious assault ships or destroyers, using Blue / Gold crews. If we assume that the Navy keeps the same number of vessels in a given ship class, the major concerns associated with using Blue/Gold crews on larger, multimission platforms are the costs and the increase in the number of sea billets.

First, having two crews for one ship implies twice the number of personnel and manpower personnel Navy (MPN) cost per ship. However, under Blue/Gold, the Navy will be able to meet presence requirements with fewer ships, so it may be able to realize some cost and manpower savings by reducing the number of ships and Sailors. Even with fewer ships and fewer Blue-Gold crews, however, there would be stretches of time during the interdeployment cycle when both the Blue and Gold crews on a single ship would be in port at the same time with their ship. It is unclear what both crews would be doing during these overlapping time periods in homeport.

Second, Blue-Gold crewing also requires an expanded shore-based training infrastructure for the offstation crew(s) and potentially other shore-based administrative support. Currently, the Navy is planning for decreases in overall endstrength levels. Increasing the number of sea billets to support Blue/Gold manning would require shifting more shore-based billets to sea billets, which in turn would adversely affect sea-shore ratios.

Finally, the Navy did not structurally design its multimission ships to operate using the Blue/Gold manning approach. Even ships within the same class are not identical, and equipment upgrades are phased across ships; they do not occur at the same time. Consequently, increasing the number of crews to support Blue/Gold manning seems unlikely for multimission ships with larger crews.

Horizon

Suggested by Strategic Studies Group XVI, the Horizon concept offered a new operational approach that allows the Navy to meet forward presence requirements and to provide crisis response and surge capability for all other operations [11]. The concept reorients the Navy from a pattern of cyclic readiness to sustained readiness by maintaining people and platforms in a continually ready state. The Horizon approach to crewing usually involves one or two more crews than hulls, such as five crews for four ships or for three ships.

Under this concept, the Navy maintains one ship continuously in the forward areas of responsibility, while the rest are in homeport serving as training ships as they prepare to go forward or in maintenance availabilities. The Horizon concept assumes that the hulls are identical in configuration and equipment aboard. Because there are more crews than ships, the extra crew(s) stay ashore in a Readiness Center. Horizon also proposes extending the interdeployment readiness cycle from 24 months to a 30-month fleet response cycle. Under the five-crew/four-ship example within a 30-month fleet response cycle, a crewmember would rotate in the following sequence:

- 7 to 9 months assigned to a Readiness Center facility working as an instructor, receiving advanced training, or working in a skill-related billet
- 12 to 15 months assigned to a Readiness Unit training both in port and under way on one of the offstation platforms (individual crewmembers are able to maintain high levels of readiness on a continual basis using advanced and collaborative training technologies and techniques)
- 2 weeks of intensive “online” turnover by fully trained and qualified crew with the onstation crew aboard the forward-deployed platform (expanded bandwidths allow Readiness Unit crews to view the same displays and work center environments as those forward)
- 6 months on the forward-deployed platform
- End of cycle and return to Readiness Center/Unit.

Advantages and challenges

In table 4, we show the effects of the Horizon crewing concept of operations on ship OPTEMPO and crew PERSTEMPO for two different scenarios as posited in [10]. The first scenario includes four ships and five crews; the second has three ships and five crews. For both scenarios, each crew deploys for 6 months and each ship deploys for 33.5 months. For a continuous presence in the Persian Gulf from San Diego, both the 5/4 and 5/3 crew/ship combinations provide reasonable time between deployments for both crews and ships.

Table 4. Impact of Horizon crewing operations on OPTEMPO and PERSTEMPO[a]

To provide continuous presence in the Persian Gulf …	Number of ships	Months of IDP	Number of crews	Turn-around ratio
Example 1 (from San Diego)	4	88.5	5	3.2
Example 2 (from San Diego)	3	58.0	5	3.2

a. Source: [10].

Many of the challenges that we noted earlier in the Blue/Gold section (multimission ships, differences within ship class) hold here as well. From a manpower perspective, assuming that the Navy keeps the same number of ships, the foremost obstacles are the increase in manpower costs, the increase in the number of sea duty billets, and the impact on sea-shore rotation ratios. Having an extra crew (or crews) not assigned to a hull implies a proportional increase in MPN costs. Having an extra crew (or crews) also implies an increase in the number of sea duty billets. At this time, the Navy cannot expect an increase in overall endstrength to accommodate increases in the number of sea duty billets. In fact, the Navy anticipates a decreasing endstrength over the next several years, implying that any increase in the number of sea duty billets will require a decrease in shore billets, which in turn will adversely affect sea-shore ratios. Concurrently, the Navy is under pressure from OSD to identify non-military-essential functions manned by active duty members and to either convert to civilian positions or outsource to private contractors, creating additional pressures on the number of available shore billets to convert to sea duty billets and maintaining some reasonable level of compliance with current sea-shore rotation policies.

Rotational crewing becomes much more appealing from a potential cost perspective, however, if we adjust our assumptions regarding the number of ships and crews. Assuming a fixed, forward presence requirement, an increase in hull use, and no change in crew OPTEMPO, the Navy would need fewer hulls and crews under rotational crewing approaches and would be able to meet its presence requirements. For example, recent CNA analysis projected the crew manning costs associated with the current DDG program of record and a rotational crewing design of 8 crews/6 ships/2 ships forward (see [12]). The program of record calls for 62 ships and crews to provide a 15-ship forward presence with a historical average yearly MPN cost of roughly $15.25 million per crew and a total yearly cost of $945.5 million. In comparison, CNA determined that the Navy could achieve the same 15-ship presences with only 34 ships and 42 crews using an 8:6:2 rotational crewing design. Under this scenario, total crew costs for manning these ships would be about $640.5 million, yielding a $305-million yearly savings.

As noted in [10], another issue is keeping all of the ships as "identical" as possible to make it easier for the crews to train and to rotate on and off the forward ship. Because ships rotate home every couple of years, it is difficult for the Navy to upgrade all ships in a squadron at (nearly) the same time. In addition, the concept of continuous improvement works against "identical" ships. Building Readiness Centers will require funding to purchase, maintain, and upgrade simulators and other training aids needed to keep crew readiness levels high. The more frequent rotation of crews from ship to shore introduces an additional management task for the Bureau of Personnel (BUPERS), which will need to issue orders when crews rotate and update records to keep track of where Sailors are. It will be important that the Navy have a software package in place that allows BUPERS to seamlessly support these evolving personnel administration activities.

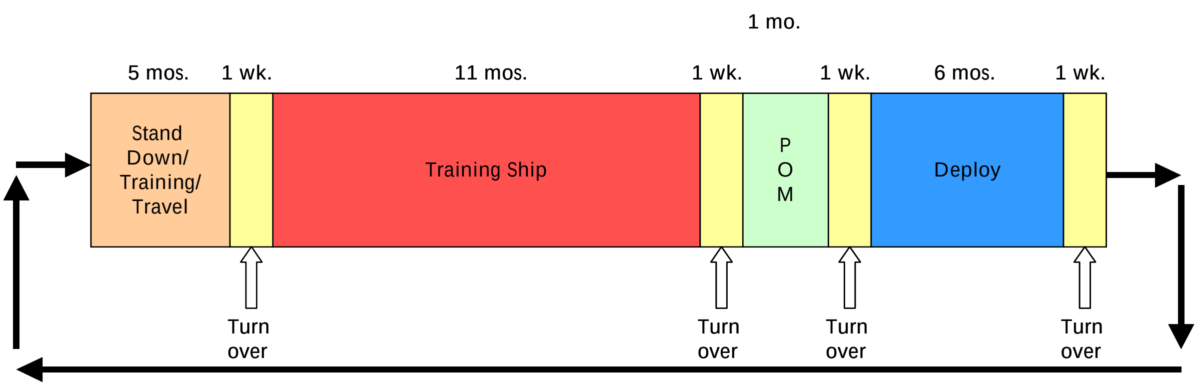
Multicrew/multihull manning on MCM-1s

To date, the Navy has not used the Horizon approach as described earlier, although it has used the multicrew/multihull approach on several types of surface ships, including Mine Countermeasure (MCM-1) ships, Coastal Minehunter (MHC) ships, and Patrol Coastal (PC) ships. One of the Navy's first applications of multicrew/multihull manning was on MCM-1s in the mid-1990s.[4] Originally, the Navy used the multicrew/multihull approach on two MCM-1 ships forward deployed to Japan, beginning in September 1994. In 1996, Fifth Fleet required that two MCM-1s be sent to the Arabian Gulf. The Navy had insufficient manpower to support crew rotation aboard two separate

4. For this discussion, we draw from information provided in [13].

two-ship forward deployments. Consequently, the Navy designated 6 of the 14 MCMs in the fleet for crew rotation to the Arabian Gulf and, in January 1996, converted the forward-deployed MCM-1s in Japan to permanent crews. The MCM-1 rotational crewing design applied by Fifth Fleet in the Arabian Gulf used six ships and eight crews. The Navy forward deployed USS *Ardent* (MCM-12) and USS *Dextrous* (MCM-13) in the Arabian Gulf and used four ships located in Ingleside, Texas, for training. Crews rotated to and from the Arabian Gulf every 6 months. We depict the 24-month MCM crew rotation in figure 1.

Figure 1. MCM crew rotation cycle—1990s application



After deploying for 6 months, crews returned to Ingleside for a stand-down / trailer-training / schoolhouse period lasting 5 months (also known as the trailer period). Next, they were assigned for 11 months to a training ship, followed by a 1-month preparation for overseas movement (POM), and then deployment. Every 6 months, one of the offstation crews completed its 11-month training period and flew to the Arabian Gulf to replace the crew on *Ardent* or *Dextrous*. For the most part, a single crew conducted its training on the same ship for the entire period, although there were occasions in which an offstation crew conducted its training on two different ships over the 11-month period, as opposed to one.

The early experiences of multicrew manning on the MCMs provide a number of lessons for more recent initiatives, particularly with respect to the importance of having enough Sailors to support multihull/multicrewing designs, maintaining crew stability, and ensuring that the quality of the training for the offship crew remains equal to that provided crews assigned to a training ship. From a manpower perspective, we think it is noteworthy that the Navy decided early in the MCM-1 rotational crewing experiment that it did not have sufficient manpower levels to support rotational crewing on more than one set of two forward-deployed MCMs. Given that the Navy is undergoing a period of decreasing endstrength levels, we anticipate that having a sufficient number of Sailors to support rotational crewing while adhering to sea-shore ratios and PERSTEMPO limits will continue to present the Navy with serious manning challenges.

Second, deploying a fully trained crew is dependent on maintaining crew stability during the training cycle. Ideally, given the rotation cycle of the MCM-1 crews, the turnover of personnel needed to occur as much as possible during the earlier training cycle—in this case, during the time a rotational crew was in the trailer-training period. While planned crew turnover was not an issue, rotational crews undergoing training in Ingleside experienced first-term attrition at significantly higher rates than other surface combatants, with the highest rates occurring among first-term Sailors on the training ships. On a positive note, rates of first-term attrition for crewmembers on the ships forward deployed in the Arabian Gulf were slightly less than first-term attrition rates for surface combatants as a whole and significantly less than MCM-1s as a whole.

Finally, CNA found that crew training did not progress well during the 5-month standdown/trailer-training/travel period [13]. Crew productivity was low during this portion of the rotation cycle, which was attributed to a lack of sufficient resources and infrastructure to provide proper training during the period. In addition, the offstation crew training during the trailer period and on the training ship was limited to the basic phase. Without formal intermediate and advanced phase training opportunities, rotational crews were not able to train and exercise with the full complement of the MCM force and battlegroup before deployment. Potential remedial actions included investing in significant schooling upgrades (such as technology modernization and simulation) to the trailer-training program and/or expanding the time the crew spent on the training ship while reducing trailer-training time. MCM rotational crews also were required to complete personnel and hull inspections during each 11-month training period. Arguments were made to relax hull inspection requirements and bring them more in line with the frequency of ship certification experienced in the broader surface Navy to allow rotational crews more time to actually train.

Multicrew/multihull manning during Operation Iraqi Freedom

The Navy stopped using crew rotation on MCM-1s during the late 1990s. During the past 3 years, however, to meet operational requirements in support of the GWOT, the Navy has reinstituted the use of rotational crewing on MCM-1s and extended the practice to MHCs and PCs. In this section, we consider the Navy's experience on the PCs to highlight the challenges that the Navy continues to experience with the multihull/multicrewing approach to manning.[5]

As of December 2005, the Navy had eight PC (Cyclone class) ships manned on a rotational basis by a total of 13 crews. All eight vessels are homeported at Naval Amphibious Base, Little Creek, Virginia, and fall under the responsibility of Regional Support Office (RSO) Norfolk. Their primary mission is coastal patrol and interdiction surveillance. With a length of 179 feet and a 10-foot draft, PCs provide the Navy with a fast, reliable platform that can quickly respond to emergent requirements in a shallow-water environment.

During the GWOT, the Navy has found that PCs are well suited for maritime homeland security missions off the U.S. coastline as well as for security and surveillance missions supporting U.S. naval operations in the Persian Gulf. The Navy has four PCs forward deployed to the Persian Gulf. USS *Chinook* (PC-9) and USS *Firebolt* (PC-10) deployed to the Persian Gulf in January 2003; USS *Sirocco* (PC-6) and USS *Typhoon* (PC-5) reported on station to the Persian Gulf in June 2004. All four ships remain under the command of Fifth Fleet, and a fifth PC joined their group in early 2006. As of February 2006, *Chinook* and *Firebolt* mark their 37th month of deployment, and *Sirocco* and

5. We obtained our information on rotational crewing on PCs from [14].

Typhoon mark their 20th month of deployment. Thirteen PC crews—designated Alfa through Mike[6]—rotationally man the five forward-deployed PCs. The Navy homeports its remaining three PCs at Little Creek; it provides training platforms for the eight remaining crews that are not manning the forward-deployed PCs. Authorized billet manning for PCs is a crew of 28 Sailors: 4 officers and 24 enlisted.

With nearly three times as many PC crews than ships in homeport plus the requirement to rotate crews on the five forward-deployed PCs every 6 months, coordinating schoolhouse and onship training is a challenge. To meet onship training requirements, the Navy must attach more than one crew to each of the three remaining ships in homeport. Because on any given day of the week only one crew actually is training on a single ship, crews rotate on and off the training ships during the week to share the training days. So, for example, at one time in the PC training schedules, Crews Alfa, Bravo, Golf, Hotel, and India were sharing available training days on one ship. In addition, during workups, PC crews will also rotate across the training hulls, so they are training on multiple ships. And the ships are not identical. There are equipment differences across all the PC hulls because these vessels once fell under Special Warfare Command and the funding was there to add extra equipment to each of the ships. Schoolhouse-based "difference" training would address these equipment differences but, due to the tight onship training schedule, it is usually not possible to schedule Sailors for schoolhouse training.

To "standardize" the maintenance of the ships and training of the crews, the Navy recently consolidated the PC force (ships and crews) at Little Creek, Virginia. While essentially creating a PC readiness squadron, the operating tempo of the ships and the intensity of the work for the PC crews are high. The three homeported PCs and the PC crews are operating under a waiver from Navy OPTEMPO rules. Every evolution involves every crewmember, and, in theater, every

6. PC crew name designations coincide with the international alphabet flags. The Navy has found that this naming application facilitates keeping track of crews not assigned to a single ship. The Navy currently has 13 PC crews. At that number, they are named crews Alfa, Bravo, Charlie, Delta, Echo, Foxtrot, Golf, Hotel, India, Juliett, Kilo, Lima, and Mike.

crewmember must be able to do nearly every task, including maintenance. In addition, the forward-deployed PCs usually do not get good port visits. When a PC pulls into port in the Persian Gulf area of responsibility, the crew must attend to ship maintenance first and is granted liberty only if force security protection levels allow it. Given the high operational stress that the PC crews and ships are under, the Navy needs to closely monitor the personnel, training, and maintenance experiences of these ships for lessons. At a minimum, the Navy needs to examine the retention behavior of Sailors assigned to the PCs since January 2003 when the first two PCs were forward deployed to the Persian Gulf.

Sea Swap

Sea Swap is similar to Blue / Gold and Horizon in design, except that the number of crews and ships are equal. Having an equal number of crews and ships eliminates the problem of crews without ships, while allowing ships to remain forward deployed longer. Under a two-ship / two-crew Sea Swap approach, a ship deploys with Crew Alfa. After 6 months, Crew Bravo relieves Crew Alfa, which returns home to take over the ship that Crew Bravo was manning. Ideally, to support consistency of training across different ships, the ships should be identical in layout and equipment.

As shown earlier in table 2, the Navy conducted its first Sea Swap experiment from August 2002 through June 2004 under the supervision of Commander, Naval Surface Force, U.S. Pacific Fleet (SURFPAC).[7] Its second experiment, which is ongoing, began in the fall of 2005 under the supervision of Commander, Naval Surface Force, U.S. Atlantic Fleet (SURFLANT). Each experiment extends the deployments of selected surface combatants. The first Sea Swap involved two sets of three ships: three DDs (Spruance class) and three DDGs (Arleigh Burke class). The current Sea Swap experiment involves one set of three DDGs (Arleigh Burke class). The design for each set of Sea Swap experiments is virtually the same, although there are some slight differences, which we will note in our discussion.

7. For our discussion of the first Sea Swap experiment, we draw from [15 through 19].

The Sea Swap experiments

Under Sea Swap 1, SURFPAC deployed a DD hull (USS *Fletcher*) and a DDG hull (USS *Higgins*). USS *Fletcher* deployed from August 2, 2002, to June 5, 2004—for a total of three crew swaps encompassing four 6-month crew cycles. USS *Higgins* deployed from November 2, 2002, to April 4, 2004, undergoing two crew swaps covering three crew cycles. Under Sea Swap 2, one DDG hull, USS *Gonzalez*, currently is deployed for an expected period of 18 months. The first ship of each type in the Sea Swap rotation deploys with its associated battlegroup. Follow-on crews train with their respective battlegroup, fly out to a forward Sea Swap city for turnover, relieve the crew on the forward-deployed ship, and then operate with forces in theater.

Under Sea Swap 1, the crew turnovers were slightly different for the DDs and the DDGs. The Sea Swap deployment of *Fletcher* occurred during the decommissioning of the Navy's Spruance-class destroyer fleet. Each oncoming crew decommissioned its ship before swapping with the offgoing crew of *Fletcher*. Consequently, the offgoing *Fletcher* crews did not remain together and return to another Spruance-class destroyer, but rather dispersed to a variety of new assignments. This was not the case for the DDG Sea Swap crews. Offgoing crews from *Higgins* returned to homeport to take custody of the Burke-class destroyer just vacated by their oncoming Sea Swap crew. The second Sea Swap is following the same rotation scheme used for the first DDG Sea Swap on USS *Higgins*, except the first crew swap occurred 6 months before USS *Gonzalez* deployed in March 2005: Crew *Laboon* turned over with the original Crew *Gonzalez* in October 2004 allowing Crew *Laboon* 6 months to become familiar with and train on its new ship before deploying.

One of the early issues that arose in the first Sea Swap experiment was the manner in which BUPERS processed orders and kept track of the different crews. BUPERS attempted to maintain level manning for each crew through their respective deployments. In some cases, BUPERS negotiated with Sailors to postpone their rotation dates until after completing the deployment phase of the Sea Swap experiment. The majority of the DD and DDG crews in Sea Swap 1 received orders to their next assignment before each swap. This was particularly relevant for the DD crews who were involved in the concurrent decommissioning process. It was preferable for the Sailors to make plans early while still ashore in homeport, rather than having the whole crew trying to coordinate its next assignment with BUPERS while forward deployed.

Despite these planning efforts, the Sea Swap timeline still did not line up with the traditional BUPERS timeline, and there were some outstanding orders issues. These involved personnel who had not met warfare qualification requirements during the predeployment period, crewmembers who were awaiting approvals to transfer to other ratings, and some crewmembers who were unwilling to extend their rotation date until the deployment was over. In addition, with multiple crews and multiple ships, there were some cases in which BUPERS sent some DDG Sailors to the wrong ship at the time of the swap.

Over the course of the various rotational manning initiatives, the Navy has experienced the reoccurring issue of keeping track of the crews separately from the ships. The issue is a little less complicated when the numbers of crews and ships are the same compared with when there are more crews than ships. However, since the alphabetic crew designation has facilitated keeping track of the many PC rotational crews, the Navy is using the same approach in Sea Swap 2. The three crews associated with the ongoing Sea Swap experiment are named Crew Golf (for the original *Gonzalez* crew), Crew Lima (for the original *Laboon* crew), and Crew Sierra (for the original *Stout* crew). Each crew has a separate Unit Identification Code (UIC), so orders must be written to the crew, not to the ship.

Personnel readiness issues involved dealing with the differences in configurations among the hulls. As is generally the case for all Navy ships (except the Trident submarines), even though hulls may be from the same class, they are not carbon copies. System configurations—both hardware and software—vary from ship to ship, and crew manning does not always match billet for billet with other ships in the same class. This was particularly true during Sea Swap 1 on both the DDs and DDGs, which required some difference training to resolve mismatches between variants of the combat and engineering systems on each type of ship. The difference training included both formal schoolhouse training and on-the-job training (OJT), which was planned and executed by the individual ships. In general, under Sea Swap 1, there was sufficient time to complete all the training requirements. In comparison, the ships participating in Sea Swap 2 have nearly identical manning and the only difference training required is for the computer baseline for *Stout*, which differs from the computer baseline on *Gonzalez* and *Laboon*.

The Sea Swap schedule also affected battlegroup training. Crews Alfa and Bravo on *Fletcher* and *Higgins* worked up with the battlegroups with which they were slated to train and deploy. Their Sea Swap deployments coincided with the forward operation of their battlegroups. The alignment of the later crews with their respective battlegroups was not exact, but for the most part the middle crews operated in theater with the battlegroups with which they trained. By the end of the Sea Swap period, the schedules were out of synchronization. The Delta crew on *Fletcher* and the Charlie crew on *Higgins* were forward in the Central Command theater with Atlantic Fleet battlegroups. However, many ships operate independently of the Carrier Strike Group (CSG) within Fifth Fleet; consequently, the actual observed impact of not training with or conducting the transit with the CSG was limited during the first Sea Swap [20]. Surface combatant crews tend to focus on preparing for Fifth Fleet operations, not CSG operations.

One issue of concern with the application of rotational crewing approaches is whether the intensity of the work increases both during the homeport training period and during deployment. CNA conducted an assessment of Sea Swap 1 (see [20]). As part of this assessment, analysts administered workload surveys to the crews to determine whether the workup training, the crew turnover process, and the work levels throughout the entire deployment were higher.

Results indicated that the workups did involve training not typically encountered under the traditional interdeployment training cycle (IDTC) [20]. Each Sea Swap crew worked extra hours beyond the Standard Navy Work Week, although the differences were not statistically significant. Anecdotal evidence indicated that Sailors felt the workload was higher throughout the deployment. Intense maintenance demands kept Sea Swap crews on the ship when they pulled into an Arabian Gulf port, while other ships' crews had liberty. The burden of maintaining the ships is likely to continue to fall on the deployed rotational crews due to the longer periods of time that the forward-deployed ship is away from the homeport, shore support organization. We saw earlier in our discussion that this tends to be an issue, as well, for rotational crews on the forward-deployed PCs.

Sailor response to Sea Swap

The CNA assessment of Sea Swap also looked at how the initiative improves or degrades the quality of life and quality of work for Sailors. Results from the quality-of-life survey administered to each of the Sea Swap 1 crews indicated that the initiative was not popular with the participating crews: predeployment expectations tended to be low, and postdeployment impressions were even more unfavorable [20].

Overall, Sea Swap reenlistment intentions, as indicated by the survey results, were comparable to reenlistment intentions found in a recent Navywide reenlistment survey. However, differences emerged by paygrade. E4s, in particular, were well above the Navywide standard for planning to leave: Nearly 50 percent of the Sea Swap E4s indicated a plan to leave the Navy compared with only about 28 percent of Navywide E4s who indicated a similar intention. The more junior (E1–E3) and the more senior (E5 and above) were slightly less negative than the Navywide standard regarding reenlistment plans. Thirty-nine percent of junior Sea Swap Sailors indicated an intention to leave versus 41 percent Navywide. Twenty-eight percent of senior Sea Swap Sailors indicated an intention to leave versus 34 percent Navywide.

As of April 2006, just over 21 months have elapsed since the end of the Sea Swap experiment on the DDs, while it has been 23 months since the end of the experiment on the DDGs. Is the reenlistment behavior for the crewmembers from the first Sea Swap in line with their expressed intentions? How does their loss behavior compare with Sailors on other surface combatants? While we are limited to the extent to which we can explore this issue in this paper, we provide a quick first look at aggregate-level reenlistment rates from Sea Swap crewmembers. Ideally, the Navy should direct a more full examination of the reenlistment experience of Sea Swap Sailors that compares to a pre-experiment baseline and controls for other retention factors.

Using CNA's longitudinal enlisted master records (EMR), we determined reenlistment rates through March 2006 for those crewmembers reaching their next decision point since the month in which the crew rotated off *Fletcher*, for the DD crews, or off *Higgins*, for the DDG crews. For comparison purposes, we also determined reenlistment rates for all DDs, all DDGs, and all surface combatants deployed at times similar to each of the Sea Swap crews. We considered a ship to be deployed at the same time as one of the Sea Swap crews if the deployment period overlapped with a given Sea Swap deployment period by 3 or more months. We determined reenlistment rates at 12 months, 18 months, and 24 months from the end of each crew's deployment. How far out we were able to track reenlistment rates varied by the amount of time since the last month of each crew's Sea Swap deployment. A full 24 months has passed since the ending date of the Sea Swap deployments for Crews *Fletcher, Kinkaid, Oldendorf, Higgins*, and *Benfold*, so we were able to calculate reenlistment rates at the 12-, 18-, and 24-month intervals for these crews. However, our EMR file only goes through March 2006, so we calculated reenlistment rates at the 23-month interval for Crew *John Paul Jones*. In addition, 24 months have not elapsed since the last month of Crew *Elliot's* deployment, so we only calculated reenlistment rates at the 12- and 18-month intervals.

In figures 2 and 3, we compare the reenlistment rates for the DD Sea Swap crewmembers with reenlistment rates for Sailors deployed at similar times on other DDs and other surface combatants (SCs). In figure 2, we provide the aggregate reenlistment rates for all Sea Swap crews. In figure 3, we show the rates for the individual DD Sea Swap crews. The blue bar indicates the reenlistment rate for crewmembers reaching a reenlistment decision point within 12 months after the last month of deployment for each DD Sea Swap crew. The red bar indicates the reenlistment rate for crewmembers reaching a reenlistment decision point by the 18th month after the last month of deployment for each DD Sea Swap crew. And the yellow bar indicates the reenlistment rate for crewmembers at 24 months. As noted above, we are not able to calculate a 24-month reenlistment rate for Crew *Elliot* because only 18 months had elapsed as of April 2006 since crewmembers completed their deployment on USS *Fletcher*.

Figure 2. Comparison of total DD Sea Swap crew reenlistment rates with crews on other DDs and other surface combatants

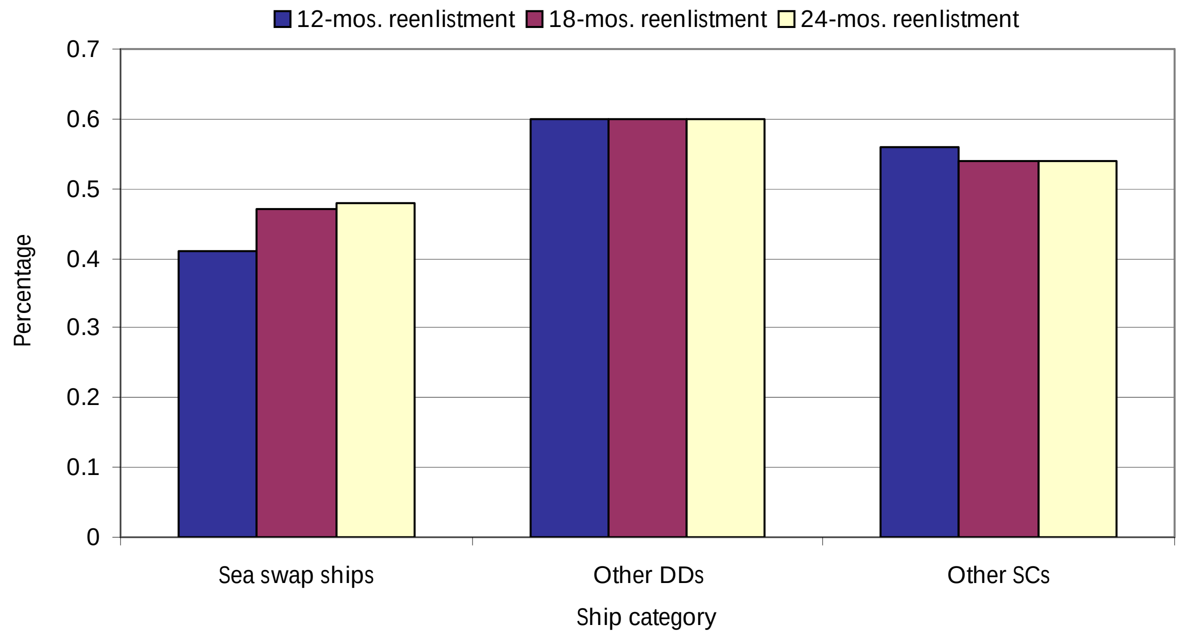


Figure 3. Comparison of DD Sea Swap crew reenlistment rates (for each crew) with crews on other DDs and surface combatants

Overall, Sea Swap crewmembers reenlisted at rates significantly lower (α =.001) than those of crewmembers assigned to other DDs and other surface combatants. Notice, however, that the reenlistment rates for the DD Sea Swap crews have increased with the passage of time, suggesting that any potential negative impact associated with the Sea Swap experience lessens over time, even though the differences remain statistically significant. Figure 3 shows two comparisons of interest. First, we compare the reenlistment rates of each Sea Swap crew with the crews from the other DDs and surface combatants. Each of the Sea Swap crew's reenlistment rates are lower than the rates for the comparison crews. The differences by time interval are not statistically significant for Crew *Fletcher,* but are for Crews *Kinkaid* (α =.05), *Oldendorf* (α =.001), and *Elliot* (α =.001).

The second comparison is between the DD Sea Swap crews. The original crew, Crew *Fletcher,* has reenlisted at higher rates than the other DD Sea Swap crews. Reenlistment rates tend to decrease across successive Sea Swap crews—that is, the reenlistment rates tend to decrease for crews involved in the later swaps. As the original crew, Crew *Fletcher* deployed when the ship was in the best materiel condition. Perhaps the gradual degradation of shipboard conditions through the *Fletcher's* 18-month deployment dramatically changed the nature of the sea experience for the subsequent crews. It will be interesting to see if this pattern emerges with the DDG crews as well.

In figures 4 and 5, we show similar reenlistment data for the DDG Sea Swap crews. Overall, following the end of their deployments, these crews have reenlisted at rates higher than those of Sailors on other DDGs and other surface combatants deployed at roughly the same time. Sea Swap crew reenlistment rates are not significantly different from other DDG crew reenlistment rates; however, they are significantly higher than the reenlistment rates for crews on other surface combatants. The reenlistment rates for the DDG crews (both Sea Swap and non-Sea Swap) are also more stable over time, tending to stay around 62 to 64 percent.

When we compare crew-specific reenlistment rates in figure 5, we find that Crews *Higgins* and *Benfold* had the highest retention. Their reenlistment rates at 12-, 18-, and 24-months following the end of

Figure 4. Comparison of total DDG Sea Swap crew reenlistment rates with crews on other DDGs and other surface combatants

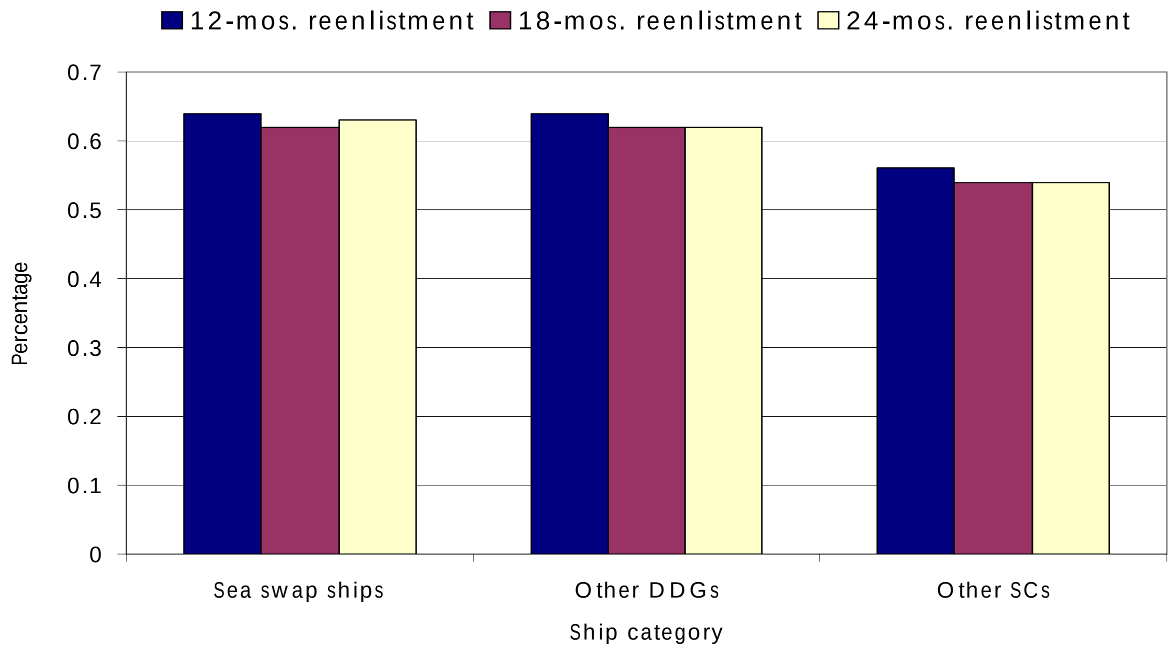


Figure 5. Comparison of total DDG Sea Swap crew reenlistment rates with crews on other DDGs and other surface combatants

their Sea Swap deployment are not significantly different from the crew reenlistment rates for other DDGs, but are significantly higher than the rates for crews on other surface combatants. Sailors from the last DDG Sea Swap crew, Crew *John Paul Jones*, have reenlisted at rates lower than the other Sea Swap crews and crews from the other DDGs. However, they are still reenlisting at rates similar to those for Sailors on other surface combatants.

From the Sea Swap assessment [20], we know that 55 percent of the crewmembers indicated that participating in Sea Swap made them less likely to stay in the Navy. Overall, the actual reenlistment behavior for Sailors from the DD Sea Swap crews tends to square with their earlier stated retention intentions, but this is not true for Sailors from the DDG Sea Swap crews. They actually have reenlisted at rates higher than indicated by the survey results on retention intentions. The reenlistment behavior patterns also differ between the two sets of Sea Swap crews: Sailors from the DD crews are tending to reenlist at comparatively lower rates, while Sailors from the DDG crews are reenlisting at higher rates. Again, we recommend that the Navy direct a more comprehensive evaluation of reenlistment rates for Sea Swap and other crews that fully controls for other important retention factors and compare it with a pre-experiment baseline for reenlistment rates.

Keep in mind that the Sea Swap design was not the same for the DD and the DDG crews. The DD crews were also decommissioning their original ships and *Elliot* was a last-minute add-on to the experiment. When the DD crews completed their deployment and rotated off *Fletcher*, they all went on to new assignments. When the DDG crews completed their deployment, they returned to the DDG vacated by the oncoming crew. Under Sea Swap 1, the DDG swap encompassed the design elements that the Navy most likely will continue to use in future applications.

For Sea Swap 2, the Navy has made some changes to address earlier issues and crew dissatisfiers. Crews on ships deploying from the east coast typically enjoy liberty in one of several highly desirable Mediterranean ports. Under Sea Swap 2, the crews turn over *Gonzalez* in Jabel Ali, which Sailors do not consider a good port visit opportunity. To ensure that the Sea Swap crews have high-quality liberty opportunities in desirable locations, the oncoming crew flies first to Rota for a week and then goes on to Jabel Ali to assume responsibility for *Gonzalez*. The offcoming crew leaves Jabel Ali, flies to Naples for a port visit, and then returns to homeport in Norfolk, Virginia.

Summary

Rotational crewing strategies raise a number of manpower concerns. First among these is the potential impact on sea-shore rotation ratios. Rotational crewing strategies that involve more crews than ships imply an increase in the number of sea duty billets for a given number of hulls that the Navy has in commission. During a period of decreasing Navy endstrength levels, this means shifting shore billets to sea billets, which has an immediate impact on sea-shore rotation ratios. Given ongoing pressures on the Navy to civilianize or outsource non-military-essential functions, the availability of shore billets to shift to sea billets presents a real roadblock to the Navy's ability to comply with current personnel policies regarding sea-shore rotation.

In addition, whether the crew-to-ship ratio is 4:3, 5:3, or any combination with more crews than ships, no part substitutes for shore duty. Instead, it adds extra sea billets that must be paid for by cutting shore billets.[8] At the same time, the shore infrastructure must grow to support rotational crewing, which furthers the demand for shore billets. Thus, the cost of rotational crewing in terms of finding offsetting shore billets to cut can be quite high, especially if the model were to be applied to larger ships or backfitted to larger legacy ships.

A second issue to be addressed is what the offstation crews without a ship are doing. Where will they work? How will they continue to train and maintain their skills? Will the Navy build shore training facilities for the offstation crews? And if so, what will be the costs associated with creating a shore infrastructure to support the offstation crews? A possible positive factor, however, is that crews remain intact. That is, while rotated to shore, the crew remains with the same command structure that can continue to look after its Sailors.

8. Sea Swap doesn't create this problem because three ships will still have three crews, so the total number of billets remains the same.

Finally, will rotational crewing strategies have an adverse effect on Sailor retention and attrition? Will rotational crewing designs potentially enhance or degrade Sailors' Navy career opportunities and quality of life? Our quick look at reenlistment rates for Sea Swap crews following the end of their deployment provides a mixed picture. Crew reenlistment rates were lower for the DD Sea Swap crews than the comparison DD crews and basically the same between DDG Sea Swap crews and comparison DDG crews. The reenlistment rates for the DDG crews may be more reflective of crews' responses to the Sea Swap design since the DD crews were also decommissioning their original ships and being reassigned to new billets following the end of their deployments. Absent the application of more sophisticated statistical techniques, the descriptive patterns suggest that overall Sea Swap had little impact on crew reenlistments. It will be essential for the Navy to monitor retention trends with any rotational crewing application or any major change in sea or shore duty attributes.

Alternative manning concepts

Closely related to rotational manning are three other alternative manning concepts:

- Sea-centric (or 130-percent) manning
- Filling unplanned losses
- Optimal manning.

We discuss 130-percent manning first because it is an alternative to rotational crewing. We then discuss filling unplanned losses because many of the alternative manning concepts call for ready sources of personnel to fill gaps. Finally, we discuss optimal manning experiments and initiatives. Optimal manning is closely related to alternative manning concepts. If rotational crewing and 130-percent manning increase the number of sea billets, then optimal manning is a way to offset these costs.

In table 5, we outline the main the parts of this section. Compared with rotational crewing, the Navy's experience with other alternative manning concepts is limited and has a shorter history.

Table 5. Optimal manning initiatives

Initiative	Approach
130% manning or sea-centric assignment	"Extra" manning ashore is available to fill unplanned losses; 30% shore manning is part of ship's manning complement; supports sea-centric assignments to warfighting positions and direct operational support billets.
Filling unplanned losses	Extra manning ashore at various commands placed in the "on-deck circle" to fill unplanned losses on multiple ships.
Optimal manning experiments	Use labor-saving technologies and processes, cross-train to reduce crew manning levels; move some Sailors to ashore detachments that still support the ships, assign others to ashore surge detachments and cross-deck with other ships in the battlegroup; cut persistently empty billets.

These experiments and practices serve as our source of evidence on how alternative manning initiatives work in practice. In this section, we describe the basic design characteristics of the Navy's alternative manning experiments and development of approaches to extra manning pools, and we identify general lessons and concerns related to manpower, personnel, and training issues.

Sea-centric, or 130-percent, manning

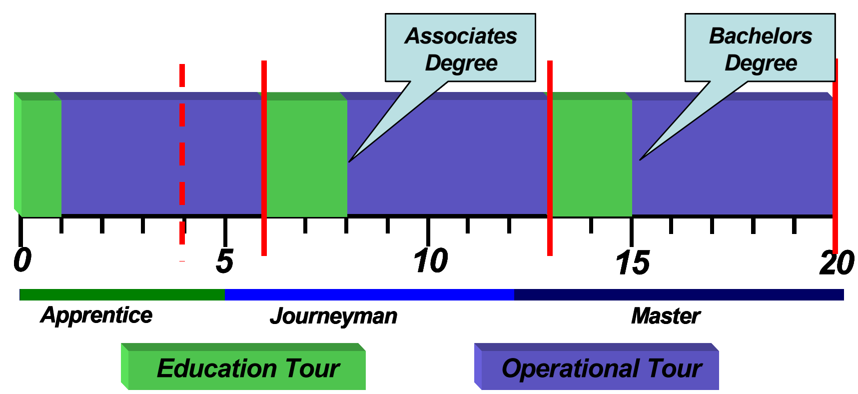
One alternative manning concept that the Navy is exploring is sea-centric, or 130-percent, manning.[9] Under this plan, the 30-percent shore manning is part of the ship's complement assigned to warfighting positions and direct operational support billets. The 130-percent manned crew is divided into two sections. The first is the "rotational" component, consisting of enlisted (E1–E6) and officers (O1–O3 Division Officers) who are rotating on and off the ship in accordance with a fixed rotational plan. These positions are manned at 130 percent of the ship's approved optimal manning level and make up the major part of the crew. The second is the "core" group, consisting of CPOs, CWOs, LDOs, and senior officers on a traditional sea billet assignment, who remain with the hull throughout their sea tour.

For the rotational component, the crew follows a fixed rotation on and off the ship. As currently envisioned by N1 (Fleet Forces Command), over a 5-year period, a Sailor rotates off the ship four times, twice for 40 days and twice for 110 days. The rotations occur after periods of roughly 300 days aboard ship. During a 5-year operational tour, a Sailor will spend 300 days in the ship's shore detachment and off the ship. These 300 days off the ship do not include the "days off" that a Sailor on sea duty receives today, such as weekends, holidays, and leave periods. Each ship's Commanding Officer (CO) will be responsible for developing the rotation plan and ensuring that the optimally manned complement of skilled Sailors remains assigned to ship's crew at all times. Having computer systems and software that readily support the planning and management of ships' crew, as well as interfaces with BUPERS, will be essential to the CO's ability to develop and implement a successful crew rotation plan.

9. We rely on [21] for our discussion of the 130-percent manning concept.

In figure 6, we show the notional baseline sea-centric career as posited in [21] by N1, FFC. The green boxes represent periods when a Sailor is receiving training and education to meet professional development requirements for progressing in his or her career. The blue boxes represent periods when the Sailor is assigned to an operational unit. The solid red lines correspond to the "standard" end of a Sailor's enlistment, tying enlistments to operational tours. The dashed red line corresponds to a notional shorter enlistment period than the standard required to meet recruiting/retention goals.

Figure 6. Notional baseline, E1 through E6, 20-year sea-centric career



The first education period includes accession training and acquiring tradecraft skills. This is followed by an "apprentice" tour within the fleet, during which the Sailor develops his or her basic trade skills. Upon reenlisting at the end of the first operational tour, a Sailor begins the training required to complete the second operational or "journeyman" tour. In addition, the Sailor will have the opportunity to complete the training required to receive an Associate degree in a major closely related to his rating. This education also is required to be competitive for promotion to Chief Petty Officer. The second operational tour again is with the Fleet and gives the Sailor the time to refine his or her technical skills and prepare to transition to the master level and CPO. The third educational period and operational tour allows for variation from the standard career. During this enlistment, Sailors who do not have either the desire or the ability to complete the requirements for a Bachelor's degree would either receive advanced skill training in their rating or would serve traditional "shore" duty. The tour following this would also see an increasing number of personnel filling billets in the fleet infrastructure activities.

Sea-centric manning also proposes a new approach to a career in the Navy with separate concentrated time periods dedicated to operational tours and to training tours while also building in "rest" time and family time. In addition, a ship will be able to conduct major drills and training evolutions in port while not having to deal with a significant percentage of the onboard crew being off at school, as typically happens during major availabilities. Affording time in an operational tour while not affecting the hull's team training plans or readiness is a benefit that should encourage ships to plan for the development of their Sailors, improving both the Sailors and their unit. Finally, schoolhouses will not have to deal with students standing duty at night while attending school because when they are at school they will not be on the ship.

130-percent manning is an idea yet to be tested. The greatest challenge to 130-percent manning will be the costs of creating the 30-percent shore pools, as outlined in [7]. Another challenge will be the cultural shift that 130 percent manning will require. Leadership will likely be an important element of pilot tests for both rotational crewing and 130-percent manning. Developing a pilot test also will be challenging because the Navy most likely will be able to test only part of these concepts versus the whole. Again, it will be important that BUPERS be able to identify Sailors participating in each "extra manning" pilot test in order to assess the impact on Navy career decisions.

Advantages and challenges

As we've already mentioned, the greatest challenge, not only for sea-centric manning but for rotational crewing, is to find the shore billets to offset the additional sea billets required. There are, however, some additional considerations regarding 130-percent manning, particularly when comparing the concept with rotational crewing.

Sea-centric, or 130-percent, manning is essentially a one-size-fits-all model. That is, at the core, there is an ideal career path that everyone would follow; then variations are allowed around this ideal based on individual circumstances. This would be similar to the existing sea-shore rotation model with its relatively fixed ideal target of 48 months at sea relative to 36 months in shore duty. The months at sea vary by rating. In both cases, these relatively fixed, one-size-fits-all models should probably be replaced by more flexible systems in which Sailors are allowed to respond freely to incentive pays.

Sea-centric manning currently incorporates policies of sending every Sailor to receive an Associate degree at the end of the first operational tour and a Bachelor's degree at the end of the second. Even if this is the current stated objective of the Navy, it is unlikely that every Sailor will need or want this amount of higher education. Many Sailors are attracted to Navy careers because they are able to get training, develop skills, and build a career without attending college. Furthermore, not everyone will achieve the E8 paygrade or therefore need the Bachelor's degree. Thus, the model results in an overinvestment in education.

In sea-centric manning, sea duty tours may be just as long or even longer but broken up into smaller slices. The question remains as to whether this will be any more palatable to Sailors. In addition, if some portion of the crew is left behind each time the ship is deployed, who monitors the people left on shore during this period? The issues regarding Sailors who are not deployed with the ships include issues of command structure, housing, and administration.

The problem of management on the beach becomes even larger for 130-percent manning than it is for rotational crewing. Although 4:3 rotational crewing and 130-percent manning call for the same number of extra Sailors, there are significant differences in the shore infrastructure. First, the 4:3 rotational crews have a ship most of the time and a command staff all of the time when they are back on the beach, so they call for less investment in housing infrastructure, and so on. Also, there is a clear command structure to oversee the Sailors when they rotate to homeport. This all means that there is less of a need for creating shore infrastructure to support the new manning concept and therefore to cut somewhere else.

Targeted 130-percent manning

Some of the objections to 130-percent manning could be overcome by adopting a less expensive version—targeted 130-percent manning. This model targets incentives to ratings with very high sea-shore ratios. From the individual Sailor's perspective, 130-percent manning might be preferable to the sea-shore ratio monetary incentives for some ratings. In some ratings, these ratios are beginning to exceed the maximum 60-month sea tour for each 36-month shore tour. Targeted 130-percent manning might be an additional tool, along with compensation incentives, to induce more people to serve at sea for longer periods of time in these ratings. In addition, offering the incentive only to sea-intensive ratings rather than all ratings makes the program much less expensive.

Royal Navy squad manning[10]

Possible support for the 130-percent manning concept is provided by a similar practice used in Great Britain's Royal Navy referred to as squad manning, or TOPMAST. In briefings on this concept, representatives of the Royal Navy always begin by stressing the great differences between the Royal Navy and U.S. Navy. The differences are not only in size but in manning structures and policies, funding levels, and training. For all this, however, the two navies face a similar problem: they are struggling to meet their missions in an era of shrinking resources. In addition, they are under pressure to reduce total manpower costs to free up money for equipment, ships, and aircraft.

Before using the TOPMAST approach to manning, people who weren't assigned to a ship were held centrally in an account similar to our Individual's Account (IA). A detailer was responsible for finding reliefs for gapped billets—that is, finding someone in a shore billet and, at short notice, posting them to the ship. Under TOPMAST, the extra personnel, referred to as the Margin, are allocated to each ship and then locally controlled in the Base Port at immediate notice to fill any gaps. The main aim is to fill quickly any gaps at sea.

10. This section is based on information provided in [22].

This program could increase the length of sea tours and decrease retention were it not coupled with a program to increase “harmony” through using a squad manning approach. With squad manning, a dedicated personnel officer is assigned to manage the training and harmony of the crew plus the Margin that is allocated to each ship.

Another difference in the TOPMAST program is that a Sailor’s time away from home is measured at the individual level rather than the sea unit level. With squads being rotated on and off the ship, the Royal Navy maintains that this is the proper way to measure time away from family and homeport. The maximum allowed is 660 days away over a rolling 3-year period.

Over the first 5 years, the Royal Navy applied TOPMAST only at the lower paygrades because there was some difficulty implementing it at the senior levels. Above the grade of E3, the lower total numbers and greater requirements for specialists in knowledge and skills made implementation more difficult. Currently, however, the Royal Navy is extending the program to the higher paygrades.

Filling unplanned losses

Many of the new alternate manning initiatives will place stresses on the distribution system and, in particular, will call for some cases of quickly filling unplanned losses. In this section, we examine a few examples of how other communities handle this problem as well as new proposals for filling losses. We compare the following:

- Medical community FAC A and FAC M billets
- The cryptology community’s “Just-In-Time” augmentation system
- Designating “at-risk” billets
- Using Assignment Incentive Pay (AIP) and sea pay to attract volunteers.

Medical FAC A and FAC M billets

The medical communities use the ideas of Functional Assignment Code (FAC) A and FAC M billets to translate peace time into mobilization requirements. Navy Medicine has used this approach for large numbers of billets since at least 1998, covering about 80 percent of medical billets. The FAC M billets are funded requirements in shore facilities, usually at Navy hospitals and clinics.

Navy Medicine maps each of the FAC M billets to a FAC A billet. The FAC A billet is an unfunded operational requirement that links each shore billet to its corresponding operational billet. The occupants of the shore billets know that if needed for operational purposes, they will be mobilized into the FAC M billets.

This system works because the FAC A and M billets are linked so that the work done in the two billets are similar. Therefore if the incumbent of the FAC M billet is mobilized into to FAC A billet, the person will have the current skills to perform that job. Also, the system is not meant to fill unplanned losses, but rather is a method to call up a new billet or set of billets.

Cryptology community's "Just-in Time" augmentation system

In the cryptology community, the stress of sea-shore rotation and worries about unplanned losses are minimized through the use of the "Just-in-Time" augmentation system. In this model, most personnel have their permanent assignments ashore in one of four Fleet Intelligence Operational Centers (FIOCs) / National Intelligence Operational Centers (NIOCs). At any time, a ship can obtain a Sailor from these centers for a short period of time to fill a need or provide a capability.

The critical factor that makes this model work for the cryptology community is that when ashore everyone is doing the same type of work they are doing when they are called to sea. There is no issue, therefore, with their skills degrading while in a shore billet.

Designating "at-risk" billets

Sometimes referred to as having an "on-deck circle," this approach designates some billets to support fleet requirements by the stipulation that incumbents agree to move to operational billets within specified periods of time. At this point, the Navy is considering the possibility of using the approach for only the most critical ratings and NECs. The idea is similar to the medical community's FAC-A, FAC-M billets described earlier. The goal of this program is to enable a shorter response time to fill unplanned losses on optimally manned ships or other ASMC ships with critical needs for personnel.

There have been several criticisms of this approach:

- Recruiting and reenlistment rates might fall if people are unwilling to accept the risk of being placed in a shore billet that is tied to a sea billet.
- Ships would be unwilling to accept personnel from these billets to accept unplanned losses because spending time ashore may have eroded their skills.
- PCS and other costs may be higher than just transferring someone from another ship on the docks.

This approach is fundamentally different from the next, in which pay is used as an incentive to attract volunteers to fill unplanned losses. In the on-deck-circle approach, certain shore billets are designated as being in line for their incumbents to be reassigned to sea duty. In the Assignment Incentive Pay model, the Navy offers incentives to Sailors to elicit volunteers to quickly fill gapped billets.

Using AIP and sea pay to attract volunteers

The Navy is moving toward a more sea-intensive force by changing not only the ratio of operational to nonoperational billets but also the amount and nature of mission-centric work done throughout a Sailor's career. Having higher levels of surge capability, training readiness, forward presence, or PERSTEMPO without additional endstrength (or while reducing endstrength) will change the nature of work and careers.

A major feature of the more sea-intensive force is that the Navy will have to find ways to quickly fill unplanned losses. Existing and expanded incentive pays that would induce Sailors to fill unplanned losses include an AIP offered to attract volunteers to fill gaps in sea billets. This would be equivalent to making all Sailors on shore duty a ready pool to fill gaps in fleet billets.

A major consideration for the Navy is the cost associated with any policy option. The Navy may find it more attractive to adopt less expensive alternatives to address the stresses of a more sea-intensive Navy. For example, theory and past empirical work indicate that flexible monetary compensation, targeted as finely as possible at the desired population, will produce the most cost-effective policy [23]. Thus a combination of improved sea pays, AIP, and selective reenlistment bonuses (SRBs), along with a version of the current sea/shore rotation system designed to give maximum flexibility, may be the best policy option. At the same time, however, it may be possible to design some pilot programs to test other proposed programs, such as sea-centric assignments and 4:3 alternative crew rotation.

One drawback to the targeted incentive pay approach is that there is no guarantee that the volunteers will be qualified to do the job for which they are applying. Even some of those with the correct rate, paygrade, and NEC may have been working out of rate so long that they are no longer qualified. Second, PCS costs and economic rents may make this policy cost ineffective.

Optimal manning initiatives

Optimal manning is "just the right number of personnel assigned to duties to perform all the missions for which the ship is designed, no more and no less" [24]. Optimal manning involves the determination of right-sizing crews on ships for today and for the future, given the efficiencies achieved through the use of new technologies, and finding new practices and procedures for doing work. To achieve more optimally manned ships, the Navy has (a) used labor-saving technologies and processes, (b) cross-trained Sailors to reduce manning levels, (c) moved some Sailors to ashore detachments that still support the ship, (d) assigned others to ashore surge detachments that also are cross-decked with other ships in the battlegroup, and (e) cut persistently empty billets.

The optimal manning concept presents the Navy with the challenge of determining exactly what is the right crew size for a given type and class of ship, in terms of experience level, skill mix, and number. Streamlining crews through the use of new technologies implies that optimally manned ships will need more skilled, senior technicians and relatively few unskilled junior personnel. Viewed from this perspective, an optimally manned Navy will require a personnel distribution that is different from the Navy’s historical pyramid structure. Rather, it suggests a structure with reduced requirements for junior personnel and increased requirements for more-experienced, mid-career personnel. To achieve an optimally manned Navy will require changes in the ways the Navy has recruited, trained, and compensated its Sailors [25].

Compared with rotational crewing, the Navy's experience with optimal manning is limited and has a shorter history. In the following subsection, we describe the basic design characteristics of the Navy's Smart Ship initiative and the optimal manning experiment and identify general lessons and concerns related to manpower, personnel, and training issues.

Smart Ship[11]

The Navy undertook the Smart Ship Project in response to a report of the Naval Research Advisory Committee (NRAC) panel on reduced manning. The report concluded that culture and tradition, rather than lack of technology, represented the major obstacle to reduced manning aboard Navy ships. As a result, the Chief of Naval Operations (CNO) asked the Commander, Naval Surface Force, U.S. Atlantic Fleet (COMNAVSURFLANT) to undertake a demonstration project on an operational ship to find ways to reduce workload and manpower requirements while maintaining readiness and safety [26]. USS *Yorktown* (CG-48) was chosen as the first Smart Ship.

11. We adapted this section from [25].

The Smart Ship Project found some effective ways to reduce manning. Some involved adopting existing technologies, while others were primarily organizational changes. The project assessment concluded that workload reductions could be achieved in three areas:

- *Policy and procedure*. The core/flex or "flex to action" initiative reorganized the watch bill so that only core functions are manned 24 hours per day. Other functions are manned by a flex team that is called on when needed. Routine maintenance is moved to the day shift, and maintenance functions are moved out of watchstanding manning.
- *Technology*. Navigation, machinery control, equipment condition monitoring, and information management functions were automated.
- *Maintenance methods*. Use of reliability-centered maintenance methods reduced the scheduled preventive maintenance workload by about 15 percent.

All the initiatives combined to reduce the weekly workload by over 9,000 hours, or about 30 percent. Translated into manpower requirements, the reduction was 44 enlisted personnel and 4 officers, or about a 12-percent reduction from the initial manning of 410.

A review of optimized manning case studies cited Smart Ship as an example of successful reengineering [27]. The Navy was able to achieve manpower reductions in part due to improved situational awareness through the use of networked personal computers, remote sensors of the status of engineering and damage control operations, and the HYDRA wireless hand-held radio. Other important features of the Smart Ship effort were an iterative approach to adopting innovations that emphasized working through early failures and the increased size of the training department to support the innovations.

The Navy has been extending the manning efficiencies realized through the Smart Ship program to other ship classes. Equipment backfits are occurring for all existing CG-47 and DDG-51 Aegis ships at the rate of four per year. In addition, the new ships of the DDG-51 class are being delivered with Smart Ship improvements. All Aegis ships should have Smart Ship manning by about 2010. The Navy also has applied some of the Smart Ship innovations on select other ships, such as USS *Rushmore*, the Smart Gator, and USS *George Washington* (CVN 73), the first Smart Carrier [25].

Optimal manning experiment on USS *Milius*, USS *Mobile Bay,* and USS *Boxer*

In June 2001, the Commander, Naval Surface Forces U.S. Pacific Fleet, formally tasked USS *Milius* (DDG-69), USS *Mobile Bay* (CG-53), and USS *Boxer* (LHD-4) to participate in the CNO's optimal manning experiment. The goal of the experiment was to find the most effective and efficient crew size for each class of ship while maintaining mission capability and the same level of quality of life as Sailors on ships that are not optimally manned. *Milius* and *Mobile Bay* began the experiment in October 2001. *Boxer* joined in July 2002 to test whether the same type of manning reductions and billet cuts could be adopted on a large deck amphibious warship. During the course of the optimal manning experiment, all three ships completed interdeployment training cycles, deployed in support of Operations Noble Eagle and Iraqi Freedom, and went through a drydock phased maintenance availability. Manning reductions achieved were 18 percent on *Milius*, 12 percent on *Mobile Bay,* and nearly 10 percent on *Boxer*.

Under this pilot project, the crews of *Mobile Bay* and *Milius* were responsible for identifying new ways to work smarter, not harder. This required letting go of "traditional" Navy practices and thinking outside the box about ways that policy, procedure, or technology change could bring about manning efficiencies [28]. The crews looked at all aspects of living and working aboard ship, and the changes implemented covered a range of activities.

Policy changes involved modifications to existing naval regulations, instructions, or publications (e.g., damage control policy), shifting from a shipwide response to a tiered response. Procedural changes are those made within the lifelines of the ship that can be made at the discretion of a ship's CO. During the experiment, personnel received cross-training that allowed the consolidation and sharing of watchstation responsibilities in numerous areas, including the bridge, the port and starboard lookouts, gas turbine engineering watches, and flight quarters on deck. Technology changes—time-saving equipment enhancements that reduced the number of support personnel required on board—included stamp vending and cash machines, self-service laundries, and self-service mess lines.

The first phase of changes that the Navy is implementing in all ship classes encompasses changes to watchstation activities—via the consolidation of responsibilities—and providing cross-training. During the optimal manning experiment, these changes proved to increase personnel flexibility in high-OPTEMPO environments and added manning options to the personnel assignment system. Table 6 begins with a complete list of phase I best practices from the optimal manning experiment that the Navy has identified for inclusion to all class ship manning documents (SMDs). Phase II changes include rating skill transfers and transitioning to a system of tiered response to damage control. Phase III and IV changes, though not shown, involve the transfer of workload to ashore support detachments for pay and personnel (known as pay and personnel ashore, or PAPA) and for the ship preventive maintenance system (referred to as PMS ashore).

21st century platforms and crews

By 2020, the Navy will introduce new platforms, equipment, and systems, many of which will have profound changes in technology and manning. Optimal manning is an inherent characteristic of new ship construction programs, such as the littoral combat ship (LCS), the DD(X), and the CVX. In developing these new platforms, the Navy is incorporating several common themes that will affect ship manning. Specifically, Navy ship design requirements call for maximizing the use of labor-saving technologies and minimizing crew sizes.

First, the Navy plans to automate routine tasks and information processing on board ship as much as possible. The number of Sailors needed to operate a ship will decrease; the requirement for collaboration between human and machine will increase. Sailors will need to be able to add context to information processing and make complex decisions based on the information available. Second, new information technology and remote access to systems will allow the Navy to shift workload from operational units to shore-based detachments.

Table 6. Phase I and II optimal manning changes to all Navy ships[a]

Function/activity	Optimal manning best practice
Phase I	
Bridge specialists	Merge Quartermaster on watch (QMOW) and Boatswain on watch (BMOW) in condition III/IV. Bridge specialist responsible for maintaining navigation plot, deck logs, passing general word, executing visual communications, and supervising the helmsman and aft lookout
Port and starboard lookouts	Not required in conditions III/IV. Officer of the deck (OOD), junior OOD (JOOD), and junior officer on watch (JOOW) maintain proper lookouts. Aft lookout remains and reports directly to the CIC surface watchstanders. Lookouts are increased based on conditions and CO's directions.
Gas turbine engineering watches	Condition III/IV minimum watchstations reduced by combining the Equipment Operator on watch (EOOW) with Damage Control Center (DCC) operator and PACC (or EPCC) and rove watches with operation/monitor watches (i.e., sounding and security with auxiliary operator)
Aft Interior Communications Electrician (IC)	Position eliminated, Duty IC dispatched when needed
Flight quarters	Previous onstation flight team of 48 members is reduced to 15. Subsequent teams man the flight deck on alternate days or as required during extended flight schedules. The Air Department is cross-trained to be part of the crash and salvage team and to provide additional personnel for backup hose teams when embarked. In the event of a crash on deck, the duty team and the Air Department hose team respond immediately. The off-duty team musters and provides a third hose team. Boat deck crew musters at first flight quarters of the day and is manned during night flight operations. The hospital corpsman (HM) mans medical versus being on deck.
TLAM	GM (NEC 0981 vertical launch specialist (vs.) tech) can qualify via PQS for the launch controller or engagement planner watches.
Phase II	
Repair lockers	Revised Repair Party Manual: incorporates a tiered response to damage control, adjusts the number of watchstations required in each repair locker to 23 watch-standers per repair locker, and, for ships with internal communications systems, eliminates some sound-powered phone watchstations.
Postal activities	Eliminate the postal clerk (PC) position aboard ship. Postal functions are covered as follows: - Stamps are sold in the ship's store - SH/SKs receive outgoing mail and packages - SH/MA ratings coordinate distribution of incoming mail & packages - DK rating provides money orders - For smaller ships, new equipment installations will include Navy cash machines, stamp vending machines, and advanced postal meters

a. Source: [28].

Next, new platforms will have equipment that is more reliable and takes advantage of remote sensors, automation, interactive technical manuals, and access to remote experts. For example, through the application of new technologies, the Navy will achieve organizational and procedural changes that effectively decrease watchstanding requirements. Cost considerations and new acquisition policies are increasing the use of commercially available technology. The Navy also is increasing the commonality of platforms across ship types in terms of the design of the ship and the equipment and technology aboard. The new ships are designed to take advantage of plug and play systems and mission modules that can be easily changed, upgraded, and used across ships of the same class. Increasing the commonality of systems will reduce the complexity of manpower requirements and support the development of generalists rather than specialists. Potential manpower outcomes may include a reduction in Navy enlisted classifications (NECs) and the combination of different ratings.

The authors of [25] note that changes in technology and required skills along with forecasted changes in civilian labor markets imply that the Navy will have to make fundamental changes in the way it manages its workforce. In their findings, they highlight the following as ways that Navy workforce management policies may have to change in the 21st century:

- Manpower requirements will no longer take the shape of a pyramid. The automation of routine tasks will lower junior paygrade requirements while increasing the need for more skilled technicians at mid-level paygrades.
- The Navy will need to consider allowing skilled technicians to have full careers without moving into supervisory ranks. This will require changes to up-or-out policies and increases in pay not tied to increases in rank.
- The Navy most likely will have to recruit more Sailors from post-secondary institutions. To accomplish this will require higher compensation either through lateral entry or pay increases not tied to rank.

- Twenty-first-century Sailors will be generalists rather than specialists, requiring more education rather than Navy-specific training.
- Operational units will have fewer apprentice level requirements. The Navy will need to develop methods to provide training in military specific knowledge that heretofore has been acquired during initial enlistment tours.
- While the Navy may realize manpower cost savings due to overall lower endstrength levels, the average cost per Sailor will increase since the Navy's workforce will include a higher proportion of mid-level, experienced, skilled technical workers.
- The Navy may need a skill-based compensation system to set pay at levels to attract and retain Sailors with high-paying civilian alternatives, and retirement incentives should be changed to retain skilled workers during their most productive years.

Additional optimal manning challenges

In gaining the efficiencies associated with optimal manning, the Navy faces numerous challenges. The first is determining what the optimal manning level is for a given ship class. Second is the ability of the Navy to provide the right mix of fully trained Sailors at the right time in order to reach and maintain 100-percent manning on ships. Third is the impact of optimal manning on the nature of sea duty and the overall attractiveness of a Navy career.

It is essential that the Navy get the optimal number of Sailors right.[12] The Navy's assessment of its manpower needs is critical to fleet readiness. If too few Sailors are on board, the ship's readiness levels will suffer. The Navy does not want to create unintended consequences of placing more work on the shoulders of fewer Sailors and potentially creating a negative effect on retention. Likewise, overstating manpower requirements draws funds away from other important resources. It also creates the potential for "make work" activities on

12. This challenge may be most relevant to applying optimal manning on the Navy's legacy ships.

ships—Sailors are doing work out of skill just to stay busy—which also is a dissatifier among Sailors.

Assuming the Navy has determined the optimal crew number, its foremost challenge is being able to provide the right mix of fully trained Sailors at the right time to reach and maintain 100-percent manning on ships. Even though the Navy made a focused effort at manning *Milius* and *Mobile Bay* at 100 percent during the optimal manning experiment, both ships had some gapped billets on board throughout the experiment. The FRP also requires that ships maintain a more constant and higher level of readiness over more of the interdeployment readiness cycle. Relief Sailors (preferably fully trained) must be available to fill losses as soon as possible. The expectation is that under optimal manning crews sizes will be smaller. Consequently, each crewmember is more critical to the maintenance of ship readiness levels. Losses become more difficult to tolerate.

A common perception is that manning follows a “bathtub” pattern over the deployment cycle. That is, manpower, as well as its associated experiences and training, is allowed to shift over the IDTC in a way that does not support level readiness. In particular, the number of Sailors on a ship would be high during a deployment, would fall rapidly when the ship returns to homeport, would stay low during the maintenance period, and then would increase as the ship trains for its next deployment. If the manning bathtub really occurs during the middle of the IDTC, the Navy most likely will have difficulties supporting the FRP or other constant-readiness models.

CNA recently examined the historical evidence on personnel levels over the course of deployment cycles and found no evidence of a bathtub pattern in personnel levels—that is, a shortage of Sailors during the time when a ship is not deployed [29]. This bodes well for new deployment concepts that call for more even readiness. Rather, the most consistent patterns CNA found were that manning rises when a ship returns from deployment, falls somewhat but remains higher than when deployed for the remainder of the IDTC, and then falls again when the ship deploys again.

The evidence does show that there are differences in the percentage of the crew that is new to a ship at different points in the IDTC. New assignments are lowest during the deployment and highest during the training workup for the next deployment. But these differences are small, amounting in most cases to only around 1 percentage point of the crew over a 3-month period. For the two ship types examined, the DDG and the CG, there were some decreases in turnover, as measured by percentage of new crew, between older classes in 1982–1993 and newer classes concentrated in the mid-1990s to 2002. These decreases were even less than the differences between points in the IDTC. Overall, these results tend to indicate that manpower levels and amounts of experienced crew historically have remained fairly constant over deployment cycles.

Alternative Sea Manning Concepts (ASMCs) and other developing Navy strategies

In this section, we conclude by considering how rotational crewing and optimal manning initiatives fit with other developing Navy strategies, specifically with the FRP and Sea Warrior.

ASMCs and the FRP

Under the FRP, the Navy has shifted its operational focus to maintaining high readiness levels throughout a ship's interdeployment readiness cycle in order to be more responsive to emerging military requirements. Before the GWOT, the Navy's focus was on rotational deployments and presence. Today the fleet must not only be forward deployed but also be able to surge substantial, capable forces. As noted in [5], the FRP codifies fundamental changes in the way the fleet operates by institutionalizing a higher level of sustained readiness and employability, thus providing increased surge capability.[13] The Navy has developed the flexible deployment concept (FDC) as a complement to the FRP to place limits on Sailor PERSTEMPO. The FDC identifies two windows of opportunity when ships could be available for employment: either during routine deployments in support of Combatant Commander objectives or during shorter “pulse” employment periods in response to emerging requirements.

The basic rotational crewing designs are not entirely compatible with the Navy's new deployment strategy. Rotational crewing emphasizes continuous forward presence, while the FRP and FDC emphasize presence with a purpose and surge. Nonetheless, the Navy seems to have found an operational niche for ships manned using rotational crewing, as proven by the use of PCs, MCM-1s, and MHCs forward

13. See [5] for a more detailed explanation of the FRP.

deployed to the Persian Gulf area of responsibility. These ships are providing a steady, low-level background presence that supplements CSGs and ESGs. However, the intensity of work for these crews remains an issue (see [7]). In addition, the Navy needs to more carefully assess TAR and retention measures for these crews.

In contrast, optimal manning initiatives and the developing approaches to extra manning pools seem *conceptually* well suited to supporting the fleet's operational requirements under the FRP. It will be important for the Navy to track and assess the impact of the planned Navy pilots of on-deck circle and sea-centric manning on manpower performance metrics. Having computer systems and software that allow the seamless integration of manpower and training information in the fleet and with BUPERS will be essential to the successful operation of both on-deck circle and sea-centric manning initiatives. Currently, the Navy does not have such systems.

ASMCs and Sea Warrior

The Sea Warrior program focuses on maximizing the use of Navy personnel by placing optimally trained Sailors in jobs that best suit their talents, skills, abilities, and desires. It strives to create a recruiting, training, and assignment process that places Sailors in the right jobs, in the right location, at the right time—thereby maximizing fleet readiness.

The Navy's experiences to date with rotational crewing provide mixed results with respect to providing Sailors with training opportunities that maintain and build their skills. The Navy has used Blue/Gold crewing on platforms designed to have special training facilities to support the training of the offstation crew. In the Sea Swap experiments, special efforts were made to ensure that Sailors received difference training (both schoolhouse and fleet-based training) in addition to normal training requirements to ensure that the crews would be at C-1 levels when they took over responsibility for the forward-deployed Sea Swap ships. In contrast, scheduling formal schoolhouse training has been an issue for the PC rotational crews, largely due to the tight scheduling of onship training for the eight offstation crews that share three homeported ships for training purposes and must meet the crew rotation requirements of the five forward-deployed PCs. Again, the intensity of work for Sailors while they are in homeport is an issue.

In comparison, the optimal manning experiments and the developing approaches to extra manning pools, by design, focus on ensuring that fully trained Sailors are placed in sea-centric, operationally oriented positions in which they can use their talents and skills. Conceptually, sea-centric manning provides dedicated training tours in addition to operational tours that give Sailors the opportunity to optimize their training and career objectives. However, a major constraint on the application of sea-centric assignment, or 130-percent manning, may be the cost.

Appendix: Critical NEC mix to support unplanned losses

In concert with the unplanned loss annual percentages, the following list identifies the 68 technicians that CNSF and PERS-40 have determined to be a rough representation of the critical NEC mix required to support unplanned losses for surface ships [28].

<u>AIC/ASTAC Flyaway Team (TACGRU/TACRON)</u>

- 1-OS1 AICS (0319),
- 2-OS2 AIC (0318),
- 2-OS2 ASTAC (0324)

<u>Tomahawk Cruise Missile Team (ATGPAC/FCTCPAC)</u>

- 4-FC2’s cross-trained on TTWCS O&M (1136)/ATWCS LCGR O&M (1334)

<u>Aegis Operators and Maintenance Team (ATGPAC/ATRC SDGO)</u>

- 1-OS2 GCCS (0342),
- 1-OS2 TADIL (0348),
- 1-FCC CSSM (1104),
- 1-FC1 AWS Mk7 (1105),
- 2-FC2 SPY B/D (1119),
- 1-FC2 FCS Mk99 (1143),
- 1-FC2 Display (1322), 1-FC2 UYQ-70 Tech (1335),
- 1-ET2 UPX-29 (1571)

<u>Combat Systems Readiness Team (ATGPAC/SIMA)</u>

- 1-QM2 ECDIS (0230),
- 1-OS2 GCCS (0342),
- 1-OS2 TADIL (0348),
- 1-GM2 5î\/54 (0879),

- 1-GM2 5î\/62 (0880),
- 1-GM1 VLS (0979),
- 1-IT1 (2735) LAN Admin,
- 1-IT2 (2780) Network Vul Tech,
- 1-ET2 HF Comms (1420),
- 1-ET2 SRQ-4 (1424),
- 1-ET2 UHF DAMA (1425),
- 1-ET2 Small Combatant Comms (1428),
- 1-ET3 AN/USC-38 Tech (1430),
- 1-ET3 SHF (1468),
- 1-ET2 SAS (1486),
- 1-ET3 JTIDS Tech (9604),
- 1-ET2 WSN 7 (9612),
- 1-IC2 Int Voice Comms Tech (4712),
- 1-IC2 Fiber Optic DMS (4778),
- 1-IC2 SGSI Maint (4758),
- 1 cross-trained 2MTR (1591),
- 1-SK2 Supply Tech Spec (2829),
- 1-DK2 Aflt Spec (2905),
- 1 Xtrained SAR Swmr (0170),
- 1 Xtrained Small Arms Instructor (0812),
- 1-FC2 SPS-48E Tech (1140),
- 1-FC2 RAM Tech (1145),
- 1-FC2 NSSM Tech (1147),
- 1-ET2 Comms (1427),
- 1-ET2 Comms (1429),
- 1-ET2 COMSEC Maint (1460),
- 1-ET2 SPS-67 (1507),
- 1 ET-2 Command Ctr Tech (1613),
- 1-IC2 Dimension 2K Tech (4716),
- 1-IC2 cross-trained Mk19/WSN2 (4721/4727),
- 1-IC2 VSTOL Lens Tech (4779),
- 1-IC2 FLOLS Tech (4787)

<u>Undersea Warfare Combat Team (FASWC/FLEASWTRACEN)</u>
- 1-STG2 SQQ89 Tech (0415),
- 1-STG2 SQQ89 Mk116 Tech (0429),
- 2-STG1 USW Supe (0466),

- 1 cross-trained SAR Swmr (0170),
- 1 cross-trained Small Arms Instructor (0812)

Engineering Readiness Team (ATGPAC/SIMA)

- 1-GSCS Eng Plant Prog Mngr (4206),
- 2-EN2 Refrig/AC Tech (4291),
- 1-EN2 Elev Hyd/Mech (4296),
- 2-EN2 RAST (4355),
- 1-EN2 963 Aux Sys (4398),
- 1-EM2 Elev E&E (4671),
- 2-EN1 (4304) Diesel Tech,
- 1-MM1 Boiler Rep (4502)

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List of figures

List of tables

CRM D0013455.A2/ Final

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