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TECHNICAL
R E P O R T

Impacts of the Fleet Response Plan on Surface Combatant Maintenance

Roland J. Yardley, Raj Raman, Jessie Riposo,
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Prepared for the United States Navy

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Preface

The Navy is implementing the Fleet Response Plan (FRP), which will allow more variability into surface combatant's operational, training, and maintenance schedules. The FRP aims to change operational readiness availability, thus permitting an enhanced surge capability by Navy aircraft carrier strike groups to meet defense requirements. Although six-month deployments will still occur, surface combatants may be deployed for longer or shorter periods. In addition, ships will enter the basic training phase earlier and will be maintained in a higher status so that they could surge if required.

As the changes associated with the FRP were unfolding, the Program Executive Office for Ships tasked the RAND Corporation to examine the relationships between the FRP and the industrial base that supports surface combatant maintenance. Specifically, this report identifies and describes the challenges the FRP presents in maintaining the U.S. Navy DDG-51 surface combatant force and the maintenance resources and approaches used to support the FRP. The analysis is based on interviews with fleet maintenance and scheduling authorities on current challenges as well as the recent initiatives and efforts to provide increased operational availability and to simplify maintenance actions for the surface combatant force. This report should be of interest to anyone concerned with the operational availability and readiness of Navy surface combatants under the post–September 11, 2001, fleet response regime.

The research was sponsored by the Naval Sea Systems Command and conducted within the Acquisition and Technology Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Department of the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

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Summary

Until recently, the Navy's ship readiness objectives and maintenance needs for surface combatants were met through a two-year cycle. Ships were deployed in forward-presence roles for six months and spent the next 18 months primarily in maintenance and training. A ship would then be ready for another deployment. This approach satisfied the many personnel, presence, maintenance, and mission requirements of the Cold War era; however, new global threats have recently challenged these traditional methods of operation.

To achieve a more responsive and more readily deployable fleet, the Fleet Response Plan (FRP),¹ adopted in 2003, institutionalizes a new readiness approach intended to allow the Navy to deploy a high number of assets quickly. Prior to implementation of the FRP, ships normally did not commence basic training until the completion of a depot maintenance availability. Under the FRP, ships returning from deployment enter basic training almost immediately, and basic training is more flexibly conducted both before and after a ship's depot-level maintenance. The desired result is for non-deployed ships to achieve a high level of readiness earlier and to maintain high readiness longer so that they can deploy on short notice. The goal of the FRP is to achieve a readiness level that will allow six Carrier Strike Groups (CSGs) to deploy within 30 days and two more within 90 days. This is approximately twice the number of carriers deployed and ready to deploy under the 24-month cycle prior to FRP. One of the primary challenges in implementing the FRP is the establishment of processes and procedures, as well as a ready industrial base, to facilitate maintenance planning and execution to meet FRP surge requirements and maintenance demands, whose timing is no longer as predictable.

To help the Navy understand this challenge, the RAND National Defense Research Institute (NDRI) undertook to characterize the implications of the FRP for maintenance needs and to identify the range of maintenance resources that could be brought to bear. The NDRI research team also undertook to quantitatively measure the impact of the FRP on maintenance provision. To limit the scope of the analysis, we concentrated throughout on the DDG-51 class of destroyers—the largest class of surface combatants and one subject to little modernization to date, which simplifies the analysis. Our sources of information were interviews with numerous fleet maintenance and scheduling authorities, along with data on ship casualty reports and maintenance costs.

¹ Also referred to as the Fleet Readiness Program.

The Fleet Response Plan and Its Challenges to Maintenance

In the previous readiness cycle, a ship returning from deployment would sequentially have a post-deployment stand-down, enter (occasionally with some delay) a maintenance period for nine weeks, and then begin four months of basic crew training with the vessel. Under the FRP, ships must formally sustain a surge readiness posture. After the post-deployment stand-down, ships immediately begin either a maintenance period or basic training. Moreover, these two activities can be combined: The nine-week maintenance period can be conducted at the beginning, within, or at the end of the basic training period. At the end of basic training, approximately six months upon return from deployment, the ship is expected to respond to an emergency surge requirement with an additional 45 days' notice if directed. This is in comparison to the 12 months required for redeployment under the pre-FRP regime. After completing integrated training, the ship is regarded as surge ready—that is, able to deploy if needed in less-than-emergency situations and to pulse in support of limited operations. Ships continue to train and achieve and sustain targeted combat readiness requirements and are designated as routine deployable.

Partly because of the more compressed and flexible maintenance schedule, the FRP has given rise to challenges in planning maintenance. Specifically, planners of maintenance availabilities must account for several new factors:

- **Allowing for surge capacity.** For example, ships may not get expected maintenance because of a lengthy deployment or because of reallocation of resources to another ship being readied for deployment. Maintenance authorities closely monitor deferred actions so that if the ship must participate in a surge, repairs critical for mission accomplishment may be made.
- **Budgeting issues that make it difficult to fund a given availability across fiscal years.** When the Department of Defense operates under a continuing resolution, such a resolution does not authorize funding for ship maintenance. Ship maintenance activities must be postponed because funds are not available to order the required repair parts. This delay further constrains the time slots open to maintenance schedulers.
- **Continuous maintenance availabilities.** Continuous maintenance availabilities are used to perform depot-level work outside a depot-level facility. This least-intensive class of depot maintenance is performed pier side and scheduled four times per year (once per quarter) under the FRP instead of twice per year (pre-FRP). As a direct result of continuous maintenance availabilities, more depot-level maintenance is being accomplished pier side and outside the shipyard environment.
- **Modernization demands.** While most maintenance demands can be scheduled within the time required to bring the ship to emergency surge-ready status, some modernizations will take 40 to 50 weeks to complete. FRP surge readiness requirements may conflict with the need for modernization; if so, these work packages will have to be broken into segments to satisfy FRP requirements. If the modernization for a ship class is spread over a long period, by the time the last ship is completed the upgrades could be obsolete. However, if the upgrades are all performed in a compressed period, surge readiness and

operational availability may be compromised. In addition, late funding adds uncertainty and slows the modernization planning process. Fleet officials identified late funding as the number-one problem in modernization.

Marshaling Maintenance Resources

Despite the challenges, FRP-driven increases in surge-related maintenance do not seem to have stressed manpower resources so far. This success may be attributed to the Navy's attempts to improve the flexibility and efficiency of maintenance resource supply. The challenge is to bring resources to bear while keeping costs low.

In recognition of this challenge, the Navy has been attempting to improve the flexibility and efficiency of maintenance resource supply. Uncertainties about the timing of a surge necessitate a flexible supply base capable of addressing the scheduling challenges. Those attempts include the following:

- **Multi-ship, multi-option (MSMO) contracts.** Historically, private shipyards have competed for each depot-level availability. Recently, the Navy has instituted the practice of awarding a single overarching contract to a prime contractor responsible for depot-level maintenance work on multiple ships in a class. This allows the contractor the flexibility to quickly bring the appropriate resources and personnel to bear to meet evolving demands. (It also places on the contractor the responsibility for meeting the demand.)
- **Regional Maintenance Centers (RMCs).** In the RMC concept, Ship Intermediate Maintenance Activities (SIMAs); Supervisors of Ships, Conversion, and Repair; port engineers; and other previously separate entities function together as a consolidated provider of maintenance. Furthermore, SIMAs are limited to work at 80 percent capacity to allow room for a surge.
- **SHIPMAIN (ship maintenance initiative).** The purpose of this initiative is to improve maintenance planning by streamlining the planning process and attempting to get work done in continuous maintenance periods instead of waiting for a major availability.
- **Maintenance teams.** Senior decisionmakers from the ship, port maintenance authorities, and maintenance supervisors and providers have established teams to cost-effectively schedule and allocate work. They do so by validating all planned work items, brokering work candidates to the appropriate activity, and ensuring that maintenance providers are used efficiently (e.g., that one provider does not have to incur additional costs by paying overtime while another has a shortage of work for equally qualified personnel).
- **“One Shipyard.”** This initiative seeks to increase the efficiency of maintenance provision by pooling resources across shipyards.
- **Distance support.** The ship's force can now obtain technical assistance from shore-based experts via the Internet.
- **Systems and engineering materiel assessment teams.** These teams can be flown to ships to collect information (e.g., on the condition of components) that can be useful in identifying and scheduling maintenance.

The Navy has recently been successful in resourcing surface ship maintenance availabilities (Congress has recently increased funding for ship maintenance). The plus-ups were applied to maintenance availabilities in fiscal years 2003 and 2004, which resulted in fully funding the maintenance requirements for ships that underwent Chief of Naval Operations availabilities during these fiscal years.

Is Maintenance Supply Meeting Demand?

Are maintenance resources, aided by the Navy initiatives listed above, meeting the changing profile for maintenance demand under the FRP? Ultimately, the answer to this question lies in the ability to provide the needed ships in a surge situation. Interviews with fleet authorities indicate that there are a sufficient number of operationally available DDG-51 ships to respond to FRP surge demands. The scheduling and maintenance implications of responding to the FRP were considered to be manageable, since there are notionally only two DDGs per CSG; so a maximum of 16 DDGs (out of 43 DDG-51s in the fleet) would be required to surge in a 6+2 FRP carrier surge scenario. (The sufficiency of other surface combatant forces is an issue we did not pursue.)

Determining whether the ships surging under the FRP are more ready or less so—and if more so, at what cost—requires a quantitative assessment. We undertook such an assessment with casualty report and cost data from Navy sources. We found no significant change in ship casualty reports or maintenance costs following implementation of the FRP. Unfortunately, the FRP was implemented too recently (and in the midst of major deployment changes following September 11, 2001) and Navy maintenance spending is too closely tied to funding to draw FRP-related inferences with any confidence. Thus, while the evidence from our interviews appears promising, any confident conclusions regarding the interrelationship between maintenance supply and FRP-related maintenance demands will require at least the passage of some time. This topic should be revisited in the future.

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Of course, the authors alone are responsible for any errors.

Abbreviations

BFIMA	Battle Force Intermediate Maintenance Activity
CASREP	casualty report
CBM	condition-based maintenance
CFFC	Commander, Fleet Forces Command
CiLabor	Capital Investment for Labor Reduction (initiative)
CMA	Continuous Maintenance Availability
CNO	Chief of Naval Operations
CNSL	Commander, Naval Surface Forces Atlantic
CNSP	Commander, Naval Surface Forces Pacific
COMNAVSURFOR	Commander, Naval Surface Forces
CSG	Carrier Strike Group
CSMP	Current Ship Maintenance Project
CWP	Cumbersome Work Practices (initiative)
DDG	guided missile destroyer
DSRA	Docking Selected Restricted Availability
ERM	Engineering for Reduced Maintenance (initiative)
ESG	Expeditionary Strike Group
FDNF	Forward Deployed Naval Forces

FMA	Fleet Maintenance Activity
FMP	Fleet Modernization Program
FRP	Fleet Response Plan (also referred to as the Fleet Readiness Program)
FTSC	Fleet Support Technical Center
GDEB	General Dynamics Electric Boat
GNFPP	Global Naval Force Presence Policy
HM&E	hull, mechanical and electrical
ICMP	Integrated Class Maintenance Plan
IDRC	Inter-Deployment Readiness Cycle
IDTC	Inter-Deployment Training Cycle
JTFEX	Joint Task Force Exercise
LANT	Atlantic
MRS	Maintenance Resource System
MSMO	multi-ship, multi-option
NAVSEA	Naval Sea Systems Command
NDRI	RAND National Defense Research Institute
NGNN	Northrop Grumman Newport News
NSTM	Naval Ships' Technical Manual
PAC	Pacific
PMS	Planned Maintenance System
POM	program objective memorandum
QDR	Quadrennial Defense Review
RCM	reliability-centered maintenance

RMC	Regional Maintenance Center
SEMAT	Systems and Equipment Material Assessment Team
SHIPMAIN	ship maintenance initiative
SIMA	Ship Intermediate Maintenance Activity
SORTS	Status of Resources and Training System
SRA	Selected Restricted Availability
SURFLANT	Surface Forces Atlantic
SURFPAC	Surface Forces Pacific
TMA/TMI	Top Management Attention/Top Management Issues
TYCOM	type commander
UTR	unfunded technical requirement
VAMOSOC	Visibility and Management of Operating and Support Costs

Introduction

Problem, Objective, and Approach

In recent decades, the Navy has maintained a continuous or near-continuous forward deployed presence in three major overseas operation areas: the Mediterranean, the Indian Ocean and Persian Gulf region, and the Western Pacific. The Navy's primary means of maintaining this presence has been through standard six-month rotational deployments, in which surface combatants (cruisers, destroyers, and frigates) as part of either a Carrier Strike Group (CSG) or other operational group would transit from home port to a forward area, operate in that area for a period of months, be relieved by the next CSG sent to that area, and finally return to home port.

When ships are not deployed, the ship and crew are employed in training and/or maintenance. The entire cycle of training, formerly referred to as the Inter-Deployment Training Cycle (IDTC), includes a post-deployment stand-down period (for crew leave); a maintenance period; basic, intermediate, and advanced training; and a six-month deployment. This cycle has traditionally run 24 months and was established to meet the requirements of the Global Naval Force Presence Policy (GNFPP) and personnel recruiting and retention goals.

The IDTC satisfied the many personnel, presence, maintenance, and mission requirements of the Cold War era, but recently, new global threats have challenged traditional methods of operation. Under the six-month rotation approach, a large number of ships are either in training or in maintenance and are not easily or quickly deployable. Under traditional deployments in the Navy, approximately 35 percent of ships and 10 percent of active-duty personnel are deployed at any given time.

When Operation Iraqi Freedom began, a large Amphibious Task Force and six CSGs were sent to the Persian Gulf, and another aircraft carrier was sent to Japan to fill the role vacated by the USS *Kitty Hawk*. The IDTC was greatly disrupted because of the speed and number of assets deployed—that is, some carriers were deployed sooner than expected, while others were deployed for longer than the traditional six months. As a result, maintenance schedules were disrupted, funding was transferred to other assets or locations where more maintenance was required (and where funding was surrendered and maintenance was deferred), and training

was accelerated or missed. Because of the difficulties encountered, the Navy intensified efforts that began in the 2001 Quadrennial Defense Review (QDR)¹ to increase the availability of the fleet and to develop an IDTC that would support this increase.

In May 2003, the Chief of Naval Operations (CNO) released a message to the Navy that instructed the Commander, Fleet Forces Command (CFFC) to make the necessary adjustments to the IDTC to achieve the capability to deploy ready assets on short notice. As a result, the Inter-Deployment Readiness Cycle (IDRC) was institutionalized to meet this objective. The IDRC provides for more-flexible maintenance scheduling while mandating earlier surge readiness.

The IDRC is a key element of the Fleet Response Plan (FRP).² The FRP, undertaken to achieve a more responsive and more readily deployable fleet, institutionalizes a new readiness approach intended to allow the Navy to deploy many assets quickly. Under the FRP, non-deployed units are required to achieve and maintain a high level of readiness so that they can deploy on short notice. The goal of the FRP is to achieve a readiness level that will allow six CSGs to deploy within 30 days and two more within 90 days. One of the primary challenges in implementing the FRP is the establishment of processes and procedures, as well as a ready industrial base, to facilitate maintenance planning and execution to meet FRP surge requirements and maintenance demands, whose timing is no longer as predictable.

To help meet this challenge, the RAND National Defense Research Institute (NDRI) undertook to characterize the implications of the FRP for maintenance needs and to identify the range of maintenance resources that could be brought to bear. The NDRI research team also undertook to quantitatively measure the impact of FRP on maintenance provision.

To limit the scope of the analysis, we concentrated throughout on the DDG-51 class of destroyers. We chose the DDG-51 class for two principal reasons:

- It is the largest single class of surface combatants and will probably remain so for the next two decades.
- To date, there has been little modernization to commissioned ships of this class that could skew (or contaminate) maintenance data.

The DDG-51 class, like the majority of nonnuclear naval ships, has its depot maintenance provided primarily by private shipyards. Limiting our analysis to this class may not fully identify the challenges faced by the public shipyards.³

As part of our study, we interviewed fleet maintenance and scheduling authorities at the Naval Sea Systems Command (NAVSEA) 04 and NAVSEA 04RM in Washington, D.C.; CFFC N43, Commander, Naval Surface Forces Atlantic (CNSL) N3 and N43, and

¹ According to GlobalSecurity.org (2005): “The requirement to be able to swiftly defeat aggression in overlapping conflicts called for in the 2001 QDR has necessitated a focus on developing new surge capabilities to complement and capitalize on our current competency in providing immediately employable forward-deployed naval forces.”

² Also referred to as the Fleet Readiness Program.

³ Another RAND study is currently examining the effects of FRP on the maintenance of aircraft carriers, which is accomplished primarily in the public shipyards.

the Regional Maintenance Center (RMC) in Norfolk, Virginia; and the Commander, Naval Surface Forces Pacific (CNSP) N3/5, N43, and N6, and RMC in San Diego, California. Additionally, we met with Maintenance Resource System (MRS) officials who develop maintenance budgets for surface combatants, and we evaluated readiness and cost data to aid us in determining the impact of the FRP on maintenance.

Organization

We present our principal findings in Chapter Three, which focuses on the implications of the FRP for maintenance. It provides a qualitative discussion of the maintenance challenges and how they are being addressed. This discussion is preceded in Chapter Two by background information in the form of questions and answers on the different aspects of maintenance for surface combatants, with a focus on DDG-51 class ships. In Chapter Four, we describe our attempt to analyze DDG-51 class readiness and cost data to assess the effects of the FRP's implementation. In Chapter Five, we present our conclusions.

Context

Before proceeding further, it is important to understand that the FRP has been implemented in the midst of changes in the demands for and maintenance of ships as well as the methods in which maintenance is being supplied to surface combatants. Ideally, we would assess the impact of the FRP on prevailing maintenance patterns in an environment in which the FRP was the only important change under way. Because that is not the case, the most valuable findings we can reach are qualitative in nature. We did perform a broad look at maintenance patterns, for both pre- and post-FRP, by evaluating dollars allotted to depot-level maintenance. We also included a review of equipment casualty reports (CASREPs), the average age of the DDG-51 class ships, and steaming hours to evaluate changes before and after the implementation of the FRP. The discussion of ongoing changes in maintenance supply and demand is an integral part of our analysis, one that we address in Chapter Three. Here, we briefly discuss two other ongoing activities that influence the interactions between the FRP and maintenance supply and demand.

Post-9/11 Deployments, Including Operation Iraqi Freedom

Since the terrorist attacks of September 11, 2001, the U.S. military has continuously operated on a wartime footing, a condition that will likely persist into the foreseeable future. The Navy, like its sister services, has conducted operations at a tempo that has greatly exceeded those tempos experienced prior to 9/11. Operation Iraqi Freedom featured the largest naval deployment in recent history, with more than 70 percent of U.S. surface ships and 50 percent of U.S. submarines underway, including seven CSGs, three amphibious readiness groups, two amphibious task forces, and more than 77,000 sailors participating. Some ships, such as

the USS *Abraham Lincoln*, were deployed for ten months—the longest deployments since the Vietnam War.

With such a large proportion of the force deployed, the need for operationally available ships, and hence the readiness rates required, has increased dramatically. This increase has presumably altered the demand for ship maintenance. Compared with peacetime operations, wartime deployments could reduce the performance of maintenance on the ships involved while having the potential to increase demands when they return home.

Sea Swap Experiments

The U.S. Navy is engaged in an experimental program that changes the way in which officers and crews are deployed aboard combatants. The traditional method is one in which a ship and its crew depart from home port, make port visits en route to the operational area, stay on station in the operational area, depart the operational area when relieved by another unit, and make port visits en route in the return to home port. In the Sea Swap program, the Navy is experimenting with keeping ships on station and rotating crews to the ships that are forward deployed. Such an experiment has been ongoing since August 2002 on destroyers.

While Sea Swap maximizes the operational availability of ships, it also affects the timing of maintenance and potentially the amount required over the long run (as in the case of longer deployments for combat). This may alter prioritizations in the planning, scheduling, and execution of maintenance activities conducted on these ships before deployment, while on station, and after returning to home port.

The Sea Swap program can be viewed as an enabler for the Fleet Modernization Program (FMP). While some ships are being maintained on station for greater periods through Sea Swap, those ships left behind can be modernized and maintained on more flexible schedules.

Understanding the Different Aspects of Maintenance

This chapter provides background information on the different aspects of maintenance related to surface combatants, with a focus on DDG-51 class ships. More specifically, it addresses the following questions:

- What are the different types of maintenance?
- What is the Navy's approach to maintenance?
- By whom is maintenance performed?
- How is maintenance accomplished during deployment?
- How are maintenance plans developed?
- What are depot-level maintenance availabilities?
- How is the surface maintenance budget developed?

What Are the Different Types of Maintenance?

There are three basic types of actions performed during industrial availabilities: preventive or planned/scheduled maintenance, corrective or unscheduled maintenance, and modernization. Preventive maintenance attempts to prevent failure; corrective maintenance restores a system after failure; and modernization improves system capability, reliability, or safety.

Preventive Maintenance

Preventive maintenance is performed periodically based on the run time of a system or its components as envisioned by the designer. These are planned or scheduled activities with the goal of minimizing system and component degradation, thereby sustaining or extending the useful life of the equipment. Such a practice is meant to increase the reliability of a ship's components and equipment and is more economically attractive than corrective maintenance, which is reactive in nature. Examples of preventive maintenance include changing oil and the filters of a circulation system after a specified run time and taking corrosion control measures (e.g., periodically applying corrosion resistant paint on a ship's hull to prevent rust formation).

Corrective Maintenance

Corrective maintenance is performed on systems and equipment that are inoperative or operating in a degraded condition. These corrective measures are generally unanticipated and there-

fore unscheduled. The decision to take a corrective maintenance action depends primarily on whether the degraded equipment is critical to performing the current mission or future missions. When an equipment casualty affecting a ship's primary mission area exceeds the ship's repair capability, a CASREP is submitted, which alerts the appropriate shore facilities that parts or technical assistance is needed.

Fleet Modernization

The FMP is a CNO-managed program that develops, plans, funds, and accomplishes ship alterations, machinery alterations, ordnance alterations, and electronic field changes (Naval Sea Systems Command, 2002). The FMP mission is to provide operational and technical modifications to “keep the war-fighting edge, fix systemic and safety problems, improve Battle-Force Interoperability, improve platform reliability and maintainability, or reduce the burden on the sailor.”¹ There are two types of ship improvements:

- A *military improvement* that results in a change of operational or military characteristics, qualities, or features, and increases the ability of the ship to perform its required operational capacities.
- A *technical improvement* that results in a change to improve the safety of personnel and equipment and/or provides increased reliability, maintainability, and efficiency of installed equipment.

These modernization actions are scheduled, planned, and normally accomplished during a scheduled CNO availability² and must be completed within three years.³ Midlife upgrades for the DDG-51 class may take 30 to 40 weeks. This may be challenging to allocate across CNO availabilities, which are normally nine weeks in duration, without affecting FRP readiness requirements.

What Is the Navy's Approach to Maintenance?

Reliability-centered maintenance (RCM) and condition-based maintenance (CBM) are the two overarching concepts adopted by the surface navy. RCM is a systematic analysis approach in which the system design is evaluated for possible failures, the consequences of these failures, and the recommended maintenance actions that should be implemented. Under the RCM method, an investigation is performed on a ship's systems and equipment to determine the service and testing necessary to maintain them in a condition that allows them to operate within established performance standards. The investigation process identifies maintenance requirements and periodicities and may identify at what level they should be accomplished.

¹ Derived from a description of the Fleet Modernization Program available at <http://www.globalsecurity.org/military/systems/ship/fmp.htm>.

² This availability is discussed later in this chapter.

³ The goal of a three-year window is to prevent installation of obsolete upgrades.

Preventive maintenance requirements such as those that are time or age based are determined using these concepts.

The CBM concept requires maintenance to be done only when there is objective evidence of the need through continuous sensing/monitoring technologies, visual inspection, and so on. For example, a sensor may be used to monitor the chemistry of the oil in a piece of equipment's circulation system, wherein the oil degrades with equipment run time, thereby changing its chemistry. Once the chemistry changes beyond a certain threshold, the equipment is due for an oil change. The approach is referred to as CBM, since the decision to change the oil is based on the actual "condition" of its chemistry.

By Whom Is Maintenance Performed?

Ships undergo some form of maintenance at all times during their life cycle, whether or not they are deployed. Fleet maintenance is performed at organizational, intermediate, and depot levels.⁴

At the organizational level, a ship's force performs planned or corrective maintenance that is within its capability.⁵ A ship's force maintenance takes advantage of the crew's maintenance and repair capabilities in order to maintain the self-sufficiency and mission readiness of the ship.

Intermediate maintenance activities also include preventive and corrective maintenance. Currently, intermediate-level maintenance may be performed by surface combatants' Fleet Maintenance Activities (FMAs), including the RMCs' production departments,⁶ and Battle Force Intermediate Maintenance Activities (BFIMAs, or the maintenance elements of deployed units beyond the organizational level). Maintenance performed by FMAs requires specialized skills, processes, technical proficiency, or equipment or instruments that are not available to the ship's force. Commercial industrial services perform maintenance that is similar to that performed by fleet maintenance activities, but which are beyond the capacity of the FMA.

Depot-level maintenance activities include preventive, corrective, and alterative or modernization efforts. These activities are time intensive, requiring a large repair infrastructure with significant manpower resources. They typically include complex industrial processes, journeyman-level technical skills, facilities, capabilities, or manpower capacity not available at FMAs or in the ship's force. This capability is provided within the surface navy by its ship repair facilities and commercial industrial repair facilities, including private shipyards under contract.

⁴ Department of the Navy, COMFLTFORCOM Instruction 4790.3 Revision Transmittal A, *Joint Fleet Maintenance Manual*, October 17, 2003.

⁵ Department of the Navy, COMFLTFORCOM Instruction 4790.3 (2003).

⁶ The next chapter provides a discussion on RMCs.

How Is Maintenance Accomplished During Deployment?

Accomplishing organizational-level maintenance while a ship is deployed is a function of what time the crew has available and what needs to be done. Organizational-level maintenance is provided in the same way, regardless of whether a ship is home-ported or overseas. If the ship's crew cannot complete a required maintenance task while deployed, they first request technical support, including distance support; if that is insufficient, they ask for technical assistance from the RMC, which coordinates the required support.

The fleet can provide some intermediate-level work when a ship is deployed. BFIMA billets are distributed throughout the fleet, over a number of different platforms (primarily the aircraft carriers), and are filled by individuals who have been trained to perform certain organizational and intermediate-level maintenance tasks. Any ship in the battle group that needs maintenance assistance can utilize the BFIMA repair capabilities or individuals who fill these BFIMA billets.

There are statutory limits on the type of maintenance that may be performed on deployed ships by foreign maintenance facilities.⁷ However, if an emergency repair, or voyage repair (as it is sometimes called), is required in order to transit the ship back to home port or to continue with the mission, established contracts are in place to get this work completed.

How Are Maintenance Plans Developed?

The Planned Maintenance System (PMS), Current Ship Maintenance Project (CSMP), and Integrated Class Maintenance Plan (ICMP) are the key systems used to identify, track, and plan maintenance.

Planned Maintenance System

The PMS details the periodic maintenance requirements to be performed by the crew at the organizational level. It is a standardized method for planning, scheduling, and accomplishing preventive maintenance by a ship's force. The maintenance procedures are developed in accordance with RMC concepts.

Current Ship Maintenance Project

A ship's company is required to document deferred preventive and corrective maintenance in the ship's CSMP. A CSMP work candidate entry is required prior to any assistance being provided by an off-ship activity. Maintenance authorities use a ship's CSMP as the source document to validate and broker work. It is essential for this document to be up-to-date, since it serves as the basis for funding of required maintenance. Only work that is documented in the CSMP is authorized for completion.

⁷ 10 U.S. Code 633 Section 7310 limits deployed U.S. naval ships to receiving only voyage repairs from foreign maintenance facilities.

Integrated Class Maintenance Plan

The ICMP is a database of maintenance tasks, including ship alteration and depot-, intermediate-, and organizational-level tasks requiring off-ship assistance. It is developed from information and experience gained from repair and maintenance histories of prior ship classes and similar systems and equipment, as well as feedback from maintenance managers, port engineers, ships’ forces, NAVSEA/fleet technical offices, the Naval Ships’ Technical Manual (NSTM), and type commander (TYCOM) maintenance manuals.

Generally, the ICMP includes systems and equipment identified as mission or safety critical; it interfaces with modernization requirements but does not include nonessential repairs for minor maintenance. The ICMP also includes mandated maintenance requirements such as inspections and tests—some of which are safety-related—directed by the NSTM or by technical manuals from the equipment manufacturer.

Since most maintenance is driven by the RCM and CBM concepts, the frequencies within the ICMP are notional. Therefore, the ICMP can be used to determine when a task *might* be due, but cannot determine when it *must* be done. There is one exception to this—the mandated requirements, which must be accomplished at the frequency prescribed.

The ICMP for DDG-51 class ships lists a total of 1,945 tasks. Of these tasks, most are completed at the depot level as shown in Figure 2.1.

There are 27 mandatory tasks (as of June 14, 2005) that need to be performed on a DDG-51 class ship. Figure 2.2 illustrates the number of mandatory tasks that must be performed, by month, since the time the task was last completed. There are two tasks that must be completed

Figure 2.1
DDG-51 Maintenance Activities Listed in the ICMP Require Different Levels of Support

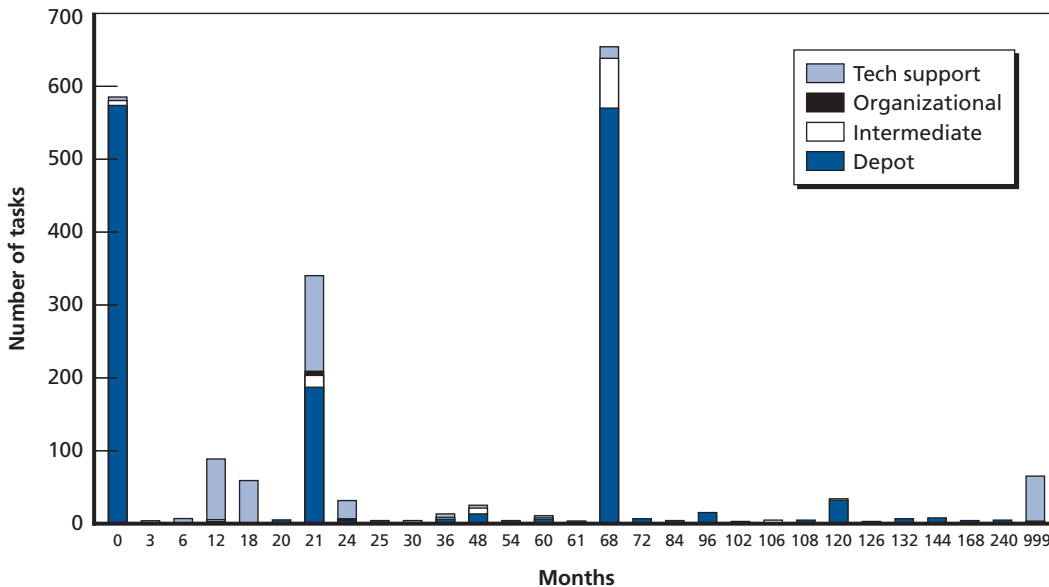
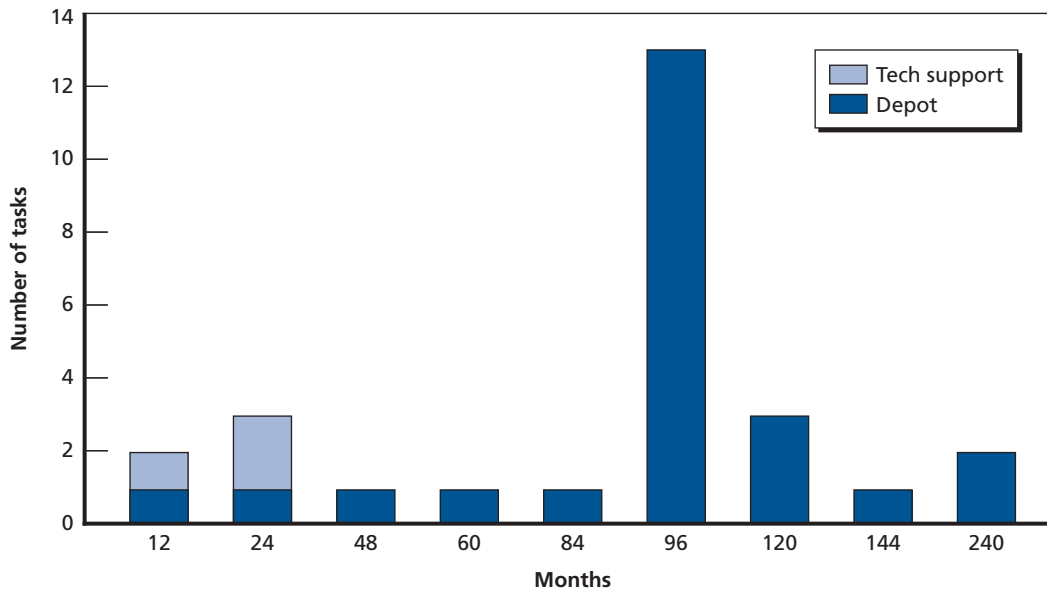


Figure 2.2
Number of Mandatory Tasks Listed in the ICMP for DDG-51 Class by Month



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every 12 months, and three tasks every 24 months. Most mandatory tasks must be completed every 96 months.

What Are Depot-Level Maintenance Availabilities?

Surface combatants currently have three kinds of depot-level maintenance periods, namely Selected Restricted Availabilities (SRAs), Docking Selected Restricted Availabilities (DSRAs), and Continuous Maintenance Availabilities (CMAs). These availabilities are all part of a ship's maintenance cycle, which, when combined with different training events, determine the readiness of a ship at any given time. These maintenance and training activities, along with inspection and certification events,⁸ constitute the IDRC, which basically addresses all the maintenance and training needs between two successive deployments.

An SRA for a surface combatant is a short, labor-intensive maintenance period typically conducted at a private shipyard. During this period, planned and corrective maintenance and modernization efforts may be conducted. The DSRA is a docking SRA, which is expanded in scope and requires dry-docking. SRAs and DSRAs are CNO SRAs.

A CMA is normally a less labor-intensive availability and includes depot-level maintenance that is performed outside a CNO SRA. The main purpose of the CMA is to provide

⁸ For additional discussion on inspection and certifications, refer to the Appendix.

a dedicated time to complete depot-level maintenance that cannot be completed in an SRA. Theoretically, material readiness can be maintained at higher levels by having multiple, dedicated maintenance periods outside the SRA.

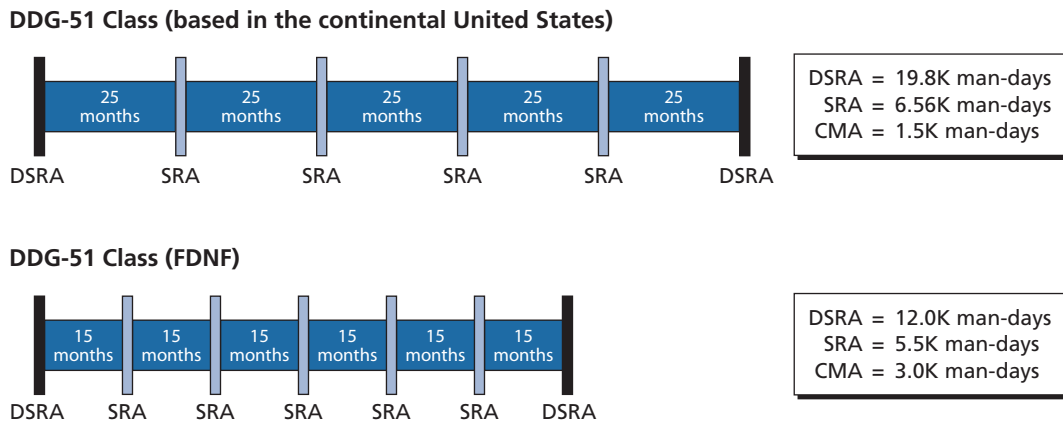
The frequency of the SRAs and DSRA's and representative man-days in each availability period, including CMAs, are listed in OPNAV Notice 4700 (June 2005).⁹ As an example, we show the programmed maintenance cycle for DDG-51 class ships in Figure 2.3. The DSRA schedule is notional. Excluding the Forward Deployed Naval Forces (FDNF) ships deployed from Yokosuka, Japan, the DSRA schedule may be extended from 96 months (eight years) to 144 months (12 years), provided repairs and modifications have been performed in specific areas, including underwater hull and freeboard; sea chests; tanks and voids; propulsion shaft outboard bearings; propulsion shaft covering; rudders, bearings, and seals; controllable pitch propeller; and cathodic protection system. The notional dry-docking interval remains at 96 months until this work is completed.

As the figure indicates, the duration of SRAs and DSRA's is approximately nine weeks. FDNF ships have more frequent SRAs, and they have CMAs with more representative man-days than the rest of the class.

How Is the Surface Maintenance Budget Developed?

The surface navy uses MRS to track historical costs of depot-level maintenance performed on ships. These data are then used to justify the Navy's surface ship maintenance budget in the

Figure 2.3
Planned Maintenance Cycle for DDG-51 Class Ships



NOTE: Duration of SRA and DSRA = ~2 months.
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⁹ Chief of Naval Operations, *Representative Intervals, Durations, Maintenance Cycles, and Repair Mandays for Depot Level Maintenance Availabilities of U.S. Navy Ships*, OPNAV Notice 4700, June 13, 2005.

Department of Defense's Planning, Programming, and Budgeting System during the budget submission process.

MRS is a database that links the resources (dollars spent on maintenance) to execution (performance of maintenance). MRS contains fixed and variable requirements. Fixed requirements are necessary inspections, certifications, and so forth based on recommended equipment and system parameters, whereas variable requirements relate to corrective maintenance necessary to return the equipment and system to required performance standards.¹⁰

The inputs to MRS are the cost data from the type commander (Surface Forces Atlantic [SURFLANT] or Surface Forces Pacific [SURFPAC]),¹¹ CSMP data for the system and equipment on which maintenance is performed, and available maintenance schedules. A ship sheet—the summation of work that has been performed on a ship during a depot-level availability—is produced by the TYCOM (SURFLANT or SURFPAC) for each ship. From these data, a three-year moving average of a typical ship availability¹² is built. The moving average is used to project the costs of future scheduled availabilities, and these costs are used for the maintenance budget in the Navy's program objective memorandum (POM) submission.

¹⁰ Kenneth S. Jacobs and Robert L. Ceres, Jr., "The Maintenance Requirements System: Risk-Based Resource Planning Comes of Age," paper presented at the American Society of Naval Engineers Conference, June 12, 2001.

¹¹ TYCOMs provide a ledger and CSMP data upon completion of availability.

¹² While FMP upgrades are performed during CNO depot-level availabilities, the costs of FMP alterations are not captured in MRS data. TYCOM-funded alterations are included in MRS data.

Managing Maintenance to Accommodate the Fleet Response Plan

In attempting to increase fleet readiness and operational availability, the Fleet Response Plan has required a paradigm shift from an elongated period of maintenance and basic training to a condensed period. As part of this shift, the Navy has faced challenges in planning and scheduling maintenance. To understand those challenges and the Navy's efforts to meet them, we interviewed fleet maintenance and scheduling authorities at NAVSEA 04 and NAVSEA 04RM in Washington, D.C.; CFFC, CNSL N3, N43, and RMC in Norfolk; and CNSP N3/5, N43, N6, and RMC in San Diego.

This chapter begins with a discussion of the way in which the FRP has changed the readiness cycle and its implications for operational availability. This sets the stage for a description of how the fleet maintenance and scheduling authorities plan and schedule availabilities within the new readiness cycle. We follow with a discussion of how maintenance resources are marshaled to meet the new schedule demands, and conclude with some steps being taken by the Navy to reduce maintenance needs.

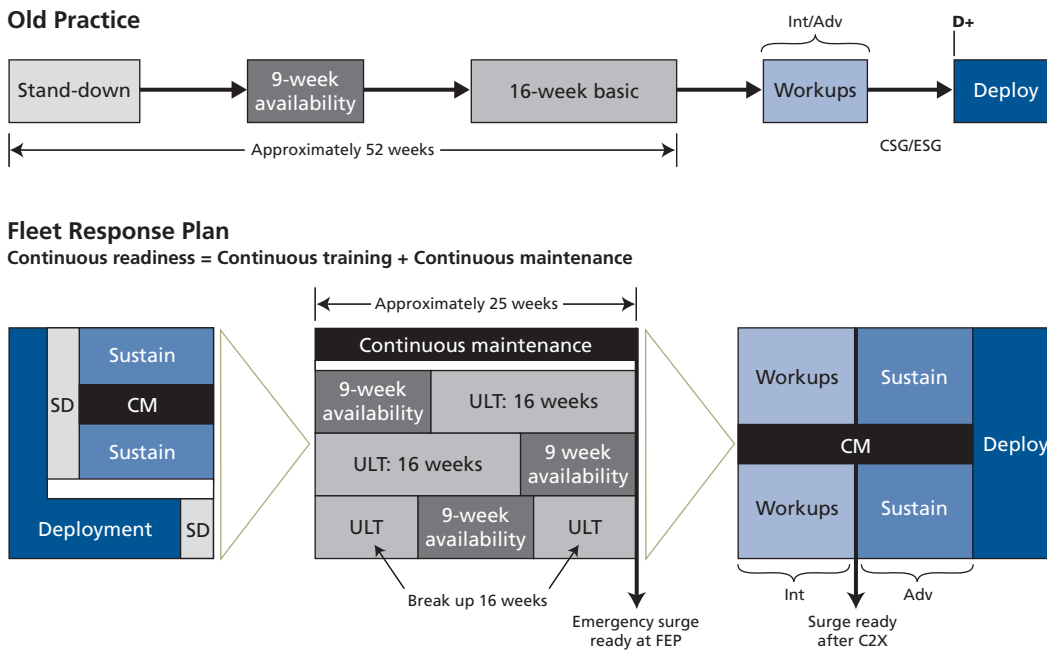
The Fleet Response Plan Changed the Readiness Cycle

Prior to the implementation of the FRP in March 2003, a ship would return from a deployment, go into a post-deployment leave and stand-down period, experience a possible delay prior to a depot-level availability, complete the maintenance availability, and then commence approximately 16 weeks of basic training, followed by intermediate and advanced phases of training (see Figure 3.1).¹ Completing each successive training phase would lead to a higher level of readiness. This predictable sequence within the context of staggered combatant deployments resulted in the level loading of maintenance facilities and of the afloat training groups that assist in training ship's company.

¹ The focus of intermediate-phase training is on warfare team training and initial multi-unit operations. Training in the sustainment phase, or advanced training, continues to develop and refine integrated battle group warfare skills and command and control procedures needed to meet the major fleet commander's specific mission requirements.

The FRP aims to deploy a fleet with a high level of readiness² on short notice. The plan calls for a readiness level that will allow six CSGs to deploy within 30 days and two more within 90 days. In the FRP environment, when a ship returns from deployment, it will achieve a high level of readiness sooner and sustain it longer. Under the FRP, there is no delay following the post-deployment stand-down—the ship either goes directly into a nine-week CNO SRA or begins basic phase of training, which is approximately 16 weeks (see Figure 3.1). Although the duration of the CNO availability has not changed under FRP, the basic phase of training is now more flexibly scheduled. Now basic training commences almost immediately³ upon return from deployment. The early commencement and completion of basic training allows an earlier start of intermediate and advanced training, and this is where the time savings are reaped. The net benefit is that a ship is more quickly graduated through basic, intermediate, and advanced training, which provides an increased operational availability of the ship to the operational commander.

Figure 3.1
Comparison of Practices Before and After FRP



SOURCE: CNSL.

NOTES: C2X = combined training unit exercises; CM = continuous maintenance; FEP = final evaluation period; SD = stand-down; ULT = unit-level training.

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² A ship’s readiness is reported through a Status of Resources and Training System (SORTS) readiness report. SORTS ratings report the capability of a unit to perform the primary and secondary wartime missions for which it is organized and designed. The capability of a ship to perform an assigned mission area is based on the personnel, supplies and equipment on hand, equipment status, and training.

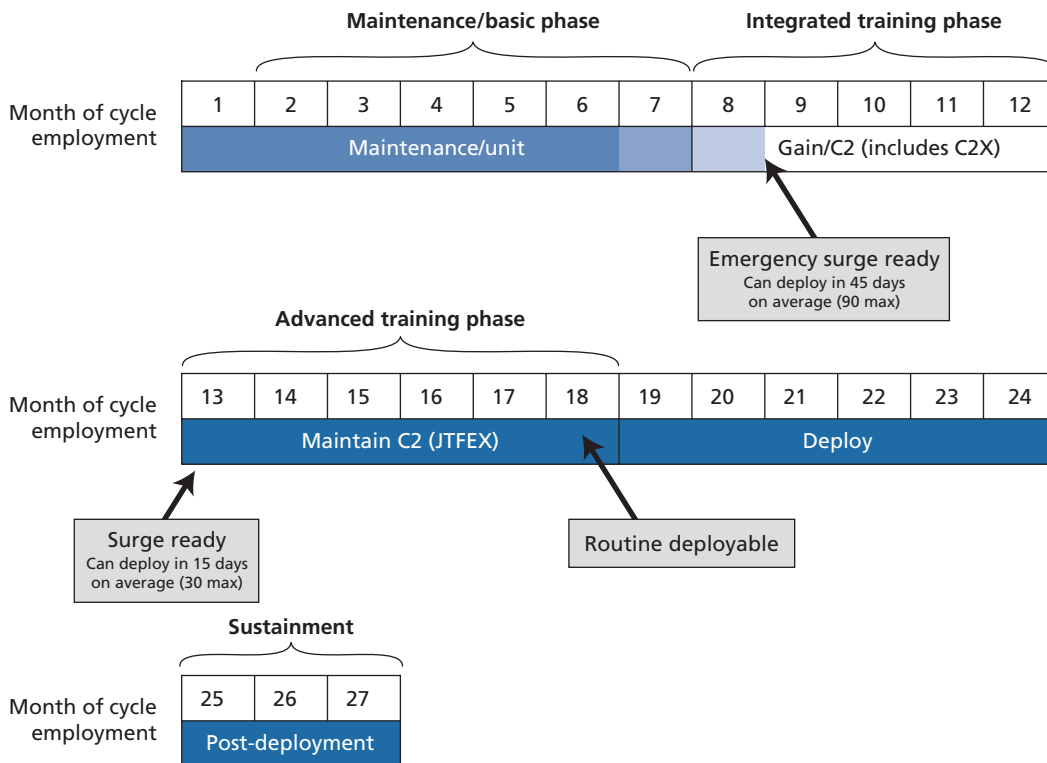
³ A post-deployment stand-down is normally scheduled to allow crew members to take leave following a deployment.

The Meaning of Readiness Under the FRP

Prior to the FRP, carrier battle group readiness goals were driven by “deployment minus” (D–) planning milestones. That is, the readiness requirements were scheduled to be met at certain milestones or dates based on the future deployment date. Under the FRP, readiness is viewed in terms of “reset plus” (R+) milestones. The focus is now on achieving readiness as soon as feasible after the ship returns to port (is “reset”). The maintenance phase is defined as approximating R+0 to R+6 months. The intermediate training phase covers approximately the next R+7 to R+12 months, and advanced training follows.

Under the FRP, the cycle of maintenance and training events—the IDRC—the has formal milestones called “Emergency Surge,” “Surge Ready,” and “Routine Deployable” (see Figure 3.2). *Emergency Surge* assets are those that are deployed only in cases of an emergency, such as in Operation Iraqi Freedom. A ship qualifies for Emergency Surge when it has achieved the required training level⁴ in its required certifications and is prepared for integrated and

Figure 3.2
A 27-Month IDRC Showing Three Phases of Training and Three Stages of Readiness



NOTE: JTFEX (Joint Task Force Exercise) is a final exercise conducted with all elements of the CSG. Upon successful completion of the JTFEX, the CSG is certified as ready to deploy and to engage in the full spectrum of naval operations.

RAND TR358-3.2

⁴ A training level is a combination of the proficiency of its watch-standers to perform their duties and the ability of the ship to sustain that training through its training team organization.

sustainment training. It is also immediately deployable as a unit for single-ship operations or as required by the numbered fleet commander at levels of operational risk correlating to the level of training accomplished when surged.⁵ Typically, Navy assets are to reach emergency surge status after completing the basic phase of training in the IDRC. This milestone is generally attained within 25 weeks upon return from deployment. Another 45 days, or six to seven weeks, must be allowed for the ship to leave port. These numbers are in contrast to a minimum of 52 weeks to the end of basic training prior to the FRP.

Surge Ready refers to assets that have completed the intermediate phase of training in the IDRC. This status is generally attained around six months after completing a maintenance period, or R+12. By this time, the CSG should have attained a designated C2⁶ readiness level—that is, it is considered combat ready.

By this point, the CSG or a single ship may also have achieved “targeted readiness.” Instead of categorically requiring the highest state of readiness prior to deploying a CSG under the pre-FRP standards, “in many instances, absent indications of imminent danger or war, intermediate levels of readiness are not only acceptable but a prudent use of resources.”⁷ A ship may be needed to perform a specific mission for which an intermediate level of readiness is sufficient (e.g., radar picket for counter-drug operations). The achievement of maximum readiness levels in all mission areas may not be needed to perform specific missions, and a ship may be surged if capable and ready to meet a specific mission requirement.

Routine Deployable refers to a ship that is ready for deployment by traditional standards—that is, after advanced training, to include the Joint Task Force Exercise with current refresher training as required. During the “routine deployable” window (spanning R+13 to R+27), the CSG maintains combat readiness and may or may not surge, depending on combatant commander needs. It may also “pulse”—that is, conduct at-sea activity away from home port during the surge-capable window that could entail anything from participating in routine training exercises to providing forward presence as desired by combatant commanders.⁸ Atlantic Fleet scheduling authorities indicated that during these periods surface combatants perform fleet services (e.g., helicopter landing platform, tracking exercises with submarines, opposition force for deploying forces) and exercise with other fleet units to sustain their readiness.⁹

⁵ Department of the Navy, COMNAVSURFOR (Commander, Naval Surface Forces) Instruction 3502.1B, July 1, 2004, p. 2-1-2.

⁶ The overall status indicates the degree to which a unit is capable of undertaking its assigned wartime mission(s), based on the organic resources under the operational control of the unit. An overall status of C2 indicates that the unit possesses the resources and has accomplished the training necessary to undertake the bulk of the wartime mission for which it is organized or designed.

⁷ Coordinated fleetwide message on FRP from the CFFC and Commander, U.S. Pacific Fleet, April 24, 2004.

⁸ “Fleet Response Plan: Postured to Deter, Poised to Strike,” briefing prepared by OPNAV N3/5 (Deep Blue), Office of the Chief of Naval Operations, March 2004.

⁹ This information was derived from an interview with Atlantic Fleet scheduling authorities in Norfolk, Virginia, on April 25, 2005.

Prioritizing Ships for Surge

Different states of readiness are reflected in the priorities for selecting ships for deployment. In practice, priorities under the FRP run as follows, from highest to lowest:

- Ships already deployed, which can be redirected—i.e., those in the Routine Deployable category
- Ships deploying next—i.e., those in the Surge Ready category
- Ships just returned from deployment that have not yet gone into an availability
- Ships just coming out of an availability or basic training—i.e., Emergency Surge assets
- Other ships as available or needed.

Thus, in general, the most ready CSGs get deployed. Expeditionary Strike Groups (ESGs) are not subject to the FRP, *per se*, but are required to be amphibious task force lift surge deployable. This means that if the currently deployed ESG assets cannot transport the necessary amount of materiel rapidly enough for the surge operation, additional ESGs will be deployed to meet the lift requirement.¹⁰

During a surge situation, scheduled maintenance actions are deferred until after deployment. Only actions that are mandated under the ICMP will be further assessed as to whether they need to be completed before the surge. Results of this assessment determine the ship's ability to deploy as part of the surge. In general, a ship's maintenance team prioritizes what must be completed prior to a surge and defers non-mandated requirements that do not have significant impact on the ship's ability to deploy and conduct required missions.

The Pacific and Atlantic fleets have different philosophies for surging a CSG. In the Pacific Fleet, the goal is to keep the CSG together throughout the IDRC. This approach makes getting required maintenance more challenging because the surface ships cannot go into an availability while the carrier is "surge" capable, either before or after a deployment. For example, one carrier was designated as surge capable for more than a year after its return from deployment, which caused the escort destroyers to miss maintenance periods. The matching of surface combatants to aircraft carriers must be carefully performed to support the maintenance demands of the escorts.

In the Atlantic Fleet, surface combatants also train and deploy with their parent CSG. Atlantic Fleet schedulers indicated that upon return from deployment, the attachment of surface combatants to parent CSGs is not as rigid. Ships are regarded as belonging to a "pool" of operational assets that can be drawn upon if and when required. If operational requirements dictate that the fleet needs to respond with a CSG, it will send the operationally ready assets. If a surface combatant that is part of a deploying CSG is in maintenance or otherwise not ready, another ship will be designated to take its place and deploy with the CSG. In Second Fleet, a "surge status message" designates ships that are available for surge, those in maintenance, and those in basic and unit training.

¹⁰ Amphibious lift refers to the number of troops, landing craft, and helicopters that can be carried on amphibious warfare ships, as well as the amount of space for vehicles and cargo.

Maintenance, Risk, and Readiness

In demanding more of maintenance and training practices, the IDRC aims to increase combat power at the cost of increased operational risk. Operational risk involves the probability of failure (of a component or system) and the severity of failure. The operational situation may require a ship to be surged at a less than full operational capability. For example, a ship may be tasked to surge without attaining all readiness training and certifications, or the ship may have outstanding maintenance actions that need to be performed. While this was also true prior to the implementation of the FRP, the risk was lower when readiness cycle activities were executed in a more sequential, deliberate fashion. The FRP may thus require operational commanders to make more operational risk management decisions in regard to a ship's readiness.

The Navy thus has powerful incentives to see that preventive, corrective, and modernization actions are performed to meet the readiness requirements formalized under the three milestones of surge status. For a surface combatant, this means placing greater emphasis than previously on planning, scheduling, and completing of maintenance activities in availabilities for which docking is not required. Additionally, training schedules must be more responsive to windows of opportunity or available gaps immediately upon a ship's return from deployment.

Maintenance Challenges

Under the FRP, units are required to maintain a high level of readiness so that they can deploy on short notice. This results in maintenance challenges related to planning and scheduling. Further challenges are associated with organizing and budgeting for a different flow of maintenance demands.

Planning DDG-51 Availabilities

Under the FRP, there is no longer a predictable commitment of surface combatants to a depot availability approximately six weeks after a deployment. Fleet schedulers (N3) must now work more closely with fleet maintenance schedulers (N4) for maintenance scheduling. We discussed the planning of availabilities with fleet schedulers and maintenance authorities, and this subsection is based largely on those interviews.

Availability planning under the FRP must account for (or can exploit) several new factors, including the need to allow for surge capability shifts in organizational roles and the constraints imposed by the budgeting system.

Allowing for Surge. When ships are in the FRP surge windows, maintenance performed on them is tracked more closely. Some maintenance has to be done earlier in view of the surge requirements and may result in higher costs because a premium may have to be paid for overtime and extra shifts.

Maintenance officials strive for responsiveness and have attempted to mitigate the negative effects, such as high premiums, associated with meeting surge requirements. A dynamic response to maintenance demands is possible because of multi-ship, multi-option (MSMO) contractors' access to subcontractors and the ability to re-prioritize work in the yards to get ships to sea.

Maintenance on some ships may be deferred, either to direct resources to other ships needed sooner or because of extended deployments. Maintenance authorities closely monitor such deferred maintenance to ensure that if the ship must participate in a surge, repairs critical for mission accomplishment can be made.

Ships not in a deep maintenance period are required to get under way within 96 hours. If the condition of some equipment prevents a ship from meeting this requirement, a disabled machinery report must be filed to alert the chain of command.

Organizational Factors. According to port engineers, the roles of the maintenance teams and other maintenance organizations need to be better defined, along with their relationship to the individual commands and the TYCOMs. Transitional issues and challenges related to roles and responsibilities of the various activities before and after RMC consolidation appear to be present. For example, some people who are accustomed to the old ways of operating are struggling with understanding how the RMC concept is to work.

Budgeting. Some fiscal laws, policies, and practices have an adverse impact on Navy ship maintenance planning and execution. Some funding challenges occur when a ship's maintenance availability starts in one fiscal year and ends in the next. Other challenges occur when the Department of Defense is operating under a continuing resolution—that is, when the defense budget has not been approved for the current fiscal year.

While obligation of Navy maintenance funds from one fiscal year to the next can be done, it takes careful planning. Navy operations and maintenance dollars can be carried from one fiscal year to the next if they are obligated in a contract or a project order for a well-specified, bona fide need, before the end of the fiscal year. However, the fleets typically do not commit in advance to that kind of cross-year funding, and they rarely have any money remaining at the end of a fiscal year to contract in this manner.

Continuing resolutions are short-term, multi-department appropriations acts passed in the absence of a departmental annual appropriations act. Generally, they allow continued expenditures under the assumption that the appropriations eventually passed will be similar to those of the preceding year. Continuing resolutions typically ban new starts in investment appropriations (SCN [Shipbuilding and Conversion, Navy], OPN [Other Procurement, Navy], etc.) but do allow for operations and maintenance appropriations to be expended. However, in practice, fleet comptrollers may not want to start operations and maintenance expenditures (for maintenance) under a continuing resolution. The reason is that, while they can be fairly sure that maintenance availabilities will be funded, they do not really know how much maintenance funding they will receive for the new fiscal year or when they will receive it.

Therefore, fiscal laws, policies, and practices create uncertainty for Navy ship maintenance execution. Fleet maintenance authorities consider these issues to be a significant challenge to their maintenance planning. Whether the Navy could mitigate this uncertainty is a topic beyond the scope of this study.

Scheduling Continuous Maintenance Availabilities and Longer Modernizations

It is a greater challenge to schedule the CMA and the longer modernizations (which can last up to a year) than the SRAs. Prior to the FRP, continuous maintenance availabilities were scheduled twice yearly on non-deployed ships based in the continental United States. Now, three-

week CMAs are scheduled once per quarter, if and when the ship is available.¹¹ This does not necessarily mean that maintenance is performed on every ship once a quarter, but an increased frequency in which a CMA may be conducted allows the maintenance organizations more opportunities to correct problems if a ship is not deployed. Maintenance representatives indicated that these more frequent continuous maintenance periods might buy increased lifespans for the ships but do not necessarily provide “extra readiness.”

The CMA periods require advance planning: jobs must be planned, parts must be ordered, and workers must be assigned to perform maintenance. Newly discovered work is often deferred to the next CMA to prevent having to pay premium dollars for expediting parts or increasing the supply of labor.

Longer modernization periods for CGs (carriers) and DDGs will be very challenging to schedule without affecting the FRP cycle. Maintenance and modernizations officials are looking at methods that could reduce the duration of overhaul periods. Modernization of cruisers, scheduled to begin in FY 2006, may take as long as 40 to 50 weeks.¹² Current plans call for breaking these maintenance modernization packages into two 20- to 22-week periods.

FRP surge readiness requirements may conflict with the need for modernization. Modernizing the ships of a given class can take up to three years from the time the alteration is approved to the installation on the last ship. If the need for surge readiness means that modernization for the ship class is spread over a long period, by the time the last ship is completed, the upgrades could be obsolete. However, if all the upgrades are complete in a compressed period, surge readiness and operational availability may be compromised or the funds available in the shorter period may be insufficient to cover all the work.

Approaches to meeting these challenges have been devised. The longer modernizations are scheduled so far in advance that the planning can be coordinated to enable the continued attainment of operational capability without the assets undergoing modernization. The modernizations of less than 20 weeks tend not to be problematic, because the modernization window—the period allowed for an availability and the basic phase of training—totals approximately 25 weeks. Thus, the goal is to fit the modernization into the modernization window and not necessarily the nine-week availability. The maintenance schedulers indicated that they divide a 20-week installation into one nine-week CNO availability and into several three- to four-week continuous maintenance periods. If important systems are not disabled between modernization work periods, the ship can be available for operations and training during the intervals.

Given that the size of the surface combatant force remains the same, using DDG-51s on Sea Swap can be an enabler for the performance of modernizations. Under Sea Swap, surface combatants are assigned to CSGs and ESGs by taking turns—one deploying from the Atlantic Fleet and then one from the Pacific, generally to the Fifth Fleet Area of Responsibility. A single

¹¹ This scheduling periodicity for continuous maintenance periods was provided to the research team by CNSL scheduling authorities.

¹² The duration varies because these modernization packages are specific to the platform.

Sea Swap deployer effectively reduces the need for the other fleet to deploy a ship. In this way, Sea Swap saves deployments. The Sea Swap deployment concept thus contributes to the FRP's objectives by increasing the fleet operational availability of ships that do not have to deploy.

For these reasons, according to schedulers, there are enough destroyers (in the pool or reserve) to utilize in the case of a surge or emergency surge situation. Fleet schedulers indicated that it is not hard to adjust to meet the demand for destroyers. The fleet still deploys according to the presence requirements in support of the Global Naval Force Presence Policy. Under the GNFPP, ships with specific capabilities are required to be forward deployed to meet specific demands. The assets that are taken off line do not prevent the fleet from meeting its operational requirements. It is less clear, however, whether the ships are as well maintained or as ready and at what cost.

Marshaling Maintenance Resources

Our interviews with maintainers and schedulers indicated that surge-related maintenance demand increases so far have not appeared to stress manpower resources to the point at which work is delayed because of manpower shortages. The challenge is to bring resources to bear while keeping costs low.

In recognition of that challenge, the Navy has been attempting to improve the flexibility and efficiency of maintenance resource supply. Uncertainties about the timing of a surge necessitate a flexible supply base capable of addressing the scheduling challenges. Better communication within the maintenance organization and proactive management of CMAs around CNO availabilities are key steps toward providing this flexibility. The establishment of regional maintenance centers and ship-specific maintenance teams are thus important facilitators for the FRP. Several other recent initiatives also contribute: SHIPMAIN (ship maintenance initiative) increases process efficiency, "One Shipyard" facilitates level loading of the labor force, deployed ships can call on distance support or on Systems and Equipment Material Assessment Teams (SEMATs), and MSMO contracts enable the contractor to start work almost at a moment's notice. These initiatives are valuable in an environment where shorter lead times to meet surge requirements are the norm. They also help minimize any overtime maintenance work needed to provide the enhanced operational availability to the numbered fleet commander under the FRP. We discuss each of these facilitating efforts below.

Multi-Ship, Multi-Option Contracts

Historically, private shipyards have competed for each depot availability. The competitive environment has been viewed as beneficial in providing good value of service for the money spent.

Recently, the Navy has instituted the practice of awarding a single overarching contract to a prime contractor responsible for depot-level maintenance work on multiple ships in a class. The contractor bids on a standard work package typical for these ships, but a supplement can be added when a specific ship requires greater attention. Such MSMO contracts have been in place for several years for the San Diego-based DDG-51s, and they are just being instituted in

the Norfolk area. MSMO contracts enable the government to eliminate the time required to compete, bid, and award a contract for each ship in a class. The government also hopes to reap savings as a result of learning across multiple ships on the same standard work package.

Another goal of adopting MSMO contracts is to size the infrastructure appropriately to meet the maintenance demands. Since the public shipyards are constrained in their ability to rapidly adjust their labor resources, MSMO contracts provide access to resources from private shipyards when demand exceeds the supply of resources at the public shipyards.

Under MSMO contracts, it is not as expensive to reschedule work, move work packages around, or change the work within a package, whereas previously, such actions might have required a new contract. MSMO contracts are written broadly enough to cover changes in work without requiring new contracts.

The long-term stability of MSMO contracts (they run up to five years) enables the prime contractor to conduct industrial planning and manage its workforce and overhead more effectively. Work planning is facilitated through the prime contractor's participation on the maintenance team. The contractor works with RMCs to schedule intermediate maintenance.

MSMO contracts have implications for availability scheduling. The contracts and work packages for CNO SRAs must be determined and locked in ahead of the availability because it takes time to perform the necessary planning and integration needed to perform the maintenance. The planning includes the development of a maintenance plan, ordering parts (some are long-lead-time), and assigning personnel to the tasks. Previously, in a fixed-price contract, SRAs were scheduled and the work package locked in at 160 days prior to the start of the availability. Now, with MSMO contracts, the work packages are locked in at 120 days prior to the availability. Thus, the result is 40 additional days for a ship's force to determine and prioritize work that needs to be completed but 40 fewer days for the contractor to coordinate the resources and personnel to complete the work package.

For CMAs, maintenance planners used to develop and "lock in" the work package approximately 60 to 90 days in advance. Now, MSMO contracts help support the completion of continuous maintenance throughout the FRP cycle because of the flexibility they provide in timing and quantity of work. Under MSMO contracts, a continuous maintenance work package is locked in at 45 days prior to start. According to one senior port engineer, the maintenance industrial base now has to be more flexible to meet these shorter lead-time demands. In this regard, continuous maintenance periods place greater stress on the maintenance industrial base and, more specifically, the MSMO contractor.

Regional Maintenance Centers

The main purpose of the RMC is to provide intermediate-level maintenance support and to serve as a location for the training and shore duty of sailors. Besides being a maintenance provider, the RMCs serve as a broker for maintenance because they create maintenance packages and distribute them to maintenance providers.¹³ The RMCs are generally a consolida-

¹³ The maintenance team resides within the RMC and distributes work to different availabilities and maintenance providers.

tion of Ship Intermediate Maintenance Activities (SIMAs);¹⁴ Supervisors of Shipbuilding, Conversion, and Repair; Fleet Support Technical Centers (FTSCs); port engineers; readiness support groups; contractors; and in two cases, public shipyards.¹⁵ Previously these entities worked separately, as required, but under the RMC they function as a consolidated provider of maintenance.

Currently, there are three RMCs established on the Atlantic coast: the Mid-Atlantic RMC in Norfolk, Virginia; the South-Central RMC in Ingleside, Texas; and the Southeast RMC in Mayport, Florida. The Pacific coast has the Pacific Northwest RMC in Bremerton, Washington; the Pacific Southwest RMC in San Diego; and the Pearl Harbor RMC in Honolulu, Hawaii. Of these, the RMCs in Norfolk and San Diego have the capacity to maintain a large fleet of surface combatants, with a sizable number of them being DDG-51 class destroyers.

The Mid-Atlantic RMC performs some I-level maintenance, or farms it out to private industry as necessary, and employs approximately 3,700 people. There are approximately 2,000 sailors conducting I-level maintenance, 1,000 sailors and civilians providing technical assistance, and 300 contractors are also part of the mix. The Mid-Atlantic RMC has two overseas detachments—one in Naples, Italy, and another in Bahrain. The organization of all RMCs is similar to that of the Mid-Atlantic RMC, with the SIMA responsible for performing the maintenance activities and housed in a production department.

The Southwest RMC was formally established in November 2004. In addition to the main intermediate maintenance facilities, the Southwest RMC maintains a small-boat repair center at the Naval Amphibious Base in Coronado and, within the SIMA, a submarine maintenance division at Point Loma. The Southwest RMC employs nearly 2,200 military and civilian personnel in more than 70 industrial shops, spanning nearly 22 acres. This command provides training and maintenance support to more than 100 surface ships.¹⁶

SIMAs are operated under a manning philosophy intended to meet the surge requirement. Work assigned to the SIMAs is limited to 80 percent of their capability. A 20 percent contingency is reserved to provide maintenance in support of FRP surges.

SHIPMAIN

SHIPMAIN was launched in fall 2002 by the Commander of the Naval Surface Forces to improve maintenance planning for surface ships and nonnuclear aircraft carriers, from the point at which work is first identified by a ship's force through the start of execution of that work in a maintenance availability. It concentrates on gaining efficiencies across multiple organizations by identifying and eliminating redundancies. By streamlining the planning process for ship maintenance, SHIPMAIN expects to capture significant savings. SHIPMAIN is pri-

¹⁴ SIMAs are responsible for providing the facilities and manpower to accomplish intermediate-level maintenance. The Supervisor of Shipbuilding, Conversion, and Repair is primarily responsible for contracting maintenance to private yards. FTSCs function as technical maintenance providers and liaisons for industry technical assistance. Port engineers are responsible for understanding and helping to schedule the engineering and maintenance requirements of one or two ships. The readiness support group is responsible for making sure the ship is ready to fight when it is required to do so.

¹⁵ These include Pearl Harbor and Puget Sound naval shipyards.

¹⁶ Taken from the Southwest RMC's Web site, <http://www.swrmc.navy.mil/>.

marily aimed at getting the work done sooner through a continuous maintenance period—while avoiding premium labor costs—rather than waiting for a major availability to do the work.

SHIPMAIN focuses on four maintenance processes:

- Requirements, including work identification and prioritization, communication, and measurement of a ship's maintenance needs in an efficient manner.
- Work package preparation, directed at improving existing planning information and process capabilities to make final work package content decisions closer to the time the work is actually scheduled to begin. This facilitates more realistic estimates of what work actually needs to be performed, leading to more accurate maintenance budgets. Such an exercise minimizes last-minute changes to a work package, for which a contractor usually charges a premium.
- Placement and oversight functions, such as awarding of contracts and managing the work package activities through their completion.
- Alterations and modernization processes, now streamlined, consolidated and provided with a single, hierarchical decisionmaking process for surface ships and carriers.

Responsibility for SHIPMAIN execution rests with a process improvement team, a panel of flag officers and Senior Executive Service personnel from various warfare and support communities. Reporting to this team are four cross-functional teams, each chaired by a flag officer and consisting of senior personnel involved in ship maintenance processes.

Maintenance Teams

To schedule maintenance in the most efficient way, the Navy aims to have a maintenance team¹⁷ allocate work for each ship to the appropriate level (organizational, intermediate, or depot) and therefore to the appropriate maintenance provider. The maintenance team continually assesses the ship's maintenance requirements and puts together the work packages and assigns them to maintenance suppliers according to existing laws and policies. The core members of these teams include the ship's commanding officer, the port engineer, the ship superintendent, the ship maintenance and material officer, the chief engineer, the naval supervisory activity project manager, and representatives from the fleet technical support center and the MSMO contractor. These teams can have additional resources as needed to complete their tasks, which are as follows:

- Validating all CSMP items to ensure accuracy of data and determining the appropriate time frame to accomplish required work
- Brokering work candidates to the appropriate activity for planning and execution

¹⁷ Interviews with fleet authorities indicate that the roles of the individuals on the maintenance team are still being defined. Prior to the implementation of the FRP, the port engineer made these decisions.

- Ensuring—in collaboration with the RMCs—that port loading of maintenance providers permits the efficient use of resources and reduces the amount of dollars paid for premium work.

The maintenance teams create a one-stop screening and brokering process for work requests, thereby eliminating the previous need to coordinate with multiple parties. They use metrics to prioritize work requests and strive for successful execution of the right job at the right time.

The maintenance team must work within the fiscal guidance defined by the Maintenance and Modernization Business Plan that it develops. The team bases the plan on the team's knowledge of the ship's material condition and its prospective operating plan. Assessment of the ship's anticipated material condition draws from the validated CSMP, ICMP applicable tasks, planned TYCOM-funded alterations, outstanding departures from specification, CASREPs, and INSURV¹⁸ material discrepancies. The plan addresses funding for CNO availabilities, advance planning, and continuous maintenance opportunities.¹⁹

One Shipyard

Historically, resource planning at public shipyards has been a challenge as a result of the uncertainties in estimating the amount of work and the necessary skills required for the scheduled maintenance effort. Public shipyards are also constrained in their ability to quickly adjust their workforce to meet maintenance demands at the skill level. This limitation results in a shipyard being forced to make last-minute changes to maintenance work packages to fit the available labor resources. The One Shipyard concept makes it easier for the shipyard to obtain needed skilled labor resources by drawing on skills available at other yards—that is, to create one pool of skilled maintenance providers that can be moved from one location to another as needed to help level peak workloads that may occur under the FRP.

As shown in Figure 3.3, this concept has as its core the four naval public shipyards—Pearl Harbor, Puget Sound, Portsmouth (New Hampshire), and Norfolk. This core is supplemented by a layer consisting of a partnership with General Dynamics Electric Boat (GDEB) and Northrop Grumman Newport News (NGNN) to perform the nuclear functions under the umbrella of a “One Nuclear Shipyard.” Finally, the overarching “One Naval Repair Shipyard” involves private shipyards that provide the additional repair capabilities. Such a concept encourages teaming arrangements and brings more stability to the industry through long-term planning. This resource and infrastructure sharing across public and private shipyards could facilitate providing cost-effective ship construction, modernization, and maintenance while maintaining core capability at the four public shipyards.

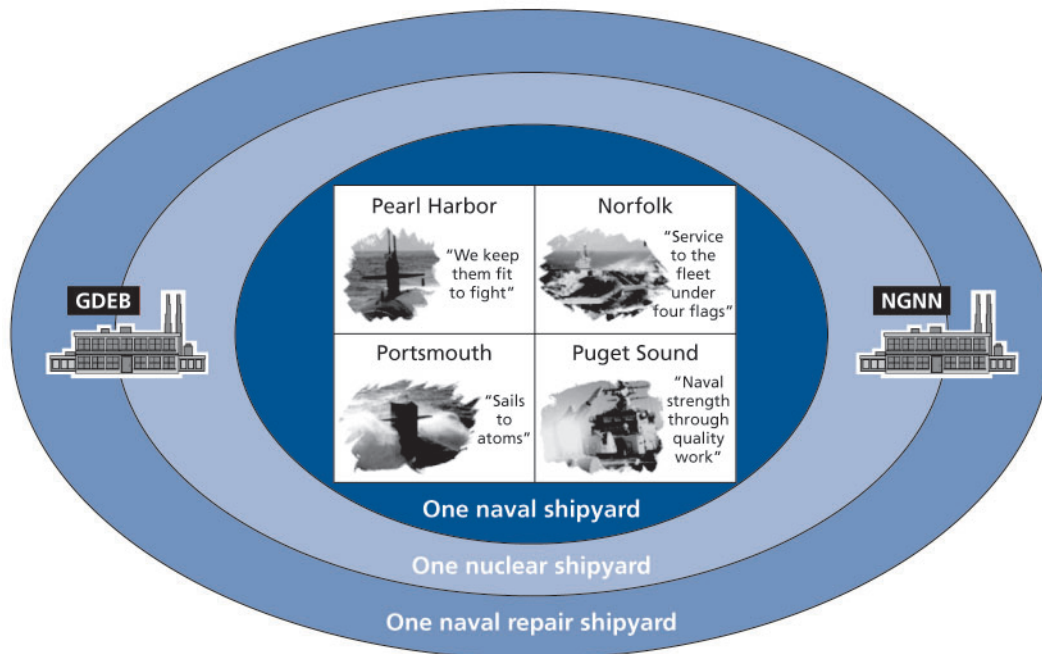
Distance Support

When a ship is deployed at sea, the on-board crew has to address day-to-day maintenance needs, some of which can be beyond their technical capabilities. In the age of wireless

¹⁸ A team of experts that inspects and provides an assessment of the ship's material condition at a given point in time.

¹⁹ Department of the Navy, COMNAVSURFOR Notice 4701, *Surface Ship Maintenance Validation, Screening, and Brokering*, December 29, 2004.

Figure 3.3
"One Shipyard" Concept Implemented at Three Different Levels



SOURCE: Extracted from a NAVSEA briefing, "DOD Depots of the Future: Maintaining Yesterday's and Tomorrow's Navy, NAVSEA Vision," October 2004.

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communication and the Internet, these maintenance needs are being addressed through distance support. Technical experts typically based at home port communicate over the Internet with the crew and assist them in identifying, documenting, and at many times, correcting the problems, many of which may be documented as CASREPs. Such an exercise provides immediate technical expertise, thereby preventing the problem from growing further; minimizes the need for technical experts to be flown to the ship; allows technical experts based at home port to address complex issues across multiple ships deployed overseas; and increases the maintenance knowledge base of the crew. Overall, the exercise is geared to promote a higher level of readiness while the ship is deployed at sea.

Systems and Equipment Material Assessment Teams

SEMATs are outside resources that can be used by maintenance authorities and ships to determine a ship's condition when deployed and when distance support proves insufficient. For example, SEMATs are sent to ships to examine the material condition of tanks, voids, remote operating gear, and watertight enclosures. Surveys by the team provide information about required repairs to these systems. This information can be used to plan and schedule work to be accomplished in future maintenance availabilities.

The Atlantic Fleet uses SEMATs more extensively than Pacific-based ships.²⁰ Atlantic Fleet maintenance authorities indicated that in the Pacific Fleet there is a larger onus on ship's company to identify maintenance requirements. The Pacific-based approach places the responsibility of identifying maintenance requirements on the ship and involves requesting the SEMATs only as they are perceived to be needed.

A move toward the Atlantic Fleet approach to using SEMATs may be advisable as the surface navy moves forward with the FRP, the Optimal Manning Experiment,²¹ and Sea Swap rotations. Off-ship experts, skilled in identification of maintenance actions and class problems, can provide an extra set of trained eyes to catch a maintenance problem early and avoid costly future degradation or repairs. This approach may be useful in addressing the long-term maintenance demands in distributed and other systems that the crew may not have the requisite skills or time to assess.

Initiatives to Reduce Maintenance Requirements

NAVSEA has taken several courses of action to improve the maintenance process. While not instituted to facilitate the FRP, these efforts could have the effect of doing so. Such initiatives include Capital Investment for Labor Reduction (CiLabor), measures to address Cumbersome Work Practices (CWP), Engineering for Reduced Maintenance (ERM), and Top Management Attention/Top Management Issues (TMA/TMI). The following is a brief synopsis of these initiatives.

The CiLabor initiative was undertaken to reduce maintenance requirements to be performed by crewmembers and to improve their quality of life. Measures range from resolving corrosion control problems to the installation of new mechanical seals in shipboard pumps.

The evaluation of CWP follows a SEA 08 initiative to reduce nuclear maintenance costs. The CWP effort is part of NAVSEA's Strategic Goal to reduce total ownership costs. While the initial focus of this effort was on maintenance in public shipyards, the reach of the evaluation has been increased to include work and practices on new construction ships and craft, and work in private shipyards.

ERM identifies high maintenance cost problems onboard ships, directs corrective action, and focuses efforts and processes to ensure that the best engineering solutions are applied to prevent such problems in future Navy ships and systems. ERM is restricted to maintenance challenges for which a solution has been found that is relatively easy to accomplish.²²

TMA/TMI is a program that was extended from the submarine community to all platforms. In TMA/TMI, TYCOMs (SURFLANT/SURFPAC) identify equipment or systems

²⁰ Information regarding the use of SEMATs was provided through discussions with Atlantic and Pacific maintenance authorities.

²¹ A DDG-51 class ship is participating in the Optimal Manning Experiment, in which the Navy is seeking to develop a more efficient model in manning ships with fewer personnel than comparable ships.

²² A summary of the ERM initiative is available at <http://www.navsea.navy.mil/maintenance/sea04m/ERM/ProgramOverview.asp>.

that experience high numbers of maintenance actions, high repair costs, or excessive downtime, and have a resultant impact on fleet material readiness and maintenance costs.²³ The identified equipment and systems are then passed to the cognizant technical authority for review and resolution.

Concluding Observation

Ultimately, the success of the FRP depends on the ability to provide the needed ships in a surge situation. Interviews with fleet authorities indicate that there are a sufficient number of operationally available DDG-51 ships to respond to FRP surge demands. The FRP requires six CSGs to respond in 30 days and an additional two CSGs in 90 days. The scheduling and maintenance implications of responding to the FRP are considered to be manageable, since there are notionally only two DDGs per CSG;²⁴ so a maximum of 16 DDGs (out of 43 DDG-51s in the fleet) would be required to surge in a 6+2 carrier surge scenario. While the fleet of DDG-51s is in different phases of deployment, maintenance, and training, the supply of the operationally available ships is considered sufficient. The sufficiency of other surface combatant forces is beyond the scope of this study but obviously relevant to the success of the FRP. Additionally, determining whether the DDG-51s surging under the FRP are more ready, and at what cost, requires a quantitative assessment. We now turn to such an assessment.

²³TMA/TMI information is available at http://www.navsea.navy.mil/maintenance/sea04m/TMA_TMI/TMA_TMIMain.asp.

²⁴ There are normally two DDG-51 class ships that deploy with a CSG, usually one Flight I or II (without an embarked helicopter) and one Flight IIA (with two embarked helicopters).

Quantifying the Impact of the Fleet Response Plan

To ascertain whether an impact of Fleet Response Plan on maintenance could be quantitatively measured, we used data from the Status of Resources and Training System, the Maintenance Resource System, and Visibility and Management of Operating and Support Costs (VAMOSOC).¹ We looked at DDG-51 casualty reports from SORTS to detect any observable differences in mission-degrading casualties before and after the implementation of the FRP. The type and duration of CASREPs may indicate changes in the responsiveness of the suppliers of parts or of the providers of technical assistance in correcting mission-degrading casualties. Material readiness increases with a decrease in the average downtime to fix CASREPs. We also looked for observable differences pre- and post-FRP in depot-level maintenance man-days and costs, which make up a substantial portion of the total maintenance effort.

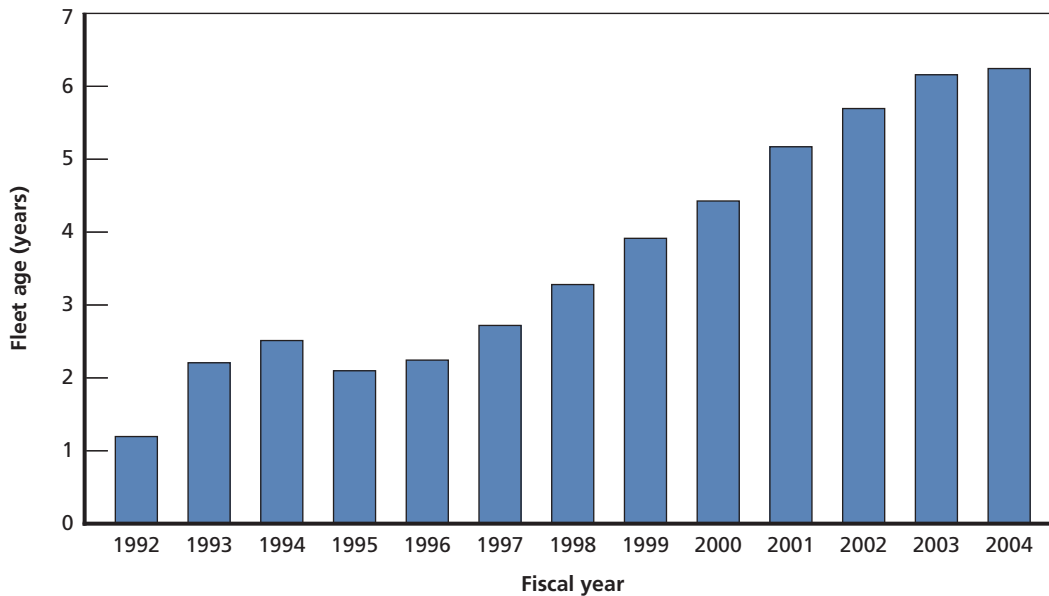
While CASREP data are available by calendar quarter, depot maintenance man-days and cost data in MRS and VAMOSOC databases are available annually by fiscal year up to FY 2004. The latter data sources therefore provide only one data point past the implementation of the FRP in May 2003, making it difficult to judge the significance of any apparent change in a trend line.

No Clear Decrease in CASREP Downtime

We evaluated the CASREPs submitted by DDG-51 class ships from the last calendar quarter of 1999 to the first calendar quarter of 2005 to determine whether there was a detectable difference after the FRP was initiated in May 2003. It should be noted that the number of DDG-51s increased from 28 to 43 over that period. The average number of DDG-51 ships in the fleet has also been growing (see Figure 4.1). It might be hypothesized that such growth would lead to a growing number of CASREPs over the period of interest, thus perhaps confounding any effect of the FRP. However, analyzing depot maintenance costs for DDG-51 class ships, we found that there was no correlation between the average fleet age and the costs. This mostly stems from the fact that ship maintenance is conducted based on the available budget.

¹ MRS provides planning data in man-days as listed in the CSMP, while VAMOSOC provides depot maintenance expenditures.

Figure 4.1
The Average Age of Ships in the DDG-51 Fleet Has Been Increasing



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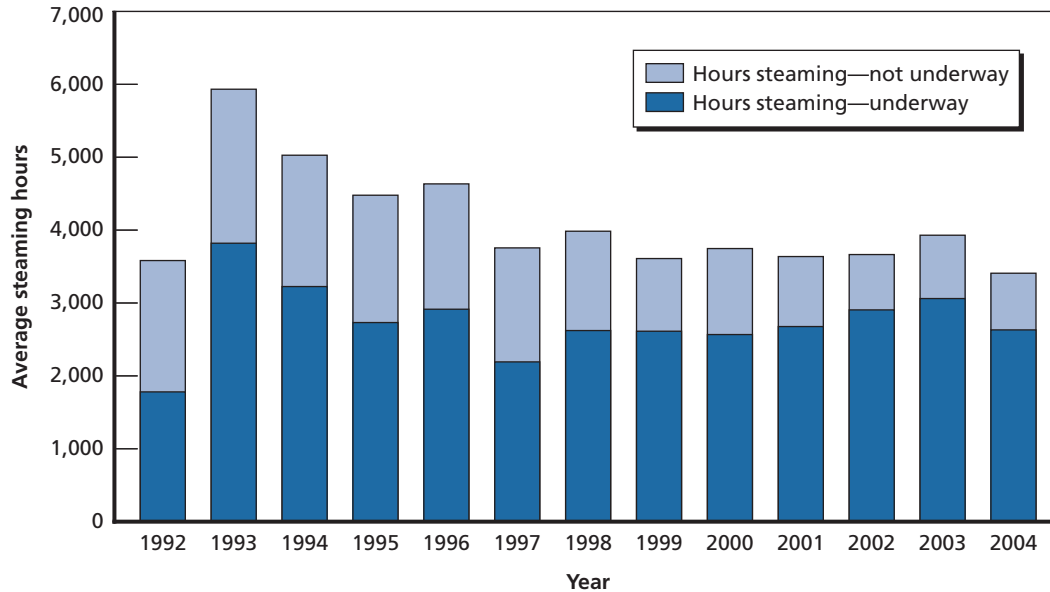
We also reviewed the trend in the average steaming hours for the DDG-51 class ship. Figure 4.2 provides the full fiscal year data for the DDG-51 class average of both steaming hours underway and steaming hours not underway (at anchor or alongside a pier).² We included the steaming hours not underway because the operation of the electrical power plant and associated services during these periods may result in increased maintenance demands.

As we expected, after September 11, 2001, and during Operation Iraqi Freedom (FYs 2001 to 2003), the data indicated that the average steaming hours underway increased. However, in FY 2004, the average steaming hours decreased to below the FY 2001 level. This may be due, in part, to the increased time on-station of Sea Swap ships, which eliminates the transit time for replacing deployed ships.

Over time, the trend in the average steaming hours while not underway has been decreasing. Steaming hours underway or not underway are both costly and maintenance intensive. When steaming, a ship uses its own fuel and mans engineering watch stations to control, monitor, and operate its equipment. The reason for the decrease in steaming hours while not underway was not evident but may be related to cost reduction decisions in the Navy.

² A ship is underway when it is not at anchor or tied to a pier. A ship that is steaming and not underway refers to when a ship is at anchor or tied to a pier; it may be providing its own power (electricity) and its own basic hotel services, such as fresh and hot water, sewage treatment, etc.

Figure 4.2
Average Steaming Hours Underway and Not Underway of DDG-51 Class Ships

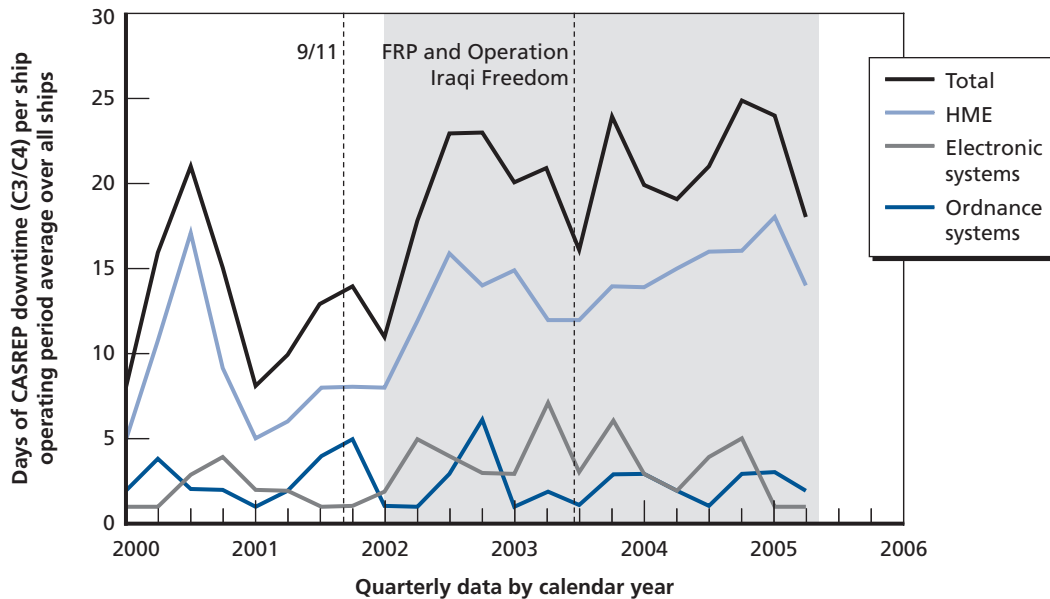


SOURCE: Data derived from the Navy Visibility and Management of Operational and Support Costs (VAMOSOC) database.
 RAND TR358-4.2

Figure 4.3 illustrates CASREP data for the DDG-51 class ships. The data represent the average number of days of downtime³ for DDG-51 class ships, per quarter for hull, mechanical and electrical (HM&E) systems, electronic systems, ordnance systems, and the aggregate. A decrease in average CASREP downtime would indicate more operationally ready equipment, systems, and fleet. The data represented are taken from the end of the quarter. For example, the period of October–December 2001 corresponds to the first data points in calendar year 2002.

³ C3/C4 CASREPs refer to degradation in a ship’s ability to perform its assigned wartime mission(s). C3 refers to a unit that possesses the resources and has accomplished the training to undertake major portions of its wartime mission. C4 refers to a unit that requires additional resources or training in order to undertake its wartime mission, but if the situation dictates, it may be directed to undertake portions of its wartime missions with the resources on hand.

Figure 4.3
Average CASREP Downtime per Ship Operating Period (C3/C4) for All Ships



RAND TR358-4.3

In Figure 4.3, the first shaded area represents the end of the quarter immediately following September 11, 2001, when multiple ships were deployed at a moment's notice. The sharp increase in total CASREP downtime past this quarter suggests that significant maintenance activity was needed to increase ships' readiness after this unforeseen event. The major equipment category causing CASREP downtime was for HM&E systems. A similar surge in total CASREP downtime is shown past the start of Operation Iraqi Freedom,⁴ which coincided with the implementation of the FRP.⁵ However, when we looked at an equal number of quarters before and after the implementation of the FRP in the shaded region shown in Figure 4.3, there was no statistically significant difference in the average number of downtime days per operating period. It is likely that the deployments ongoing after September 11, and especially after the beginning of Operation Iraqi Freedom, would imply greater demand for assets and thus more CASREPs.⁶ That could have offset any beneficial effect of the FRP. Or to look at it another way, the FRP may have prevented a more obvious increase in CASREPs.

When looking at the available data from the period beginning in 2000 to the implementation of the FRP and compare them to the post-FRP period, we see a statistically significant

⁴ Combat operations for Operation Iraqi Freedom were from March 20, 2003, to May 1, 2003.

⁵ The FRP was implemented in May 2003.

⁶ The statistical analysis used a two-sample T-test, looking at both equal and unequal variances. For a sample consisting of 8 points after the FRP and 8 points before the FRP, both tests suggest that at a 5 percent significance level, the mean number of days of CASREP downtime per ship operating period did not change after FRP implementation.

increase in the average number of days of CASREP downtime between the pre-FRP group and the post-FRP group. However, in both analyses, the sample sizes are small, and there are many factors or explanations that would affect the cause and effect of these CASREPs.

No Measurable Change in Depot Maintenance Man-Days and Costs

We examined the MRS⁷ and VAMOS⁸ databases to determine whether there were changes in maintenance costs that could be attributed to the institution of the FRP. As with the CASREPs, we were not able to clearly associate a cost change with the implementation of the FRP for any of the several measures of costs.

We found increases in total costs during FY 2003 and FY 2004. However, depot-level costs are driven not only by what maintenance is needed but also by the available budget. Indeed, maintenance budgets were large during 2003 and 2004. Work packages for ships returning from combat operations were larger than normal because of extended deployment length and the higher wartime operational tempo. In previous years, maintenance requirements were not necessarily fully funded. Per RADM Mark Hugel's remarks before the House Armed Services Committee's Subcommittee on Military Readiness:

During fiscal year 2003, the Navy executed \$3.9B on ship maintenance, which included 95 ship and submarine maintenance periods. Due to the surge maintenance requirement associated with the successful execution of [Operation Iraqi Freedom] and other strategic objectives of the Global War on Terrorism, the Navy requested and received \$1.4B in supplemental operations and maintenance funding. This significant and much appreciated funding was applied to increased depot and intermediate maintenance requirements of 62 ships and submarines.

During fiscal year 2004, \$3.5B of planned ship maintenance, which included 73 maintenance availabilities, was funded. However, the requirement for our ships and submarines to remain engaged in the Global War on Terrorism remained. Through the continued support of the Congress, \$600M of Supplemental Operation and Maintenance funds were appropriated and provided to the Navy for ship depot maintenance. This critical funding was applied to depot and intermediate maintenance on 42 ships and submarines that were directly involved in supporting the Global War on Terrorism (GWOT).⁹

In any given fiscal year, certain ships have depot maintenance performed on them and others do not. As a result, depot maintenance data do not exist for every ship in a given year. This results in a large variation in the man-days expended for each ship by fiscal year, making it

⁷ This database is used for planning and budgeting of maintenance costs within the Navy.

⁸ This cost database tracks annual depot and intermediate maintenance expenditures of ships by individual hull numbers and by class.

⁹ Statement of Rear Admiral Mark A. Hugel, U.S. Navy, Deputy Director, Fleet Readiness Division before the Subcommittee on Military Readiness of the House Armed Services Committee, April 6, 2005.

difficult to detect any potential impact of the FRP on depot maintenance man-days expended prior to and after its implementation. The substantial variations from year to year within a ship and across ships of the class make it extremely difficult to detect any impact of FRP past FY 2003.

We also examined man-days expended for DDG-51 representative availabilities for the continental United States, SRAs, continuous maintenance, and DSRAs. As previously discussed, past availabilities are used to project the man-days and costs for future availabilities. These representative data are used to project DDG-51 maintenance requirements for continuous maintenance, SRAs, and DSRAs for fiscal years 2005, 2006, and 2007. The man-day and material estimates represent what MRS calculates as the average availability package for a ship of the class.

In Figures 4.4 through 4.6, LANT (Atlantic) and PAC (Pacific) represent the availability man-days used to develop the three-year moving average for the POM submission. “Past LANT” and “Past PAC” indicate the historical cost of completed availabilities in the Atlantic and Pacific-based DDG-51s, respectively,¹⁰ outside the three-year moving average. Only the most recent three years of completed availabilities are used to develop budget needs for future years. PAC and LANT outliers are availabilities that were not considered by maintenance and MRS officials as a representative availability because of the unique circumstances of the maintenance performed.

The continuous maintenance availabilities man-day projections also include allowances for deferred maintenance. MRS tracks work that was approved and should have been completed during availability but was deferred for financial reasons. These deferred maintenance actions are called unfunded technical requirements (UTRs).¹¹ MRS adds a portion (25 percent) of UTRs back to the continuous maintenance line in order to provide a feedback mechanism to complete deferred maintenance and to prevent a “death spiral” in funding. UTRs are an input to the maintenance requirements of ships, and added to maintenance funding needed for future availabilities. It is generally a small portion of the requirement. Recently, and per Hugel’s comments above, Congress has plussed up maintenance accounts to “buy down” UTRs. The plus-ups are applied to current availabilities. Therefore, in fiscal years 2003 and 2004, congressional plus-ups have resulted in fully funding the maintenance requirements for ships that underwent CNO availabilities during these fiscal years.

Figure 4.4 indicates that there has been a slight decrease in SRA maintenance POM man-days from FY 2001 to FY 2004 for the DDG-51 class. Figure 4.5 reveals that the POM continuous maintenance man-days have been relatively constant over the same period, except for a slight decline in FY 2002. For an individual ship, if depot-level work is not completed during an SRA, then it is completed during a continuous maintenance period. Therefore, if man-days expended in an SRA are lower for an individual ship, the man-days allotted for a ship’s continuous maintenance budget is correspondingly increased.

¹⁰ DDG-51s home-ported in Japan are not included in these totals.

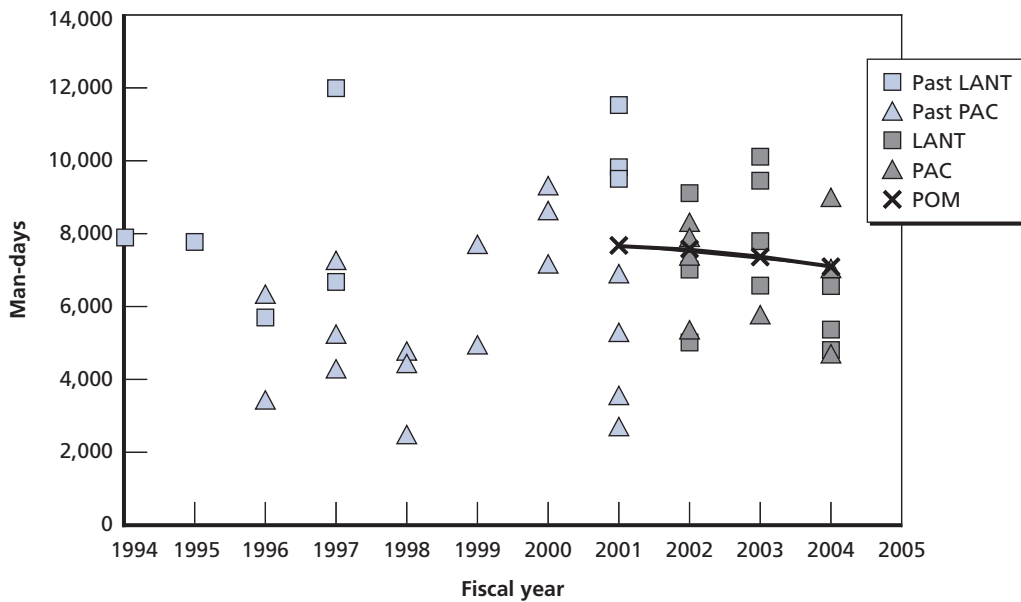
¹¹ For ships with scheduled CNO availabilities, UTRs are identified by an evaluation of open maintenance actions contained in the ships automated information file. UTRs are maintenance requirements that would either save maintenance dollars in the long run or fix a personnel safety of mission degrading.

The DDG-51 DSRA man-days experienced a small rate of increase from FY 2001 to FY 2003 and a significant increase in FY 2004. One reason for the FY 2004 increase was that the historical man-days used to project DSRA costs were made up of data from first dockings only. Some DDG-51s are now going through a second docking, which is being found to require more extensive maintenance and associated man-days. Increased maintenance in second dockings that may apply to the rest of the class include radar-absorbent tiles corroded in superstructure, MK-99 illuminator overhauls required, air intake louvers rusting, thicker hull coating required to make an eight-year docking interval, and maintenance for strut bearings and sheaves.¹²

It is not clear whether changes to the budgeted maintenance man-days result from increased operational availability under the FRP, improvements to depot-level maintenance actions (shorter SRAs and more continuous-maintenance periods), MSMO contracts, increased self-sufficiency of the ship's crew, pressure to reduce dollars budgeted for maintenance, or other reasons. As more availabilities are completed in the FRP environment, budgeted man-day data may provide a useful barometer of increased maintenance requirements.

In summary, using the MRS data displayed in Figures 4.4 through 4.6 and the VAMOS data that were separately evaluated, we were not able to detect any measurable change in depot maintenance and modernization costs after the implementation of the FRP.

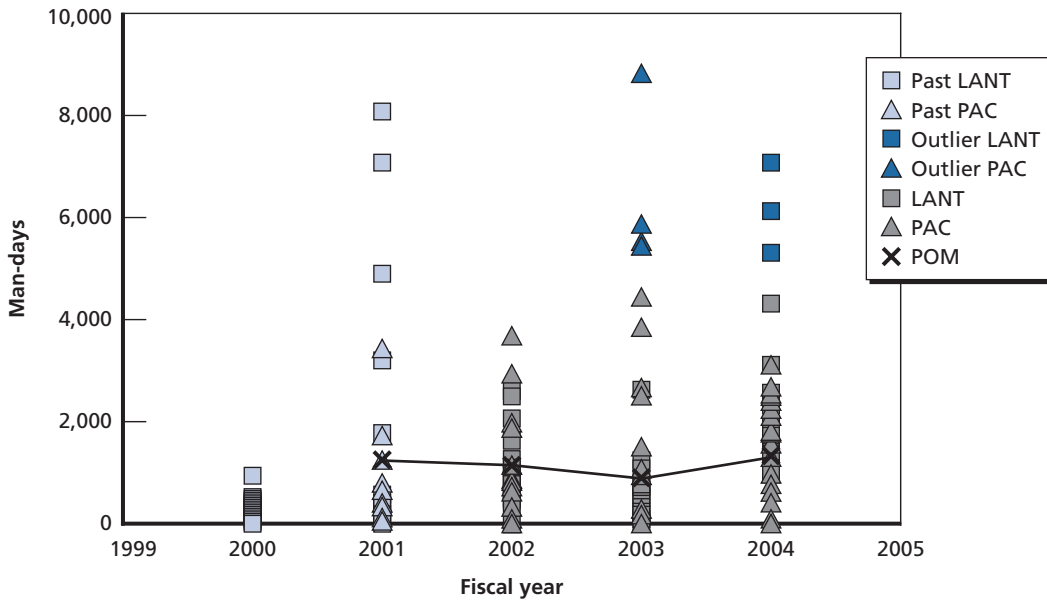
Figure 4.4
DDG-51 Selected Restricted Availability Man-Days, from MRS



RAND TR358-4.4

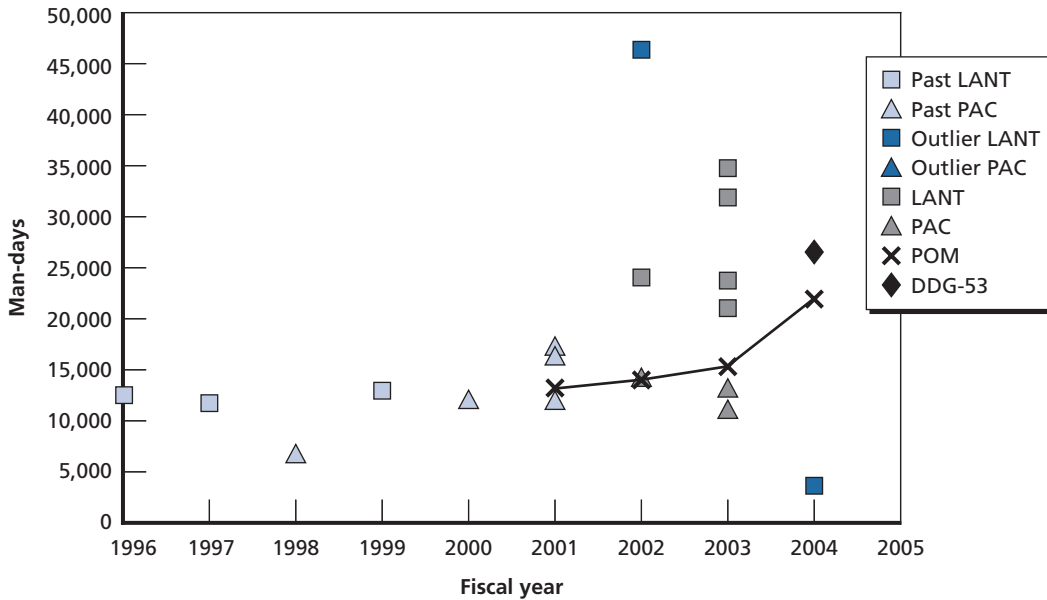
¹² Information was derived from a briefing delivered at an MRS meeting on April 24, 2003, in San Diego.

Figure 4.5
DDG-51 Continuous Maintenance Availability Man-Days, from MRS



RAND TR358-4.5

Figure 4.6
DDG-51 Docking Selected Restricted Availability, from MRS



RAND TR358-4.6

Concluding Remarks

This project focused on analyzing the implications of Fleet Response Plan for the demand and supply of maintenance. The research was done qualitatively through interviews with fleet schedulers and maintainers within the Navy and quantitatively through an analysis of ship casualty reports and ship operational and maintenance data. We focused on the DDG-51 class of ships because it is the largest class of surface combatants and because there has been little modernization, which simplifies the analysis.

The purpose of the FRP's approach to training, readiness, and maintenance is to generate more ship operational availability per cycle to the operational fleet commander. This increased availability is to be achieved primarily through condensed training around scheduled availabilities and compressed SRAs. Ships are now expected to attain surge readiness earlier and sustain the readiness longer. For example, ships must be ready for emergency surges in less than eight months after returning to port after deployment, whereas 12 months was regarded as sufficient in the regime preceding the FRP.

Fleet authorities indicated that there are a sufficient number of operationally available DDG-51 ships to respond to FRP surge demands. The FRP requires six CSGs to respond in 30 days and an additional two CSGs in 90 days. The scheduling and maintenance implications of responding to the FRP were considered to be manageable, since there are notionally only two DDGs per CSG; so a maximum of 16 DDGs (out of 43 DDG-51s in the fleet) would be required to surge in a 6+2 carrier surge scenario. While the fleet of DDG-51s is in different phases of deployment, maintenance, and training, the supply of the operationally available ships for an FRP response was considered sufficient. (Whether this would be true of other surface combatants is an issue we did not pursue.)

The sequence of ships that would respond to an FRP 6+2 surge requirement would be that surface combatants already deployed would be routed to the area of concern; ships preparing for deployment would accelerate training, maintenance, and surge; ships recently returning from deployment would surge; other surge capable assets would be utilized as available; and ships in basic training would have training accelerated. If any of the assets that are part of a CSG are not ready due to maintenance implications, replacement assets can be deployed as needed from a pool of surface combatants proactively managed by the fleet schedulers and maintainers.

In our quantitative analyses, we did not detect any change in readiness levels as measured by a ship's CASREPs or depot maintenance man-days expended costs since the implementa-

tion of the FRP. The readiness analysis was confounded by deployments following September 11, 2001, and associated with Operation Iraqi Freedom, which was launched around the same time as the FRP. The depot maintenance man-day analysis was confounded by increasing maintenance budgets in fiscal years 2003 and 2004 in support of the Operation Iraqi Freedom and constrained by a limited number of ship depot availabilities since the implementation of the FRP. Moreover, the unavailability of maintenance data at the work package level makes it difficult to detect any change in trends on the cost of completing the same work before and after the implementation of the FRP.

A balance must be achieved in meeting FRP surge readiness requirements and modernization requirements. Some surface combatant modernization packages will take 40 to 50 weeks to complete. To support the increased operational availability under the FRP, these work packages will be broken into 20- to 22-week segments. While the goal is to have class fleet alterations completed in three years (to prevent obsolescence), the need for surge readiness results in spreading the modernization over a longer period. However, if all the upgrades are completed in a compressed period, surge readiness and operational availability may be compromised.

Congress has recently increased funding for ship maintenance. The plus-ups were applied to maintenance availabilities in fiscal years 2003 and 2004 and resulted in fully funding the maintenance requirements for ships that underwent CNO availabilities during these years.

Surge-related maintenance demand increases do not seem to have stressed manpower resources so far. The challenge is to bring resources to bear while keeping costs low. Uncertainties about the timing of a surge necessitate a flexible supply base capable of addressing the scheduling challenges. The supply base is the subject of many initiatives intended to make it more flexible and ready to support surge demands. These initiatives support the changes in the timing, type, and amount of demand placed by the FRP. For example, One Shipyard is being implemented to leverage manpower across the country to meet regional peak demands in maintenance requirements. SHIPMAIN is being implemented to improve the efficiency of the requirements generation, work planning, and scheduling processes. The objective is to get maintenance done faster and by the right provider.

The newly set-up RMCs use MSMO contracts as a valuable tool to employ contractors almost at a moment's notice and are themselves staffed to meet peaks in the demand for maintenance. MSMO contracts provide flexibility to the contractors, enabling them to increase the number of shifts at their facility, hire more workers or pay overtime salary for existing workers, and subcontract to other facilities. All these options cost more but have the potential to get the tasks accomplished in the time frame allotted to meet a surge demand. While a peak in maintenance demand would be necessary to get DDG-51 class ships underway in an FRP environment, a dynamic response is available to attempt to fulfill that demand. Qualitative evidence suggests that such attempts are meeting with success. Quantitative supporting evidence will have to await the accumulation of more data with the passage of time and a return to lower operating tempos. The Navy should revisit this topic in the future and expand the scope of future analyses to encompass other surface combatants.

Certifications

The *Surface Force Training Manual* is the primary source of policy, direction, and requirements for all aspects of maintenance and unit-level training phases (basic phase) training in support of the Fleet Readiness Program. The training manual lists detailed criteria to determine a ship's readiness to perform its assigned missions or core competencies. While this criterion addresses the minimum qualifications, required schools, and training and competency requirements of a ship's crew and training teams, it also addresses the material condition and equipment readiness that is considered necessary to support mission requirements. For example, surface combatants must be able to launch and recover helicopters. This capability is dependent on a satisfactory ship's aviation certification, which includes an evaluation of the material condition of aviation facilities (non-skid deck, JP-5 fueling facilities, etc.). Degradation of a ship's facilities requires maintenance actions to restore them to operational standards. These maintenance actions may be performed by a ship's company or by non-organizational support. Another example is that a ship's Air Warfare certification is dependent on the satisfactory Tactical Aid to Navigation (TACAN) certification, among other material operating requirements. Maintenance and unit-level certifications are considered current if performed within 24 months (minus six months or plus three months).¹ The required maintenance and unit-level training phase certifications for the DDG-51 class ships are:

- a. Aviation
- b. Anti-Terrorism/Force Protection
- c. Air Warfare
- d. Communications
- e. Cryptology
- f. Electronic Warfare
- g. Medical
- h. Intelligence
- i. Damage Control
- j. Engineering
- k. Navigation

¹ Certifications and qualifications requirements for surface combatants are delineated in Department of the Navy, COMNAVSURFOR Instruction 3502.1B (2004).

- l. Seamanship
- m. Strike Warfare
- n. Surface Warfare
- o. Undersea Warfare
- p. Visit, Board, Search and Seizure
- q. Maintenance Material Management
- r. Search and Rescue
- s. Ballistic Missile Defense
- t. Force Supply Management.

A satisfactory certification, in each respective mission area, is dependent on the material condition of the systems and components supporting the mission area. Therefore, the requirement to be certified in a mission area drives the requirement that planned, preventive, or corrective maintenance be performed on the associated systems.

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