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CRS Report for Congress

Navy DDG-51 Destroyer Procurement Rate: Issues and Options for Congress

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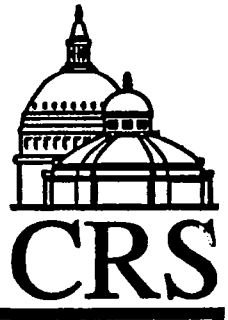

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NAVY DDG-51 DESTROYER PROCUREMENT RATE: ISSUES AND OPTIONS FOR CONGRESS

SUMMARY

Congress has procured 29 Arleigh Burke (DDG-51) class destroyers since FY1985; the first 3 had entered service by the end of 1993. The DDG-51 program is one of the Department of the Navy's highest-priority procurement programs. The Administration wants to continue procuring 3 DDG-51s per year (28 total through FY2004), at a current cost of about $900 million per ship.

The issue for Congress is whether to modernize the Navy's surface combatant force by maintaining the DDG-51 procurement rate at 3 ships per year or by adopting a different modernization strategy. Congress' decision on this issue could have important implications for DoD funding requirements, U.S. military capabilities, and the U.S. defense industrial base.

New technologies first fielded in the 1980s have substantially increased the capabilities of surface combatants. They are not only escorts, but important combatants in their own right. In future years, the Navy will focus on operations in littoral (near-shore) areas. The littoral is a complex, compressed battle space that can be very demanding on naval forces.

At the end of 1993, the Navy operated a total of 135 surface combatants (119 active and 16 reserve). The Navy's goal is to achieve and maintain a force of 124 surface combatants (114 active and 10 reserve). If this goal is accepted, then a long-term average building rate of *more than* 3 ships per year is needed. If the rate is reduced to less than 3 ships per year for a time, it must then be higher than 3 ships per year at some other time. The Navy's goal also calls for 80 of the 114 active surface combatants to be higher-capability ships like the DDG-51s by about 2005. If this goal is accepted, another 25 to 30 higher-capability ships would be needed by about 2005. The Administration's plan would provide 28 such higher-capability ships by about 2009.

The Navy's surface combatant force-level goal has an analytical basis and is not *a priori* unreasonable; it also cannot be conclusively demonstrated or refuted on military grounds. The force-level goal can vary with policy objectives, subjective judgments, and analytical assumptions. Changes in these factors can produce force-level goals either higher or lower than the Navy's.

Congress and the Executive Branch face the issue of whether to maintain DDG-51 production at two shipyards or consolidate production at a single yard. A procurement rate of 3 ships per year is a low rate with minimum flexibility for sustaining DDG-51 production at two yards, but it is not necessarily a rock-bottom rate. With a substantial amount of additional, non-DDG 51 work, a procurement rate of 2.5 ships per year would be sufficient to sustain two yards, with some risk. With a very substantial amount of additional, non-DDG-51 work, a procurement rate of 2 ships per year might sustain two yards, but at a higher level of risk to the survival of the yards. Giving additional, non-DDG 51 work to one or both of the DDG-51 yards may require an explicit policy decision to not give this work to other private or public shipyards.

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INTRODUCTION

The DDG-51 Program

Congress began procuring Arleigh Burke (DDG-51) class destroyers in FY1985. DDG-51s are multimission surface combatants capable of operating either independently or in conjunction with other naval or military forces. They are equipped with the Aegis system -- the Navy's most capable ship combat system -- and can attack targets that are in the air, on land, on the surface of the sea, or underwater.

The DDG-51 program has been one of the Defense Department's most expensive weapon acquisition programs since FY1989. It is the only large, year-to-year program in the Navy's FY1995-FY1999 shipbuilding plan, and it is one of six major procurement programs that the Department of the Navy has identified as being central to its long-term "recapitalization" (i.e., modernization) plan.[1] The Administration wants to procure 3 DDG-51s per year for the next several years, at a current cost of about $900 million per ship.

In 1993, interest began to develop in Congress and the Defense Department in the idea of reducing the DDG-51 procurement rate to something less than the Administration's planned rate of 3 ships per year. In February 1993, the Congressional Budget Office, in the 1993 edition of its annual report on options for reducing the federal budget deficit, included an option to reduce the DDG-51 procurement rate to 2 ships per year for the period FY1994-FY1998.[2] In May

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[1] The other five programs are the FY1995 aircraft carrier (CVN-76), the LPD-17 (formerly LX) amphibious shipbuilding program, the New Attack Submarine (and SSN-23), the F/A-18E/F Hornet aircraft program, and the Medium Lift Alternative, or MLA (which the Navy intends to be the V-22 tilt-rotor aircraft). The Department of the Navy states that "These programs were all maintained at the expense of other programs" in the Department's FY1995-FY1999 Program Review (PR-95). Statement of Vice Admiral T. Joseph Lopez, Deputy Chief of Naval Operations (Resources, Warfare Requirements & Assessments), [before the] Acquisition Subcommittee of the House Armed Services Committee, 13 April 1994. p. 3.

[2] U.S. Congress. Congressional Budget Office. Reducing the Deficit: Spending and Revenue Options. Washington, 1993. p. 45.

1993, Representative Santorum introduced H.R. 2037, the DDG-51 Destroyers Act, which would reduce the DDG-51 procurement rate to two ships per year for the period FY1994-FY1997.[3]

In October and November 1993, it was reported that the Office of the Secretary of Defense had considered reducing the DDG-51 procurement rate to 2 ships per year before approving the 3-per-year rate at a meeting of the Defense Acquisition Board on Oct. 19, 1993.[4] In December 1993, the DoD Inspector General issued an audit report on the DDG-51 program recommending that it be reduced to 2 ships per year through FY1999.[5]

Interest in reducing the DDG-51 procurement rate to something less than 3 ships per year is likely to continue in 1994, because of concerns that other defense programs are insufficiently funded. In March 1994, the Congressional Budget Office, in the 1994 edition of its annual report on options for reducing the federal budget deficit, included the option of reducing the DDG-51 procurement rate to 2 ships per year for the period FY1995-FY1999.[6]

Issue for Congress

The issue for Congress is whether to modernize the Navy's surface combatant force by maintaining the DDG-51 procurement rate at 3 ships per year or by adopting a different modernization strategy. Congress' decision on

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[3] No action has been taken on the bill other than referral to the House Armed Services Committee, but the bill gained four cosponsors in November 1993 and a fifth in February 1994.

[4] OSD, Navy Hash Out DDG-51 Plan; OSD Pushes 2/yr Instead of 3/yr Buy. Inside the Pentagon, Oct. 23, 1993: 1, 18; OSD Likely to Approve Navy Plan for Three DDG-51 Destroyers Per Year. Inside the Navy, Oct. 25, 1993: 1-2; Holzer, Robert. U.S. Navy Wins Nod to Build 15 Destroyers. Defense News, Nov. 1-7, 1993: 1, 36.

[5] U.S. Department of Defense. Office of the Inspector General. The DDG-51 Destroyer Program as Part of the Audit of the Defense Acquisition Board Review Process -- FY 1993 (U). Washington, 1993. (Audit Report No. 94-019 [Project No. 2AE-0033.04], December 10, 1993) p. i-ii. (Unclassified executive summary provided to author by Navy Office of Legislative Affairs, Jan. 5, 1994.) See also Rosenberg, Eric. Slash the Navy's DDG-51 Destroyer Program: IG. Defense Week, Jan. 3, 1994: 1, 11; Ward, Don. How Many Burkes Should a Navy Build? Navy Times, Jan. 24, 1994: 8. For a press account on the internal Pentagon rebuttal to the Inspector General's Audit, see Rosenberg, Eric. Pentagon Slams IG Over DDG-51 Destroyer Findings. Defense Week, Apr. 4, 1994: 5.

[6] U.S. Congress. Congressional Budget Office. Reducing the Deficit: Spending and Revenue Options. Washington, 1994. p. 39-40.

this issue could have important implications for DoD funding requirements, U.S. military capabilities, and the U.S. defense industrial base.

The purpose of this report is to support Congress in considering this issue. The report provides background information on the DDG-51 program and the roles and missions of U.S. Navy major surface combatants, outlines notional options for Congress, and discusses military, industrial-base, and budgetary factors that Congress may consider in assessing these options.

Sources of Information

Unless otherwise indicated, information in this report relating to the DDG-51 program was supplied by the Navy in the course of several Navy briefings for the author and consultations between the author and the Navy during the second half of 1993 and early 1994. The author collected additional information relating to the industrial-base aspects of the report during this period through visits to Bath Iron Works and Ingalls Shipbuilding, the two DDG-51 shipyards, discussions with officials from those shipyards, and discussions with officials from Martin Marietta, the primary DDG-51 combat system contractor.

KEY POINTS

The following are some of the key points made in the report.

On the Capabilities of Surface Combatants

Three technological developments fielded during the 1980s -- the Tomahawk cruise missile, the Aegis combat system, and the Vertical Launch System (VLS) -- have given U.S. Navy surface combatants substantially more potential to operate independent of aircraft carriers or selectively substitute for them, and to influence events ashore and support military operations on land. Since World War II, surface combatants have been thought of as escorts; indeed, the term "escort" has often been used as a synonym for surface combatants. In the wake of these technological developments, however, surface combatants are no longer just escorts of other ships; they have become combatants in their own right.

On the Post-Cold War Operating Environment

With the end of the Cold War, the focus of U.S. military strategy has shifted away from the scenario of a major East-West conflict, and toward the goals of maintaining regional stability, responding to and containing regional crises, and fighting major regional conflicts (MRCs). For naval forces, including surface combatants, this shift in strategic focus toward regional concerns means a decreased emphasis on mid-ocean operations, war at sea, and stand-alone operations (i.e, operations in which the Navy is largely separate from the other services), and an increased emphasis on operations in littoral (i.e., near-shore)

waters, operations intended to influence events ashore, and joint and combined operations.

The littoral is a complex, compressed battle space, and operating in it is not necessarily easier than operating in mid-ocean waters. Indeed, in certain respects -- such as the variety of potential threats and reaction time -- littoral operations can be more demanding on naval forces than the Cold War scenario of mid-ocean operations against Soviet maritime forces. For surface combatants, the shift in focus to littoral operations that are intended to influence events ashore will, among other things, increase the importance of theater missile defense operations, strike operations with the Tomahawk land-attack cruise missile, and naval surface fire support operations.

On the Fit Between Procurement Rate and the Force-Level Goal

The Navy's force-level goal for surface combatants is to achieve and maintain a force of 124 ships (114 active and 10 reserve). If this goal is accepted, and if surface combatants are to remain in service for 30 or 40 years, then a long-term average procurement rate of *more than* 3 ships per year is needed. If the rate is reduced to less than 3 ships per year for a time, it must then be higher than 3 ships per year at some other time, so that the required long-term average procurement rate of more than 3 ships per year is achieved.

The Navy's force-level goal also calls for about 80 of the 114 active surface combatants to be higher-capability ships by about 2005. Higher-capability ships are currently characterized by having both the Aegis combat system and VLS. DDG-51s and the final 22 ships in the 27-ship Ticonderoga (CG-47) class are higher-capability ships. If this element of the Navy's surface combatant force-level goal is accepted, then the Navy would need to acquire another 25 to 30 higher-capability surface combatants by about 2005. The Administration's planned DDG-51 procurement rate would provide 28 additional higher-capability ships by the year 2009.

On the Appropriateness of the Force-Level Goal

The Navy's requirement for a force of 124 surface combatants, including about 80 higher-capability ships by about 2005, has an analytical basis and is not *a priori* unreasonable; it also cannot be conclusively demonstrated or refuted on military grounds. The force-level goal can vary with policy objectives, subjective judgments, and analytical assumptions. Changes in these factors can produce force-level goals either higher or lower than the Navy's force-level goal.

At a level of 124 ships, the percentage of the Clinton Administration's planned 330-ship Navy accounted for by surface combatants would be roughly consistent with the percentages under the Reagan Administration's planned 600-ship Cold War fleet and the Bush Administration's planned 415-ship Base Force fleet. A force of 114 active surface combatants will sustain a level of overseas deployments of surface combatants consistent with the Navy's new policy of maintaining "tethered" forward deployments of Navy ships. Depending on

assumptions about warfighting scenarios, fighting two nearly simultaneous, medium-sized major regional contingencies might require about 124 surface combatants or some higher or lower number.

At a level of about 80 ships, the percentage of the surface combatant force accounted for by higher-capability ships would be somewhat higher than the percentage under the Reagan Administration's planned Cold War fleet, but roughly in scale with the Bush Administration's planned Base Force fleet. Operating successfully in the littoral region can require ships with a high-capability anti-air warfare system such as the Aegis weapon system. Aegis and VLS also enable surface combatants to expand their contribution to littoral combat operations by giving them the ability to fire large numbers of Tomahawk missiles and (in the future) provide theater missile defense.

On Procuring a Modified (128-Cell) DDG-51 Design

The current (Flight IIA) version of the DDG-51 design has a total of 96 VLS cells for storing and firing missiles (32 cells in the front end of the ship, 64 cells in back end). This compares with a total of 122 cells on VLS-equipped CG-47s. One option for DDG-51 procurement would be to procure a modified version of the DDG-51 design with a 64-cell (rather than 32-cell) VLS magazine in the front end. This would give the DDG-51 design a total of 128 VLS cells. This modification, which would lengthen the ship by about 12 feet, would increase the procurement cost of the ship by about $19 million, or a bit more than 2 percent, while increasing its weapon capacity by 33 percent. The newly emergent mission of theater missile defense, as well as the potential for using VLS-launched weapons for naval surface fire support, might increase requirements for VLS cells. In light of these considerations, this option may merit further examination by the Navy and Congress.

On Rebuilding Older Ships as Higher-Capability Ships

As an alternative to procuring new DDG-51s, higher-capability ships can also be obtained by rebuilding older cruisers and destroyers (i.e., CGN-36, CGN-38, DDG-993, and DD-963 class ships) as Aegis/VLS ships. The cost effectiveness of this option, however, is very questionable due to the high cost to rebuild them (possibly almost as much as procuring new DDG-51s), their advanced age and higher annual operating and support costs (particularly the CGN-36s and CGN-38s) compared to DDG-51s, and the reduced survivability features they would have in their rebuilt condition compared to DDG-51s.

Another alternative for obtaining higher-capability ships would be to upgrade the first five CG-47 class Aegis cruisers (CG 47-51) to the higher-capability CG-52 standard. This upgrade would involve, among other things, adding VLS and the Tomahawk weapon control system to these five ships. This alternative, which would cost a minimum of $100 million per ship, would significantly expand the capabilities and potential usefulness of these ships by giving them an ability to fire Tomahawks and a potential future capability (with additional radar and computer modifications) to conduct theater missile defense.

Given the significant original investment to build these ships, their relatively constrained current capabilities, and their relatively young ages, this alternative appears more cost effective than the option of rebuilding older cruisers and may merit further examination by the Navy and Congress. This option can be pursued either in lieu of DDG-51 procurement, or in addition to the Administration's planned DDG-51 procurement.

On Options for Upgrading Other Ships

There are two principal options for upgrading older ships to something less than the higher-capability (i.e., Aegis/VLS) standard. One would be to backfit VLS to the 7 ships in the 31-ship Spruance (DD-963) class that are not now scheduled for backfitting. This would cost about $25 million per ship, and would significantly expand their ability to contribute to littoral combat operations by enabling them to fire large numbers of Tomahawks. This option can be pursued either in lieu of DDG-51 procurement, or in addition to the Administration's planned DDG-51 procurement. The additional VLS capacity on these seven ships would be equivalent to the VLS capacity on about 4.4 new DDG-51s.

Of the 24 DD-963s currently scheduled to receive VLS, 18 have been backfitted to date. Of the 6 remaining scheduled backfits, 4 are scheduled to begin in FY1994, and 2 in FY1995. If it is determined that extending the VLS backfit program to the other 7 ships in the class is not cost-effective, then the obverse option of reducing the backfit program to something less than 24 ships might also merit consideration. The goal of backfitting 24 of the 31 DD-963s was established in the mid-1980s, when the Navy was planning to achieve and maintain a 600-ship fleet including 242 surface combatants. With the Navy now moving toward a 330-ship fleet with 124 surface combatants, Congress may wish to consider whether 24 VLS-equipped DD-963s are still necessary.

The second principal option for upgrading older ships to something less than the Aegis/VLS standard would be to upgrade some or all of the 51 Oliver Hazard Perry (FFG-7) class ships with an anti-air warfare system based on a frigate-sized phased-array radar (i.e., a phased-array radar smaller and less powerful than the Aegis system's SPY-1 radar). Given the cost involved -- up to $200 million per ship -- this option would most likely be pursued to compensate for a decision to procure fewer than 28 additional DDG-51s. The AAW system on the upgraded ships would not be as capable as the Aegis system and would lack the Aegis system's potential for theater missile defense operations, but it would be more capable than the AAW systems currently on these ships, and would offer a level of capability similar to that now envisioned by some NATO allies in Europe for their future surface combatants. The cost effectiveness of this option would depend on the amount of gain in AAW capability realized by the upgrade, and the feasibility and costs of extending the service lives of these ships.

On the Industrial Base and the Procurement Rate

Congress and the Executive Branch face the issue of whether to maintain DDG-51 production at two shipyards or consolidate production at a single yard. In assessing this issue, Congress may consider factors such as the benefits of competition, the ability to return to higher rates of production if necessary in the future, overhead and efficiency, shutdown and termination costs, and local and state economic impact.

A Navy study of the DDG-51 industrial base suggests that while a procurement rate of 3 ships per year is a low rate with minimum flexibility for sustaining DDG-51 production at two yards, it is not necessarily a rock-bottom rate. With a substantial amount of additional, non-DDG 51 work, the Navy study suggests that a procurement rate of 2.5 ships per year (i.e., 2 ships one year, 3 the next, and so on) would be sufficient to sustain two yards, with some risk. With a very substantial amount of additional, non-DDG-51 work, the Navy study suggests that a procurement rate of 2 ships per year might sustain two yards, but at a higher level of risk to the survival of the shipyards. It should also be noted that giving additional non-DDG 51 work to one or both of the DDG-51 yards may require an explicit policy decision to not give this work to other private or public shipyards.

The Navy study suggests that with a substantial amount of additional, non-DDG 51 work, a rate as low as 1.5 ships or 1 ship per year would be sufficient to sustain a single DDG-51 production yard.

The study suggests that the DDG-51 supplier and engineering base can be sustained with a procurement rate as low as 2 ships per year, though not without loss of some suppliers, supplier disruption, and restructuring of supplier operations. At a procurement rate of 1.5 ships or 1 ship per year, maintaining the DDG-51 supplier and engineering base could become difficult or problematic due to loss of key suppliers and engineers.

BACKGROUND

This chapter provides background information on the DDG-51 program and on major surface combatants in the U.S. Navy.

DDG-51 PROGRAM

The DDG-51 class destroyer was conceived in the late 1970s as a less expensive, more numerous companion to the Aegis-equipped Ticonderoga (CG-47) class cruiser.[7] The DDG-51 design is smaller than the CG-47 design and carries fewer weapons, but is equipped with a version of the Aegis Combat System very similar to the version on the CG-47.[8] The key features of the Aegis Combat System are a highly capable phased-array radar called the SPY-1 and an associated bank of high-speed computers that run the Aegis system's extensive software. Compared to older U.S. surface combatants that lack the Aegis combat system, the CG-47 and DDG-51 class ships can react to threats more quickly, handle more targets simultaneously, use their various weapons in a more integrated manner, and maintain better awareness of the tactical situation around them.[9] The DDG-51 and CG-47 designs both have gas turbine propulsion plants, but the DDG-51 class uses a new hull design that has better survivability features than the CG-47 design.

Two shipyards build DDG-51 class ships: Bath Iron Works of Bath, ME, and Ingalls Shipbuilding of Pascagoula, MS (a division of Litton Industries). The program has more than 1,400 prime contractors in 44 states. By far the largest of these is Martin Marietta, the primary contractor for the Aegis system; other prime contractors include FMC Northern Ordnance Division, Hughes, Paramax, Raytheon, and Rockwell.

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[7] A total of 27 CG-47 class ships were funded between FY1978 and FY1988. The first entered service in 1983 and the 27th will enter service later this year.

[8] For an early, more detailed comparison of the DDG-51 and CG-47 designs, see U.S. Library of Congress. Congressional Research Service. The Navy's Proposed Arleigh Burke (DDG-51) Class Guided Missile Destroyer Program: A Comparison With an Equal-Cost Force of Ticonderoga (CG-47) Class Guided Missile Cruisers. Report No. 84-205 F, by Ronald O'Rourke. Washington, 1984. 61 p. (November 21, 1984)

[9] The part of the Aegis Combat System that handles anti-air warfare is called the Aegis Weapon System. For a more detailed description of the Aegis Weapon System, see U.S. Library of Congress. Congressional Research Service. The Aegis Anti-Air Warfare System: Its Principal Components, Its Installation on the CG-47 and DDG-51 Class Ships, and Its Effectiveness. Report No. 84-180 F, by Ronald O'Rourke. Washington, 1984. 18 p. (October 24, 1984)

As shown in the table below, a total of 29 DDG-51s have been funded through FY1994 at a total procurement cost of about $23 billion.[10]

TABLE 1. DDG-51 PROCUREMENT FY1983-FY1994
(billions of then-year dollars, rounded to nearest ten million)

	84	85	86	87	88	89	90	91	92	93	94	Tot.
Quantity	0	1	0	2	0	5	5	4	5	4	3	29
Cost*	0.00	1.25	0.00	1.81	0.00	3.64	3.68	3.15	3.92	3.21	2.67	23.33
Funding*	0.08	1.14	0.10	1.62	0.01	3.58	3.65	3.17	3.98	3.35	2.72	23.62

* **Cost** is the combined procurement cost of the ships funded in a given fiscal year. **Funding** is the amount of procurement funding provided for that fiscal year; it is the sum of advanced procurement funding for ships procured in future years, funds required to complete funding of ships procured in that fiscal year, cost growth and escalation on ships funded in previous years, and outfitting and post-delivery costs for ships entering service. In addition to procurement funding, the DDG-51 program has also been provided funding over the years for research and development and military construction.

At the current procurement rate of 3 ships per year, the ships have a unit procurement cost of about $900 million.[11]

Three DDG-51s were in service as of Dec. 31, 1993; the 29th is scheduled to enter service in 1999. The last of the 3 ships funded in FY1994 and subsequent DDG-51s will be built to a somewhat altered design known as the Flight IIA configuration. The Flight IIA configuration is intended to make the DDG-51 design more appropriate for operations in littoral waters. Compared

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[10] With regard to FY1986, the fact that no ships were funded in the year following the year in which the lead ship was funded is a normal feature of Navy shipbuilding programs that is intended to allow time for problems in the ship's design that are discovered in the construction process to be fixed before construction begins on the follow-on ships in the class. With regard to FY1988, the Reagan Administration originally requested funding for 2 CG-47s and 3 DDG-51s as part of a plan to gradually phase out CG-47 production while phasing in DDG-51 production. But since the DDG-51 production effort had fallen behind schedule and only 5 ships remained to be funded in the CG-47 program, Congress decided to fund the final 5 CG-47s in FY1988 and defer procurement of additional DDG-51s to FY1989. (See the reports of the House and Senate Armed Services Committees on the FY1988 defense authorization bill [p. 58-59 of H.Rept. 100-58 and p. 46 of S.Rept. 100-57, respectively].)

[11] The combined cost of the 3 ships requested for FY1995 is $2,697.7 million, or $899.23 million each. (U.S. Department of Defense. Procurement Programs [P-1], Department of Defense Budget For Fiscal Year 1995. Washington, 1995. [February 1994] p. N-20.)

to earlier DDG-51s, the Flight IIA design features, among other things, the addition of a helicopter hangar, a mine-hunting capability for the bow sonar, and (when it becomes available) a new close-in air-defense missile.

The originally planned procurement rate for the DDG-51 program was 5 or 6 ships per year. This was reduced to 4 ships per year by the Bush Administration's 1990 Major Warship Review, to 3.5 ships per year by the Bush Administration's outgoing FY1994-FY1999 defense budget outline, and to 3 ships per year by the Navy's 1992/1993 Investment Balance Review (an internal resource-allocation process). The 3-per-year rate was endorsed by the Office of the Secretary of Defense in October 1993 and now appears in the Clinton Administration's FY1995-FY1999 Navy shipbuilding plan. The currently planned DDG-51 procurement rate thus represents a reduction of 40 percent to 50 percent from the rate originally planned during the Cold War.

As shown in the table below, the Navy's current plan is to continue procuring 3 DDG-51s per year until FY2003, at which time the Navy wants to shift to procurement of its planned next-generation destroyer, DD21, meaning the "destroyer for the 21st Century." The Navy thus wants to procure a total of 28 more DDG-51s. At a unit procurement cost of about $900 million, these 28 ships would cost about $25 billion in FY1995 dollars.

TABLE 2. DDG-51/DD21 PROCUREMENT, FY1995-FY2005
(number of ships procured per year)

	95	96	97	98	99	00	01	02	03	04	05
DDG-51	3	3	3	3	3	3	3	3	1	3	
DD21									1	0	3

While the DDG-51 program has received oversight attention from Congress over the years on various issues, it has been relatively uncontroversial compared to other major Navy or DoD acquisition programs. Although the DoD Inspector General's December 1993 audit report raised some issues regarding the treatment of the DDG-51 program in DoD's formal acquisition milestone process,[12] the program appears to be experiencing no major cost, schedule, or technical problems. Consequently, interest in Congress and elsewhere in reducing the DDG-51 procurement rate appears motivated primarily not by specific concerns about the DDG-51 program, but rather by a general desire to reduce large procurement programs, if possible, so as to reduce total DoD funding requirements or release funding for other DoD programs.

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[12] The DDG-51 Destroyer Program as Part of the Audit of the Defense Acquisition Board Review Process -- FY 1993 (U), op. cit., and Pentagon Slams IG Over DDG-51 Destroyer Findings, op. cit.

MAJOR SURFACE COMBATANTS IN THE U.S. NAVY[13]

This section provides information on the types and classes, force levels, service lives, and roles and missions of U.S. Navy surface combatants.

Types and Classes

Grouped in order of descending size and level of engineering, U.S. surface combatants include battleships (now retired), cruisers and destroyers, and frigates. U.S. cruisers used to be considerably larger than U.S. destroyers. Over the last quarter century, however, U.S. cruisers have become smaller and U.S. destroyers larger. Consequently, U.S. cruisers and destroyers now overlap in size and capability. The CG-47 design, for example, is built on a modified version of the basic Spruance (DD-963) class destroyer hull and was originally classified as a destroyer (DDG-47). Compared to U.S. cruisers and destroyers, U.S. frigates are considerably smaller and less complex in their engineering. Frigates, for example, have one shaft and propeller, while cruisers and destroyers have two shafts and propellers.

U.S. surface combatants can be grouped a second way -- into higher- and lower-capability ships. The higher-capability ships would include the newer cruisers and destroyers; the lower-capability ships would include the frigates and the older cruisers and destroyers. In terms of key systems, higher-capability ships are currently distinguished by having both the Aegis system and the Vertical Launch System (VLS). The capabilities of the Aegis system were described briefly in the previous section on the DDG-51 program. VLS permits a surface combatant to carry large numbers of Tomahawk cruise missiles. Lower-capability ships lack one or both of these systems.

The table below summarizes the U.S. Navy surface combatant classes involved in this analysis (it excludes some older classes that are expected to be completely retired by the end of the decade[14]). Aside from the CG-47s and

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[13] Some discussions of major surface combatants include aircraft carriers among the surface combatants, since carriers are surface ships that engage in combat operations. A carrier, however, differs significantly from other surface combat-oriented ships in that its air wing constitutes its main armament and its design is determined primarily by the requirement to embark, maintain, and operate a collection of wheeled aircraft. For these reasons, this report, like many treatments, places carriers into a separate category of their own. Since this discussion is limited to major surface combatants, smaller surface combatants, such as corvettes and patrol craft of various kinds, are not considered.

[14] Most of the six ships in the CGN-38 and CGN-36 classes are scheduled for retirement by the end of the decade. One, the Texas (CGN-39), was taken out of service in 1993, and another, the Virginia (CGN-38), is scheduled to be decommissioned by the end of FY1994. The CGN-38 and CGN-36 classes, however, are young enough that they could be kept in service until 2005-2010.

DDG-51s, these include ships built mostly in the 1970s: the Virginia (CGN-38) and California (CGN-36) class nuclear-powered cruisers, which were originally intended to accompany nuclear-powered aircraft carriers; the Kidd (DDG-993) class destroyers, which were originally ordered by Iran but were purchased by the U.S. Navy when the Iranian government canceled its order; the 31 Spruance (DD-963) class destroyers, which as originally built were primarily anti-submarine warfare ships but with VLS are now strike and anti-surface warfare ships as well; and the Oliver Hazard Perry (FFG-7) class frigates, which were built primarily for the Cold War wartime mission of convoy escort and duties in lower-threat environments.

As can be seen in the table, the higher-capability ships in the analysis include the 29 DDG-51s funded to date and 22 of the 27 CG-47 class ships (i.e., CG-52 and up). The lower-capability ships include the first 5 CG-47s (CG-47 through CG-51), which lack VLS; the DD-963s, which lack Aegis; and the remaining classes, which have neither Aegis nor VLS.

To be rated as a guided missile ship ("G" in the designation), a U.S. Navy surface combatant must have an area-defense anti-air warfare (AAW) system.[15] The Virginia (CGN-38), California (CGN-36), and Kidd (DDG-993) class ships carry an area-defense AAW system called the New Threat Upgrade (NTU). It is the second most capable area-defense AAW system after Aegis, but the step down from Aegis to NTU is a fairly large one, because NTU is built around an old-style, mechanically rotating radar rather than a phased-array radar like the SPY-1 radar in the Aegis system. The area-defense AAW system on the Oliver Hazard Perry (FFG-7) class frigates is in turn less capable than NTU. The DD-963s are equipped with only a point-defense AAW system.

Service Lives

There has been some variation in recent years in projected service lives for service combatants. In most instances, service lives have been put at 30 to 35 years. The Navy's 1988 Surface Combatant Force Requirements Study (SCFRS), however, put the figure at 40 years.

A ship's service life is usually determined by an analysis that takes three factors into account. One factor is Expected Service Life (ESL), which focuses on the condition of the ship's basic hull and structure. ESL for a ship can change if its hull and structure are found to be aging either faster or slower than expected. ESL can often be extended through structural overhaul, repair, and modification work, but the cost of this work can be substantial.

Consequently, this analysis includes the five CGN-36 and CGN 38 class ships still in service as of Dec. 31, 1993.

[15] An area-defense system is capable of defending not only the ship on which it is installed, but other ships in the area as well. A point-defense system, in contrast, can only defend a single point -- the ship on which it is installed.

TABLE 3. SURFACE COMBATANT CLASSES: SELECTED DATA

Class*	Number built or funded through FY1994	Entered service	AAW system			VLS
			Area defense		Point defense	
			Aegis	non-Aegis		
Ticonderoga (CG-47 to -51)	5	83-87	X			
Ticonderoga (CG-52 to -73)	22	86-94	X			X
Virginia (CGN-38)	4	76-80		X		
California (CGN-36)	2	74-75		X		
Arleigh Burke (DDG-51)	29	91-	X			X
Kidd (DDG-993)	4	81-82		X		
Spruance (DD-963)	31	75-83			X	X**
O. H. Perry (FFG-7)	51	77-89		X		

Shaded columns -- Aegis and VLS -- denote systems that ships must currently have to qualify as higher-capability ships.

* CG = guided missile cruiser; CGN = nuclear-powered guided missile cruiser; DDG = guided missile destroyer; DD = destroyer; FFG = guided missile frigate.

** 24 of the 31 ships are to be backfitted with VLS; 18 of the 24 have now been backfitted.

A second factor is Mission Effectiveness Life (MEL), which focuses on the ability of the ship's combat system to defeat projected threats. As an adversary's weapons improve, the ability of a given ship combat system to defeat an attack by that adversary declines. Eventually, a point is reached where the combat system can no longer defend the ship adequately against an adversary attack. The MEL for a ship can change if there are changes in a ship's missions or in the projected rate of improvement of adversary weapons. Ship combat systems can be upgraded to keep pace with improving adversary weapons, but there are usually limits to such upgrades because of inherent limits in the combat system or because installing the upgrade would exceed the ship's space,

weight, center-of-gravity, power-generation, or personnel limits. Upgrading the combat system of an older ship can involve substantial cost, because it can involve extensive rip-out and rebuilding of parts of the ship. This is particularly true for upgrades that were not envisioned at the time the ship was originally designed.

As shown in the table below, for the ship classes considered here, the Navy currently judges MEL to be either equal to or somewhat less than ESL, and currently judges the FFG-7s' ESL and MEL to be about 10 years less than the ESL and MEL of the cruisers and destroyers.

TABLE 4. SURFACE COMBATANT SERVICE LIVES

Class	Expected Service Life (ESL)	Mission Effectiveness Life (MEL)
CG-47	35	35
CGN-38	35	30
CGN-36	35	30
DDG-51	35	35
DDG-993	35	30
DD-963	35	35
FFG-7	25	20

A third factor is the ship's annual operating and support (O&S) cost, which can rise as the ship ages and its basic mechanical and electrical systems deteriorate and must be repaired more frequently or replaced. Finding repair parts for older equipment can become increasingly difficult if the equipment goes out of manufacture and parts suppliers become scarce. Equipment on older ships might require more personnel to operate and maintain than analogous equipment on newer ships, and might require unique or specialized training, which can increase personnel costs. This can be particularly true with regard to an older ship's propulsion system.

Ships are thus retired under any of four scenarios: (1) ESL and MEL have not expired but a shift or reduction in the Navy's missions eliminates the need for ships of that kind; (2) ESL and MEL have not expired but the ship's annual O&S cost has increased to the point where it is no longer cost-effective to operate the ship to perform its missions; (3) ESL or MEL has expired and cannot be extended; (4) ESL and/or MEL have expired, but the cost of extending ESL and/or MEL, perhaps combined with an increasing annual O&S cost, makes it cost-ineffective to extend the ship's life.

Force levels

Historic

Figure 1 shows the number of surface combatants in the U.S. Navy from 1948 through 1993; figure 2 shows surface combatants as a percentage of all ships in the Navy. As can be seen in the figures, although the total number of surface combatants dropped substantially around 1970, when large numbers of World War II-era destroyers reached the end of their service lives and were retired, the percentage of the Navy accounted for by surface combatants has remained fairly steady over time, with the figure for most years falling between 30 percent and 40 percent.

Planned

The Navy's current force-level goal for surface combatants is a force of 124 ships, including 114 active ships and 10 in the Naval Reserve Force (NRF). Of the 114 active ships, about 80 are to be higher-capability ships by about 2005. The 10 NRF ships are to be lower-capability ships (specifically, FFG-7s).

The table below shows how this force-level goal for surface combatants compares with the goals in the Reagan administration's 600-ship Navy plan and the Bush Administration's 415-ship Base Force Navy plan. As can be seen in the table, the Navy's current plan, although smaller than the Base Force plan, would have surface combatants constitute about the same share of the Navy as under the Reagan and Bush Administration plans. The Base Force and current Navy plans contain a somewhat higher percentage of higher-capability ships than the Reagan administration plans.

At the end of 1993, the Navy had a total of 135 surface combatants in service and another 27 (the final CG-47 and 26 DDG-51s) funded or under construction. Thus, without additional retirements, the Navy by 1999 would have a total of 162 surface combatants.

The Navy plans to reduce the surface combatant force over the next year or so to a total of 124 ships, and then maintain the force at about this level thereafter. This plan involves retiring a number of surface combatants, particularly the CGN-38s and many of the FFG-7s, between now and 1999, several years before they reach the end of their Mission Effectiveness Lives.[16]

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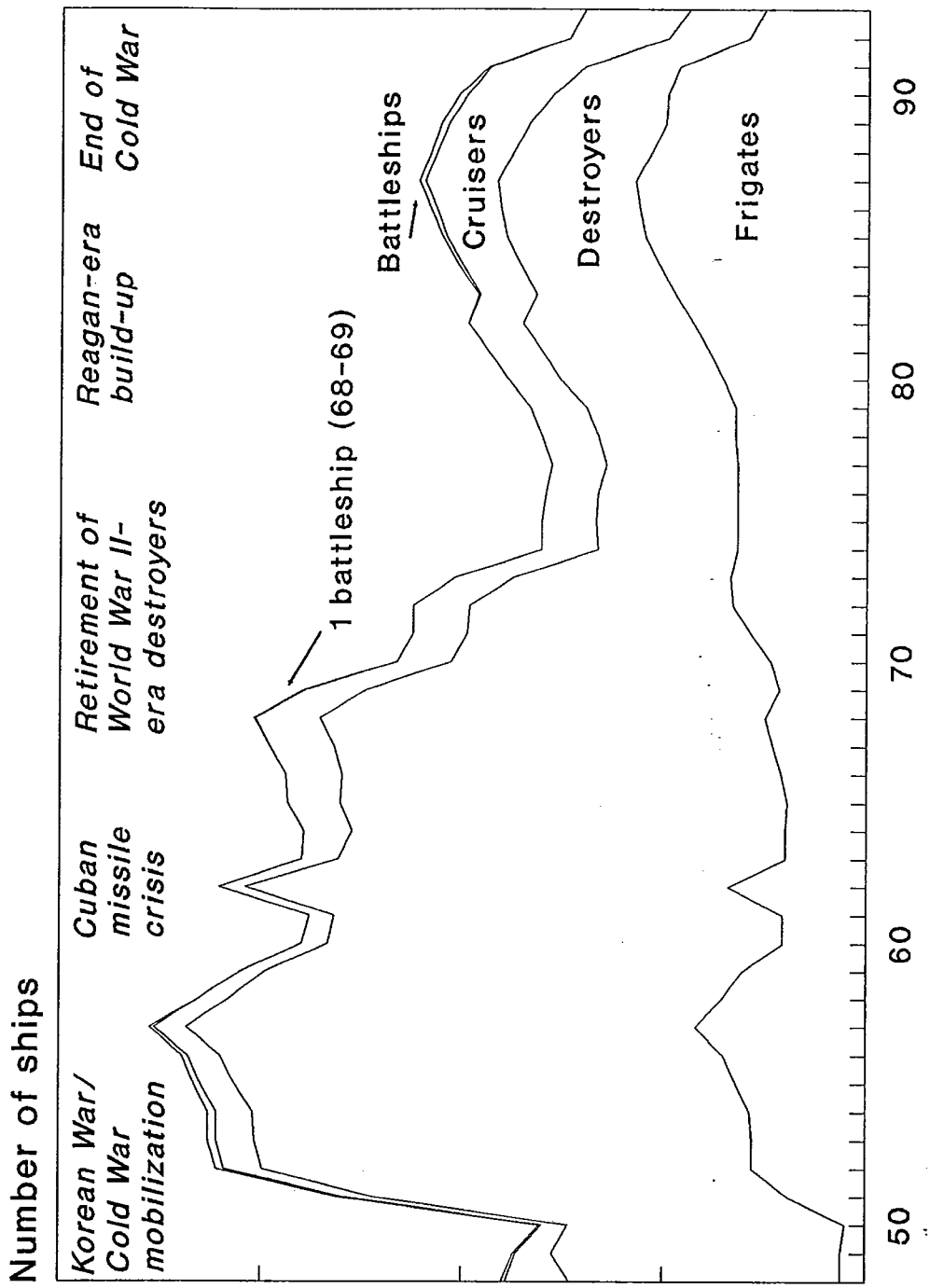
[16] The CGN-36s probably would have been retired early as well, except that they have recently completed expensive nuclear refueling overhauls that were funded a few years ago, when the Navy was planning a larger surface combatant force. The Navy apparently plans to keep the CGN-36s in service for at least a few years so as to better amortize the cost of their refueling overhauls. Although the CGN-38s are younger than the CGN-36s, the CGN-38s have not yet had their nuclear refueling overhauls funded and would need them to remain in service; retiring these ships thus avoids the cost of their overhauls.

Figure 1

Surface combatant force levels

FY1948-FY1993

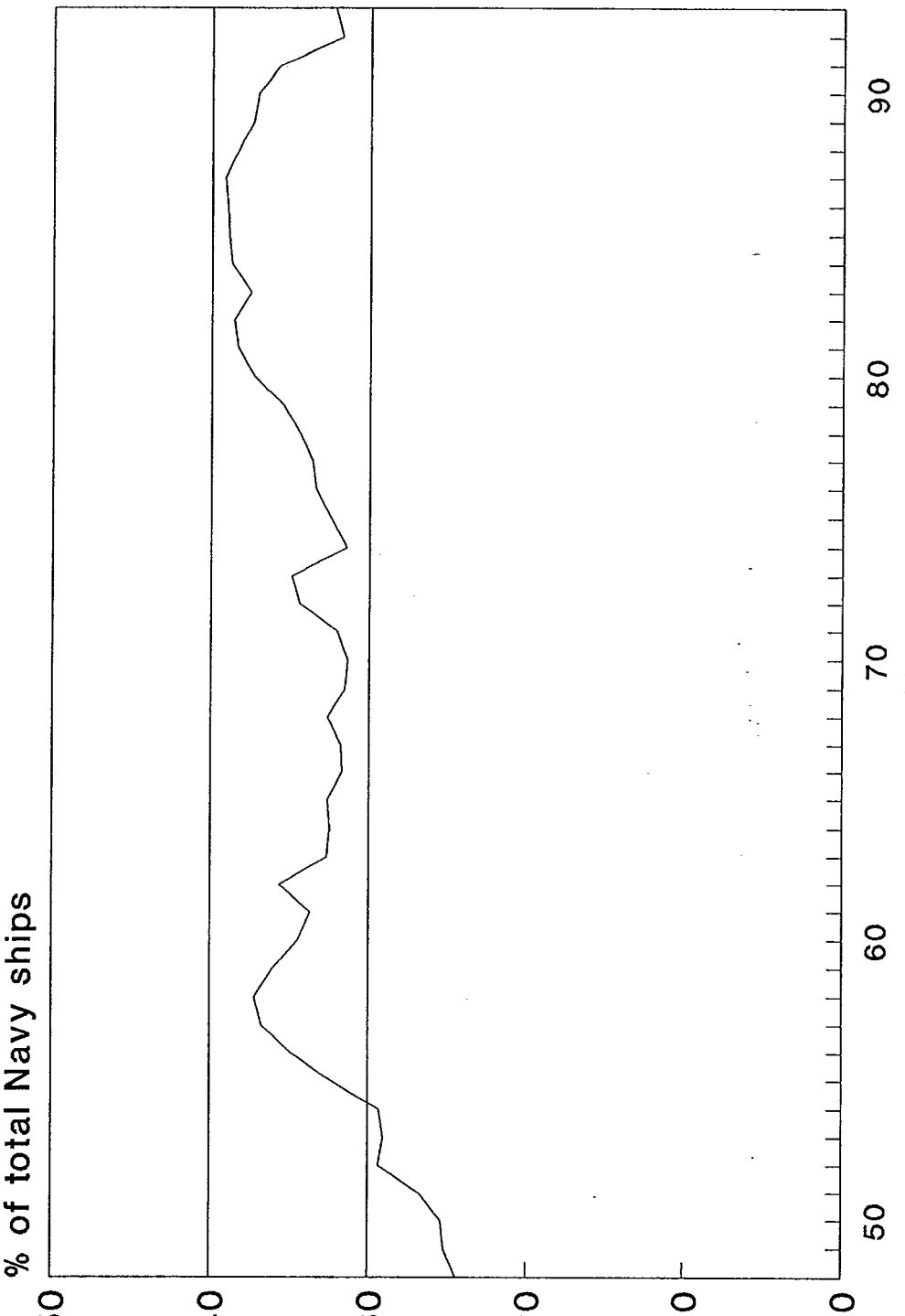


Source: Prepared by CRS, 2/94, based on U.S. Navy data.

Figure 2

Surface combatant force levels

as percent of total Navy, FY48-FY93



Source: Prepared by CRS, 2/94, based on U.S. Navy data.

TABLE 5. SURFACE COMBATANT FORCE-LEVEL GOALS

Ships	Reagan plan		Bush Base Force	Current Navy plan
	Original	1988[a]		
Battleships	4	4	0	0
Higher-capability	137	120	~100	~80
Lower-capability (active)	75[b]	78	~35	~30
Lower-capability (NRF)	26[b]	26	16[c]	10
TOTAL	242	228	~150[c]	124
As % of total Navy	≤40%	≤38%	~36%	~36%
% that are higher-capability	57%	53%	~67%[d]	~67%

a In 1988 the original Reagan administration goals were revised by the Surface Combatant Force Requirements Study (SCFRS).

b Some early presentations of the original Reagan plan show 127 frigates (101 active *plus* 26 NRF, rather than 101 active *including* 26 NRF).

c Plus 40 frigates -- 8 training frigates (FFTs) and 32 mobilization frigates -- in the Innovative Naval Reserve Concept (INRC) separate from the NRF.

d Calculation excludes 40 INRC frigates.

Projected (no further procurement or early retirements)

Figures 3, 4, and 5 show the projected number of surface combatants in the Navy, without further procurement or early retirements, using MEL, ESL, and a 40-year life, respectively. As shown in the figures, the total number of surface combatants exceeds the Navy's force-level goal of 124 ships until 2003, 2008, and 2020, respectively, and then drops below the goal. The excess ship totals in the early years of the figures provide an opportunity for retiring some ships before the end of their MEL, ESL, or 40-year lives.

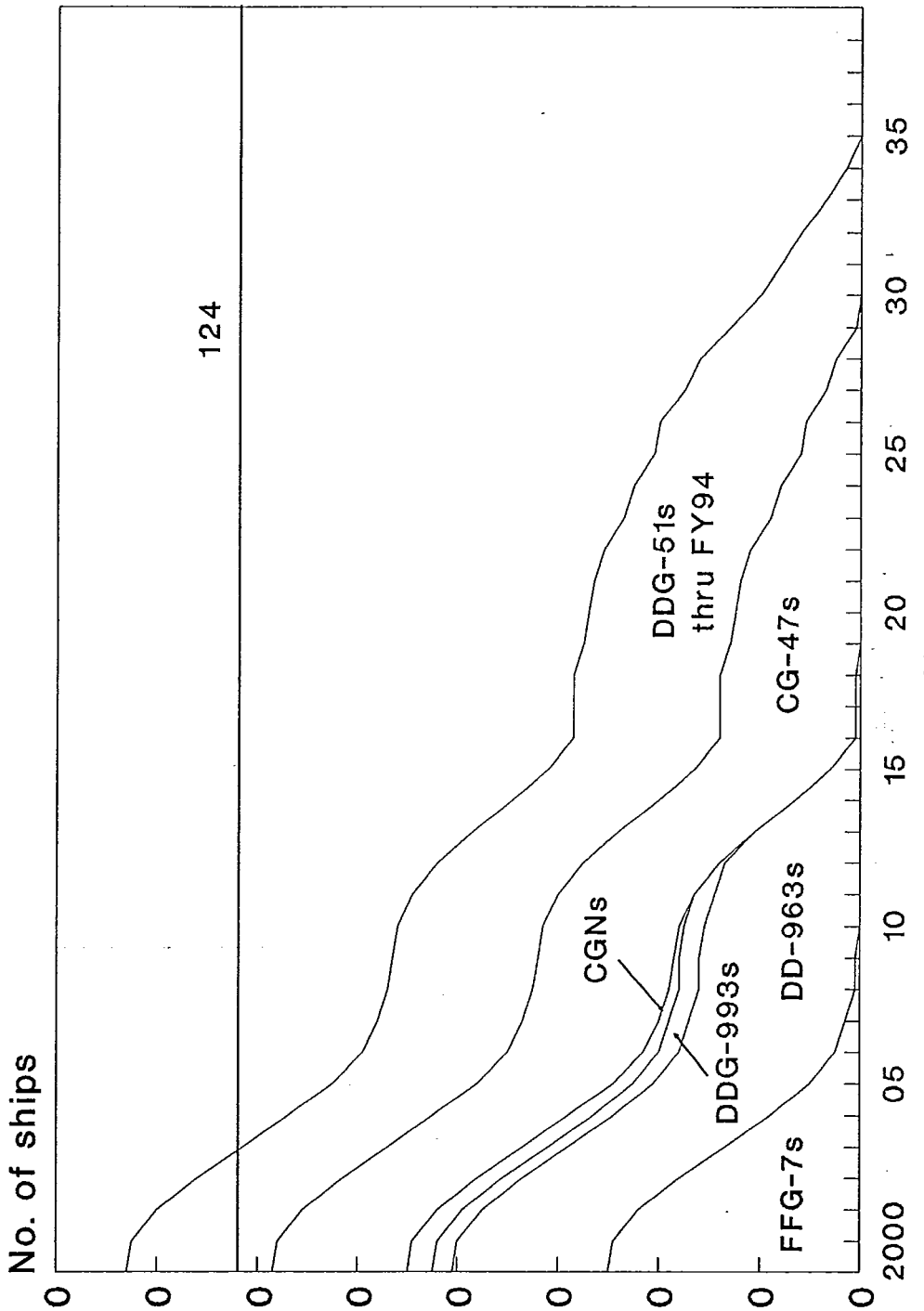
Roles and Missions

In General

U.S. Navy surface combatants perform a wide variety of roles and missions, including the following:

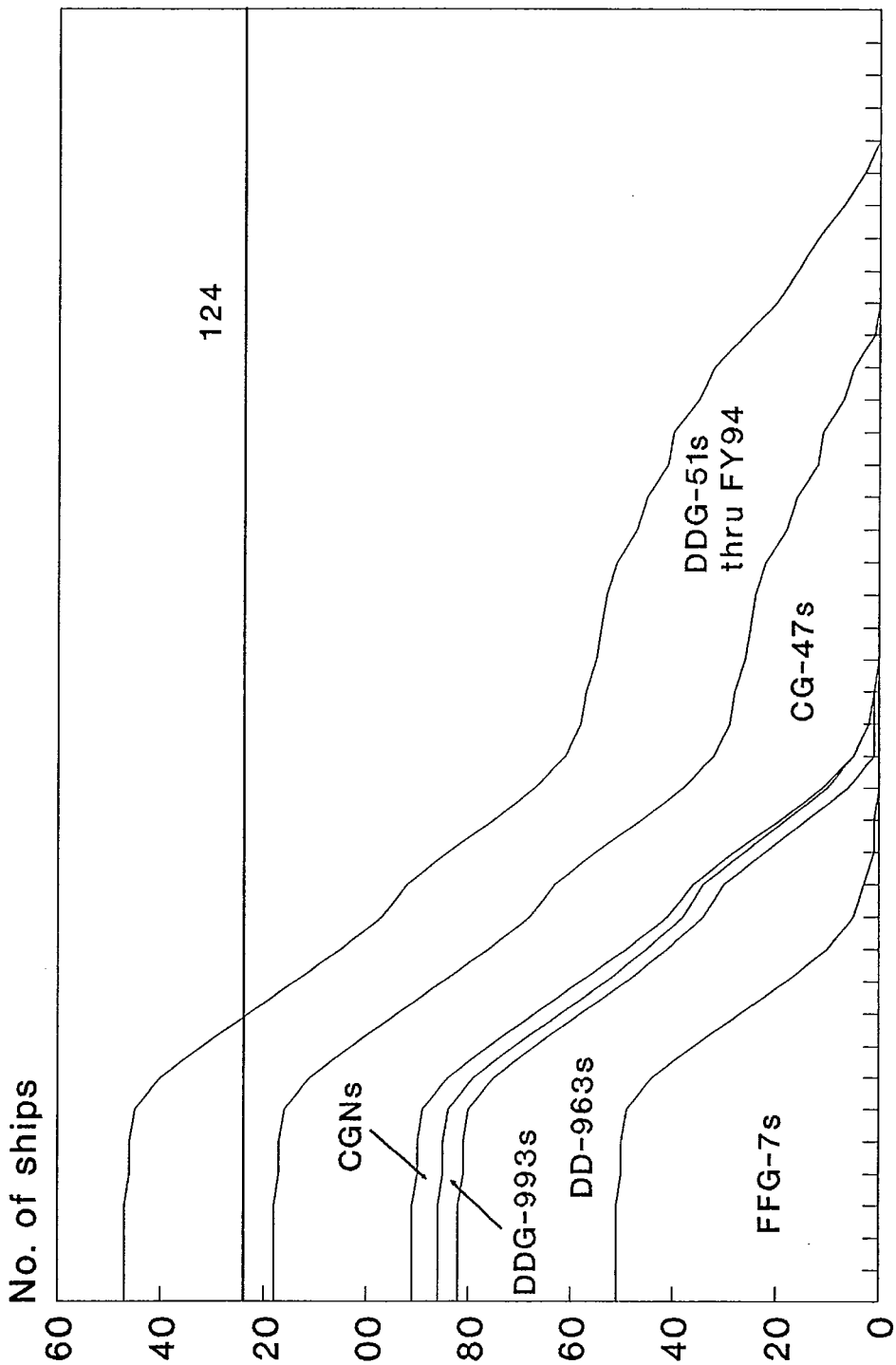
- presence and deterrence
- evacuation/humanitarian assistance/disaster relief
- maritime surveillance and interception
- protection of merchant ships

Figure 3



Source: Prepared by CRS, 2/94, based on U.S. Navy data.

Figure 4



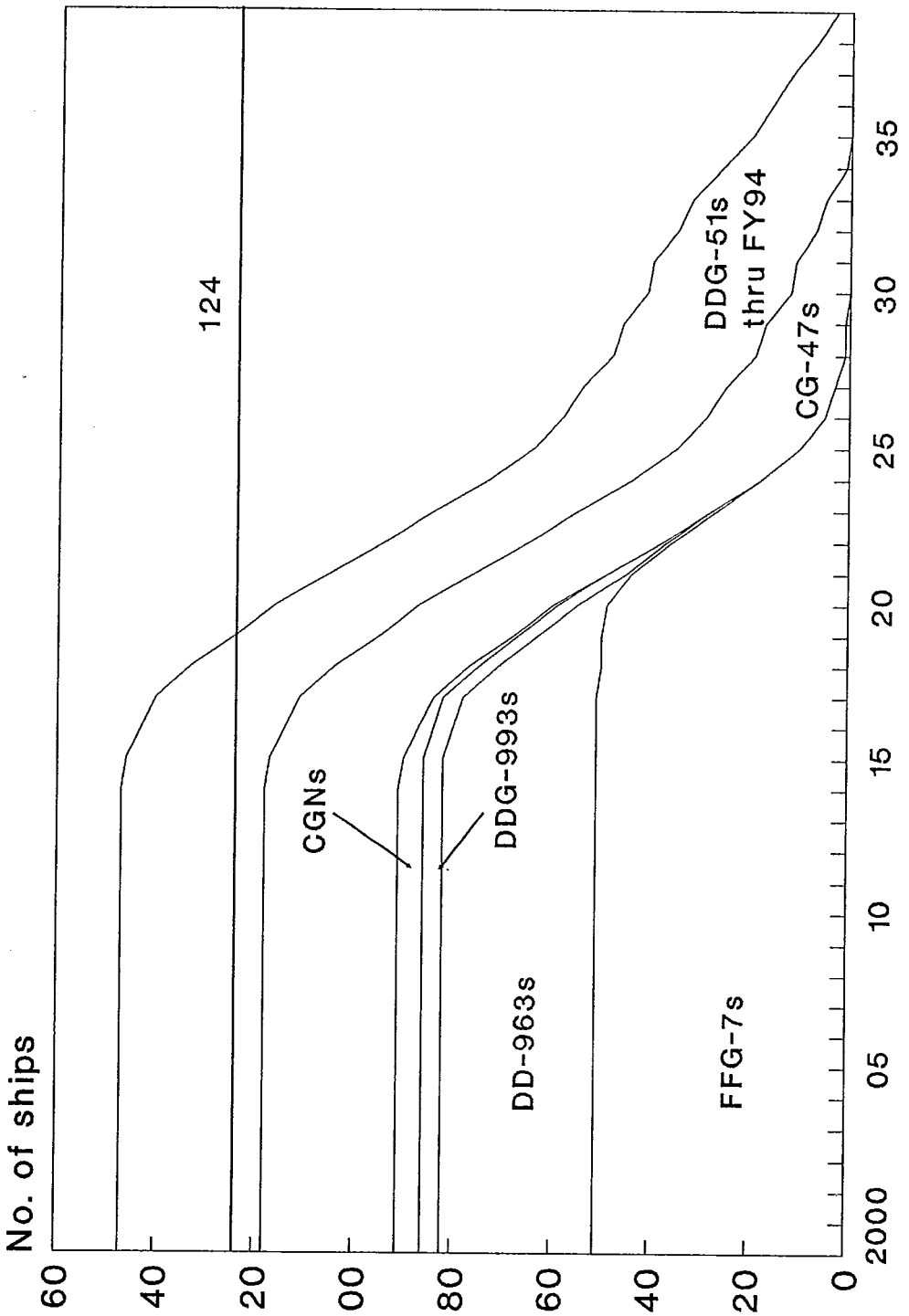
Source: Prepared by CRS, 2/94, based on U.S. Navy data.

Figure 5

Surface combatant force levels

Using 40-Year Life

(No early retirements, no further procurement)



Source: Prepared by CRS, 2/94, based on U.S. Navy data.

- protection of Navy ships
- influence situations ashore/support military operations on land[17]

Maritime surveillance and interception can include sanctions enforcement operations such as those currently in effect against Iraq, Haiti, and in the Adriatic Sea, and drug-interdiction operations in the Caribbean and the Eastern Pacific. Protection of merchant ships includes operations such as the 1987-1988 tanker-escort operation in the Persian Gulf. Protection of Navy ships was a responsibility during Operation Desert Shield/Desert Storm. Influencing situations ashore and supporting military operations on land can include defense of port areas against air and missile attack and attacking coastal and inland targets.

Surface combatants perform these roles and missions in a variety of naval formations, including carrier task forces, non-carrier task forces, and formations consisting of a few or several surface combatants. About one-half of U.S. Navy surface combatant operations are performed apart from carriers and amphibious ships.

Performing these roles and missions can involve a variety of warfare areas above, below, and on the surface, including the following:

- anti-air warfare (AAW) -- defense against aircraft and cruise missiles
- theater missile defense (TMD) -- defense against ballistic missiles
- anti-submarine warfare (ASW) -- defense against submarines and torpedoes
- mine warfare (MIW) -- for surface combatants, primarily avoidance of mines
- anti-surface warfare (ASuW) -- defense against ships, boats, and patrol craft
- strike warfare (StkW) -- attacking targets on land away from friendly forces
- naval surface fire support (NSFS) -- attacking targets on land in support of nearby friendly ground forces
- command and control/battle management

Recent Changes

U.S. Navy surface combatant roles and missions have changed in recent years due to technological developments, which have affected what surface combatants can do, and to the post-Cold War shift in U.S. strategic focus, which has affected what surface combatants might be called on to do.

Technological developments. Three key systems that entered service in the 1980s substantially expanded U.S. Navy surface combatant capabilities:

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[17] This list of roles and missions was compiled from Navy briefings to the author and Navy testimony to Congress.

- **The Tomahawk cruise missile**, which entered service with surface combatants in 1982, gave surface combatants an ability to attack targets hundreds of miles away and thereby made surface combatants comparable to aircraft carriers in terms of potential attack range.

- **The Aegis combat system**, which entered service in 1983, gave surface combatants a much-improved AAW ability, better situational awareness and battle management capability, and a potential capability for conducting theater missile defense operations.

- **The Vertical Launch System (VLS)**, which entered service with surface combatants in 1986, enabled surface combatants to carry large numbers of Tomahawk cruise missiles.[18]

These three key technological developments have given U.S. Navy surface combatants substantially more potential to operate independent of aircraft carriers or selectively substitute for them, and to influence events ashore and support military operations on land. Since World War II, surface combatants have been thought of as escorts; indeed, the term "escort" has often been used as a synonym for surface combatants. In the wake of these technological developments, however, surface combatants are no longer just escorts of other ships; they have become combatants in their own right.

Shift in strategic focus. With the end of the Cold War, the focus of U.S. military strategy has shifted away from the scenario of a major East-West conflict, and toward the goals of maintaining regional stability, responding to and containing regional crises, and fighting major regional conflicts (MRCs). For naval forces, including surface combatants, this shift in strategic focus toward regional concerns means a decreased emphasis on mid-ocean operations, war at sea, and stand-alone operations (i.e., operations in which the Navy is largely separate from the other services), and an increased emphasis on operations in littoral (i.e., near-shore) waters, operations intended to influence events ashore, and joint and combined operations.

Operating in littoral areas is quite different from operating in mid-ocean waters, and not necessarily easier. Indeed, in certain respects, littoral operations can be more demanding on naval forces than the Cold War scenario of mid-ocean operations against Soviet maritime forces.

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[18] The Vertical Launch System stores and launches missiles from simple, vertical silos that are sunk into the main deck of the ship and covered with individual hatches. Compared to the older, rail-style missile launchers on U.S. surface combatants (which store missiles below deck and then employ complicated machinery to move them to an above-deck missile-launching rail), VLS has several advantages, including the following: increased magazine capacity; a faster missile launch reaction time and firing rate; fewer moving parts and hence greater reliability; and less above-deck equipment, which can contribute to the ship's radar cross section and is vulnerable to damage from attack.

The land/sea junction of the littoral area is environmentally complex. Diverse and shifting weather patterns, and the nearby presence of land, can affect the performance of radar systems. The varying depth, temperature, and salinity of the water, and the varying conditions on the bottom, similarly alter sonar performance.

Littoral waters can feature a wide variety of potential threats, including shore-based aircraft, missiles and artillery; ships; boats and patrol craft; submarines; minisubs; swimmers; and mines. Many of these potential threats would not be present in mid-ocean waters. Littoral operations also pose an identification-friend-or-foe (IFF) challenge. The area can feature a mix of friendly, hostile, and neutral actors, and a mix of military and civilian air and sea traffic.

Littoral operations can feature a number of physical or political constraints on tactics. Supporting military operations on land may require surface combatants to remain relatively stationary for extended periods of time, reducing the potential for evading detection and targeting by enemy forces. In relatively closed bodies of water like the Persian Gulf, there may be limited room to maneuver for purposes of self-defense. Operating close to shore, and in close quarters with potentially hostile submarines and surface craft, means that enemy missile flight distances, and thus defensive system reaction times, can be quite short, putting a premium on being able to react rapidly.[19] There may be strict rules of engagement (ROE) that may prevent the ship from taking certain kinds of defensive actions, particularly preemptive ones. And lastly, elected officials and the public at large may have high expectations of U.S. forces, including expectations of "clean" or "surgical" strikes with a minimum of damage to civilians and untargeted property.

The littoral, in short, is a complex, compressed battle space that can place particularly high demands on the capabilities of surface combatants. Compared to mid-ocean operations, littoral operations are not a lesser included case, but rather a different case that might be easier in some respects, but is more difficult in others.

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[19] A subsonic anti-ship cruise missile like the widely proliferated Exocet, for example, may approach at a speed of about 600 miles per hour, or 1 mile every 6 seconds. A supersonic anti-ship missile might travel at twice that speed. Even allowing time for the anti-ship missile to get up to cruising speed, if the enemy launch platform is only a few miles away, the defending ship might have less than a minute to detect the missile, properly identify it as a threat, compute a fire control solution, fire a weapon, and destroy the missile at a safe distance from the ship. Shooting down a missile aimed at another ship can add to the challenge because the target ship might be even closer to the anti-ship missile's launch point, and because the defending missile might have to fly further to intercept the anti-ship missile.

The Department of the Navy summarized its view of the littoral operating environment in . . . *From the Sea*, the Department's recent white paper on the roles and missions of U.S. naval forces in the post-Cold War era:

> The littoral region is frequently characterized by confined and congested water and air space occupied by friends, adversaries, and neutrals -- making identification profoundly difficult. This environment poses varying technical and tactical challenges to Naval Forces. It is an area where our adversaries can concentrate and layer their defenses. In an era when arms proliferation means some third world countries possess sophisticated weaponry, there is a wide range of potential challenges.
>
> For example, an adversary's submarines operating in shallow waters pose a particular challenge to Naval Forces. Similarly, coastal missile batteries can be positioned to "hide" from radar coverage. Some littoral threats -- specifically mines, sea-skimming cruise missiles, and tactical ballistic missiles -- tax the capabilities of our current systems and force structure. Mastery of the littoral should not be presumed. It does not derive directly from command of the high seas. It is an objective which requires our focused skills and resources.[20]

The difficulty of operating successfully in littoral areas is highlighted by four events involving surface combatants operating in the Persian Gulf in recent years. In May 1987, the frigate Stark (FFG-31), while operating as part of the Middle East Force (the Navy's standing presence/deterrence force in the Gulf), was heavily damaged, and 37 crew members were killed, by French-made Exocet cruise missiles fired from Iraqi aircraft. In April 1988, the frigate Samuel B. Roberts (FFG-58), while engaged in the U.S. tanker-escort operation in the Gulf, was heavily damaged by a simple contact mine judged to have been laid by Iran. In July 1988, the Aegis cruiser Vincennes (CG-49), while also engaged in the tanker-escort operation, mistakenly shot down an Iranian civil airliner, killing all 290 people on board. And in February 1991, during operation Desert Storm, the Aegis cruiser Princeton (CG-59) was damaged by an Iraqi-laid bottom mine, thought to be of Italian manufacture, while operating off the coast of Kuwait.

In summary, the shift in U.S. strategic focus might be said to have changed U.S. surface combatant operations as follows: Anti-air warfare, anti-submarine warfare, and anti-surface warfare must be done differently because of the different conditions of the littoral operating area. Naval surface fire support and command and control/battle management must be done differently because the Navy's increased emphasis on joint and combined operations means that these functions will more likely involve coordination with sister services and coalition military forces. Theater missile defense, mine avoidance, strike operations, and naval surface fire support will be more important because these are operations that are important in littoral waters or are directed at influencing the situation ashore.

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[20] U.S. Department of the Navy. . . . From the Sea: Preparing the Naval Service for the 21st Century. Washington, 1993. p. 6-7.

OPTIONS FOR CONGRESS

This chapter outlines notional options for Congress for surface combatant modernization. It discusses options for procuring DDG-51s and options for upgrading and extending the service lives of existing surface combatants.

OPTIONS FOR PROCURING DDG-51s

Procure 28 Additional DDG-51s: Numerous Options

The Administration's plan to procure 3 DDG-51s per year is only one of many ways of procuring a total of 28 additional DDG-51s during the period in question (FY1995-FY2004). One alternative would be to reduce the procurement rate to something less than 3 ships per year during the future years defense plan, or FYDP (i.e., for FY1995-FY1999), and then increase it to something greater than 3 ships per year thereafter (i.e., for FY2000-FY2004). Another alternative would be the obverse: increase the rate to something more than 3 per year for the FYDP, and reduce it to something less than 3 per year thereafter. Appendix A shows 6 notional procurement profiles for each of these alternatives. Many other profiles for procuring a total of 28 ships are also possible.

Procure Fewer Than 28 Additional DDG-51s: Numerous Options

Similarly, there are numerous ways to procure fewer than 28 additional DDG-51s during the period FY1995-FY2004. One alternative would be to reduce the procurement rate to something less than 3 ships per year for the FYDP, and then procure at the 3-per-year rate thereafter. Another would be the obverse: procure at a 3-per-year rate during the FYDP, and then reduce the rate thereafter. A third alternative would be to procure at a rate of less than 3 ships per year for the entire period in question. Appendix A shows 6 notional procurement profiles for each of these alternatives. Many other profiles for procuring fewer than 28 ships are also possible.

Procure Modified DDG-51 Design with 128 VLS Cells

The current (Flight IIA) version of the DDG-51 design has a total of 96 VLS cells for storing and firing missiles (32 cells in the front end of the ship, 64 cells in back end). This compares with a total of 122 cells on VLS-equipped CG-47s.[21] One option for DDG-51 procurement would be to procure a modified

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[21] VLS magazines for U.S. Navy surface ships come in two sizes -- 32 cells and 64 cells. Until recently, three cells in each magazine have been used for a strike-down (reloading) crane, leaving a total of 29 or 61 usable cells for missiles. VLS-equipped DD-963s have a single 61-cell VLS magazine in the front end; VLS-equipped CG-47s have two 61-cell magazines (one in the front end, one in the back end); pre-Flight IIA DDG-51s have a 61 cell magazine in the back end

version of the DDG-51 design with a 64-cell (rather than 32-cell) VLS magazine in the front end. This would give the DDG-51 design a total of 128 VLS cells. This modification, which would lengthen the ship by about 12 feet, would increase the procurement cost of the ship by about $19 million, or a bit more than 2 percent, while increasing its weapon capacity by 33 percent.[22]

Several factors influenced the early Navy decision to give the DDG-51 design only about three-quarters as much VLS capacity as the CG-47 design. As mentioned in the background chapter, the Navy originally envisioned the DDG-51 design as a smaller and more affordable companion to the CG-47 design. The Navy was under Congressional pressure to ensure that the procurement cost of the DDG-51 design would not exceed 75 percent of the procurement cost of the CG-47 design.[23] The Navy may also have feared that making the DDG-51 design look too much like the CG-47 design would encourage support for the idea of terminating the DDG-51 program in lieu of continued procurement of CG-47s.[24]

As mentioned in the background chapter, however, the differences between U.S. Navy cruisers and destroyers have narrowed in recent years. The version Aegis system on DDG-51s, in fact, is in some respects more capable than the version on many of the earlier CG-47s. DDG-51 procurement and production, moreover, is now well established, while CG-47 procurement ended in FY1988 and CG-47 production is almost finished. The newly emergent mission of theater missile defense, as well as the potential for using VLS-launched weapons for naval surface fire support, might increase requirements for VLS cells. In light of these considerations, this option may merit further examination by the Navy and Congress.

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and a 29-cell magazine in the front end. Flight IIA DDG-51s do not have strike-down cranes in their VLS magazines and thus have a 64-cell magazine in the back end and a 32-cell magazine in the front end.

[22] There would be a one-time design cost of about $42 million to alter the design of the ship, and a lead-ship installation cost of about $31 million. The installation cost for follow-on ships would be about $19 million. This change could be implemented within two years and could thus be applied to all DDG-51s procured in FY1997 and later years (the final 22 ships in the class, under current plans).

[23] See the report of the House Appropriations Committee on the FY1985 Defense Appropriation Bill (H.Rept. 98-1086), p. 153.

[24] For a discussion of this option, see The Navy's Proposed Arleigh Burke (DDG-51) Class Guided Missile Destroyer Program: A Comparison With an Equal-Cost Force of Ticonderoga (CG-47) Class Guided Missile Cruisers, op. cit.

OPTIONS FOR UPGRADING/EXTENDING EXISTING SHIPS

Extend Service Lives Without Upgrading

One option regarding management of existing ships would be to extend the service lives of existing ships without upgrading them in any significant way. This option could be applied to all existing classes of ships. The per-ship cost of this option would vary depending on class, age and condition of individual ship, and the intended length of the service life extension. The cost-effectiveness of this option for any given ship would depend on the cost of extending its life, its annual O&S costs, the ability of the ship to perform one or more useful missions, and the Navy's need for ships to perform various missions.

Rebuild Existing Ships as Aegis/VLS Ships

A second alternative would be to rebuild existing ships as high-capability (Aegis/VLS) ships. The primary candidates for this option would be the CGN-38, CGN-36, DDG-993, and DD-963 class ships (the FFG-7s are too small to accommodate Aegis). As rebuilt, these ships might not carry as many missiles or guns as a CG-52 or DDG-51 class ship, and would lack certain survivability features built into the CG-52 and DDG-51 design. The nuclear propulsion plant of the rebuilt CGNs would give them great cruising endurance compared to non-nuclear-powered ships, but would also make them logistically different than the other surface combatants. The CGNs would also be more personnel-intensive, requiring about 600 personnel each to man, compared with about 385 for a CG-47 and 325 for a DDG-51. If begun today, the first rebuilt ship might enter service in about five years, and small number of rebuilds might be completed each year. These ships will be 18 to 26 years old in 2000. The Navy estimates that this option would cost roughly $750 million to $875 million per ship; the higher figure is almost as much as a new DDG-51.

Upgrade CG 47-51 to CG-52 Standard (Backfit VLS)

A third alternative would be to turn the first five CG-47 class ships (CG 47-51) into high-capability (Aegis/VLS) ships by upgrading them to the CG-52 standard. This upgrade would involve, among other things, adding VLS and the Tomahawk weapon control system to these five ships. The Navy estimates that this option would cost a minimum of $100 million per ship. This alternative would significantly expand the capabilities and potential usefulness of these ships by giving them an ability to fire Tomahawks and a potential future capability (with additional radar and computer modifications) to conduct theater missile defense. These ships will be 13 to 17 years old in 2000.

Extend or Curtail DD-963 Class VLS Backfit Program

A fourth alternative would be to upgrade the capability of existing ships to something less than the Aegis/VLS standard. One option for such an upgrade would be to extend the 24-ship program to backfit DD-963s with VLS to all 31

ships in the class. Including the 7 DD-963s not currently in the program would cost about $25 million per ship and would significantly expand the ability of these 7 ships to contribute to littoral combat operations by enabling them to fire large numbers of Tomahawks. The additional VLS capacity on these seven ships would be equivalent to the VLS capacity on about 4.4 new DDG-51s.[25] These ships will be 20 to 22 years old in 2000.

Of the 24 DD-963s scheduled to receive VLS, 18 have been backfitted to date. Of the 6 remaining backfits, 4 backfits are scheduled to begin in FY1994, and 2 in FY1995. If it is determined that extending the VLS backfit program to the final 7 ships in the class is not cost-effective, then the obverse option of reducing the backfit program to something less than 24 ships might also merit consideration. The goal of backfitting 24 of the 31 ships was established in the mid-1980s,[26] when the Navy was planning to achieve and maintain a 600-ship fleet including 242 surface combatants. With the Navy now moving toward a planned 330-ship fleet including 124 surface combatants, Congress may wish to consider whether 24 VLS-equipped DD-963s are still necessary.

Backfit FFG-7s With Phased-Array Radar AAW System

Another possibility for upgrading existing ships to something less than the Aegis/VLS standard would be to backfit some or all of the FFG-7s with an AAW system based on a frigate-sized phased-array radar (i.e., a phased-array radar smaller and less powerful than the SPY-1). The Navy estimates that this work would cost at least $150 million per ship and more likely $200 million per ship. FFG-7s upgraded with such a system would be less capable in AAW than an Aegis-equipped ship, and they would lack the Aegis system's potential for TMD work, due to the more limited power of a smaller phased-array radar compared to the Aegis system's SPY-1. But the ships' AAW capability would nevertheless be improved to a standard roughly comparable to that of frigates now planned by some West European navies.[27] The first upgraded ship might enter service 5 years after the start of the program, and as many as 5 ships might be upgraded per year. These ships will be 11 to 23 years old in 2000. The cost effectiveness of this option would depend on the amount of gain in AAW capability realized by the upgrade, and the feasibility and costs of extending the service lives of these ships so as to better amortize the cost of the upgrade.

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[25] The VLS on a backfitted DD-963 has 61 missile cells; the VLS on a Flight IIA DDG-51 has 96. Seven DD-963 VLSs would thus have 427 missile cells, or about as many as on 4.4 Flight IIA DDG-51s.

[26] Bunker Hill Get First VLS. Surface Warfare, January/February 1985: 3; U.S. Congress. House. Committee on Appropriations. [Hearings on] Department of Defense Appropriations for [Fiscal Year] 1987, 99th Cong., 2nd Sess., Part 4. Washington, U.S. Govt. Print. Off., 1986. p. 186

[27] See, for example, "Aegis" May be Future Frigate AAW Fall-Back. Jane's Defence Weekly, Mar. 5, 1994: 1.

COMBINING OPTIONS INTO INVESTMENT STRATEGIES

Options for procuring either 28 or fewer than 28 DDG-51s can be pursued by themselves, or in conjunction with options for upgrading or extending the service lives of existing ships. The alternatives of upgrading CG 47-51 to the CG-52 standard and of increasing or decreasing the planned number of DD-963 VLS backfits might be appropriately combined with options to procure either 28 or fewer than 28 additional DDG-51s. The alternatives of extending the service lives of existing ships, of rebuilding existing ships as Aegis/VLS ships, and of backfitting the FFG-7s with an improved AAW system might be more appropriately combined with an option to procure fewer than 28 additional DDG-51s. The option to build modified (128-cell) DDG-51s can be combined with various alternatives; combining it with the option to curtail the DD-963 VLS backfit program would in effect transfer VLS cells from DD-963s to new DDG-51s that will remain in service longer. Alternatives to upgrade existing ships might not be cost effective unless the service lives of the affected ships are also extended, so that the cost of the upgrade can be amortized over a longer period.

ASSESSING THE OPTIONS

This chapter discusses military, industrial-base, and budgetary factors that might be considered in assessing the options introduced in the previous chapter.

MILITARY FACTORS

Is a procurement rate of 3 DDG-51s per year and a total of 28 additional DDG-51s needed for military reasons? This question can be broken into four parts:

- Is 3 per year (28 total) needed to maintain the planned total force level of 124 surface combatants?
- Is 3 per year (28 total) needed to achieve the planned force level of about 80 higher-capability ships by about 2005?
- Is the force-level goal of 124 surface combatants, including about 80 higher-capability ships by about 2005, appropriate?
- If the force-level goal is not excessive, are there nevertheless higher-priority defense programs that are underfunded?

Of these four questions, the fourth is beyond the scope of this report and is treated in another CRS product.[28] The discussion below consequently examines the first three questions.

Procurement Rate for 124 Total Ships

Is 3 Per Year (28 Total) Needed to Maintain the Planned Total Force Level of 124 Surface Combatants?

Over the long run, an average procurement rate of *more than* 3 ships per year would be needed to sustain the planned total force level of 124 surface combatants. The long-term average procurement rate for a given kind of ship is equal to the planned force level divided by service life. Assuming a 30-year service life, maintaining a force of 124 ships would require a long-term (30-year) average procurement rate of about 4.1 ships per year. A 35-year service life would require a long-term (35-year) average procurement rate of about 3.5 ships per year. Assuming a 40-year life, the long-term (40-year) average procurement rate would have to be 3.1 ships per year. The table below shows the force levels that can be maintained with various average long-term procurement rates, with

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[28] For a discussion of competing defense budget priorities, see U.S. Library of Congress. Congressional Research Service. Defense Policy: Threats, Force Structure, and Budget Issues. CRS Issue Brief 90013, by Robert L. Goldich and Stephen Daggett. Washington, 1994 (updated regularly) 15 p.

the shaded cells showing combinations of procurement rate and service life that maintain a force of roughly 124 ships.

TABLE 6. LONG-TERM AVERAGE PROCUREMENT RATES AND RESULTING FORCE LEVELS

Long-term average procurement rate	Resulting force level with service life of:		
	30 years	35 years	40 years
4 per year	120	140	160
3.5 per year	105	123	140
3 per year	90	105	120
2.5 per year	75	88	100
2 per year	60	70	80
1.5 per year	45	53	60
1 per year	30	35	40
0.5 per year	15	18	20

Over the shorter run, the procurement rate can be reduced to fewer than 3 ships per year -- as long as the procurement rate is increased at some other point to more than 3 ships per year, so that the required long-term (e.g., 35-year) average procurement rate is maintained. As shown in Figure 3 from the background chapter, if ships now in service are kept in service until the end of their Mission Effectiveness Life (MEL), the Navy's surface combatant force would not drop below 124 ships until about 2003. Assuming a 5-year delay between the procurement of a ship and its commissioning, this means that procurement of additional DDG-51s could be deferred until FY1998. Deferring additional procurement until FY1998, however, would require an average procurement rate of about 3.8 ships per year for the 33-year period FY1998-FY2030.

Similarly, as shown in Figure 4 from the background chapter, if ships now in service are kept in service until the end of their Expected Service Life (ESL), the Navy's surface combatant force would not drop below 124 ships until about 2008. Procurement of additional DDG-51s could thus be deferred until about FY2003. But this would require an average procurement rate of about 4.4 ships per year for the 28-year period FY2003-FY2030. And as shown in Figure 5 from the background chapter, if ships now in service are kept in service until the end of a 40-year life, the Navy's surface combatant force would not drop below 124 ships until about 2020. Procurement of additional DDG-51s could thus be deferred until about FY2015. But the average procurement rate would have to be about 5.9 ships per year for the 21-year period FY2015-FY2035.

Figures 6, 7, and 8 show resulting force levels with procurement rates of 3 ships, 2 ships, and 1 ship per year, for MEL, ESL, and a 40-year life, respectively.

Procurement for About 80 Higher-Capability Ships

Is 3 per year (28 total) needed to achieve the planned force level of about 80 higher-capability ships by about 2005?

A total of 51 higher-capability ships have been funded to date -- the final 22 ships in the CG-47 class, and 29 DDG-51s. Upgrading the first 5 CG-47 class ships to the CG-52 standard -- an option discussed in the previous chapter -- would increase the total to 56 higher-capability ships. Thus, if the Navy is to achieve a force of about 80 higher-capability ships by about 2005, about 25 to 30 additional higher-capability ships would be needed. Under the Administration's planned DDG-51 procurement rate of 3 ships per year (28 total), 28 additional DDG-51s would enter service by the year 2009.

As mentioned in the previous chapter, higher-capability (i.e., Aegis/VLS) ships can also be created by rebuilding existing CGN-38, CGN-36, DDG-993, and DD-963 class ships. These classes comprised a total of 40 ships at the end of 1993. The question thus becomes whether it would be more cost-effective to rebuild these existing ships than procure new DDG-51s.

As discussed in the previous chapter, a rebuilt ship would cost almost as much as a new DDG-51, but have only a fraction of a DDG-51's 35-year service life remaining in them. If the service lives of these ships cannot be extended, rebuilding these ships in lieu of procuring DDG-51s would thus not appear to be cost-effective.

It might be possible to extend the service lives of the rebuilt ships to better amortize the cost of their rebuilding, but even then, the cost-effectiveness of a rebuilding effort as a substitute for procuring DDG-51s is open to question, for three reasons: (1) the structural and other work needed to extend the ships' service lives would increase the cost of rebuilding them; (2) the rebuilt ships, particularly the CGN-38 and CGN-36 classes, would likely have higher annual operating and support (O&S) costs than DDG-51s; (3) the rebuilt ships would lack modern survivability features built into the DDG-51 design (or could gain them only by further increasing the rebuilding cost).

Appropriateness of 124/80 Goal

Is the force-level goal of 124 surface combatants, including about 80 higher-capability ships by about 2005, appropriate?

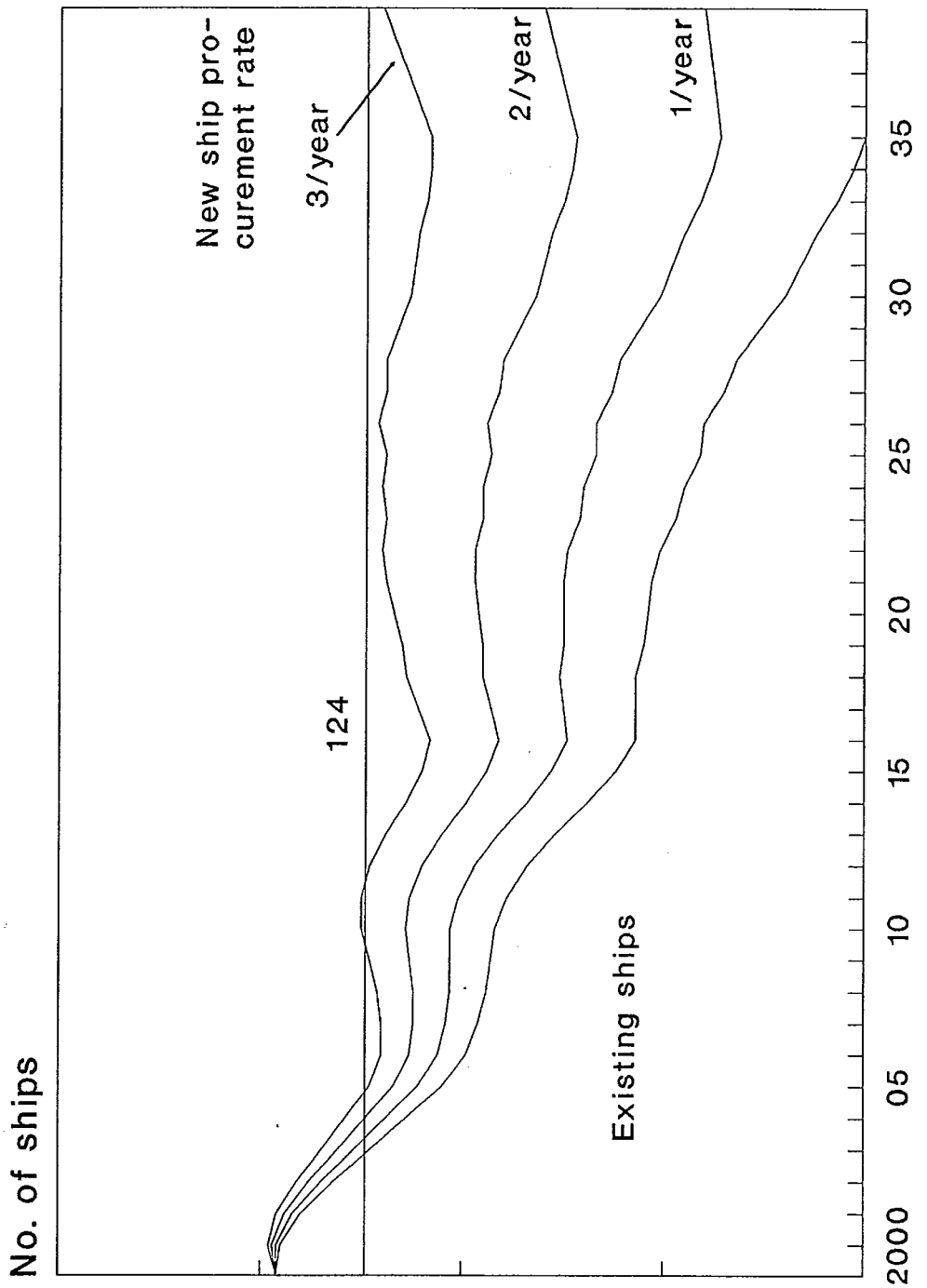
If one accepts that the Administration's plan to procure 3 DDG-51s per year (28 total) is generally consistent with its surface combatant force-level goal, a follow-on question is whether the force-level goal itself is appropriate. As discussed in a previous CRS report, a naval force-level goal can be established

Figure 6

Surface combatant force levels

Using Mission Effectiveness Life

(No early retirements, further procurement as shown)



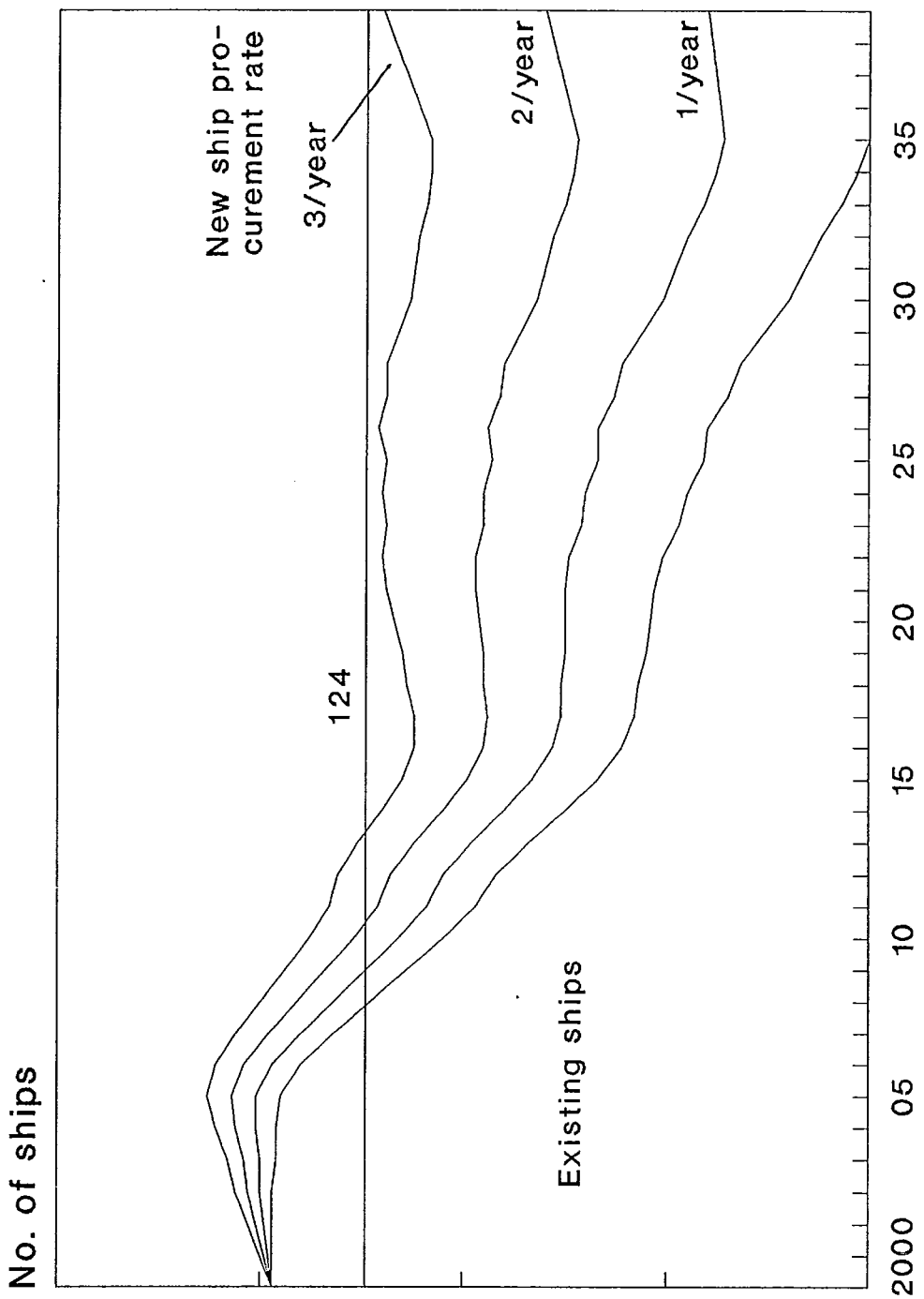
Source: Prepared by CRS, 2/94, based on U.S. Navy data.

Figure 7

Surface combatant force levels

Using Expected Service Life

(No early retirements, further procurement as shown)



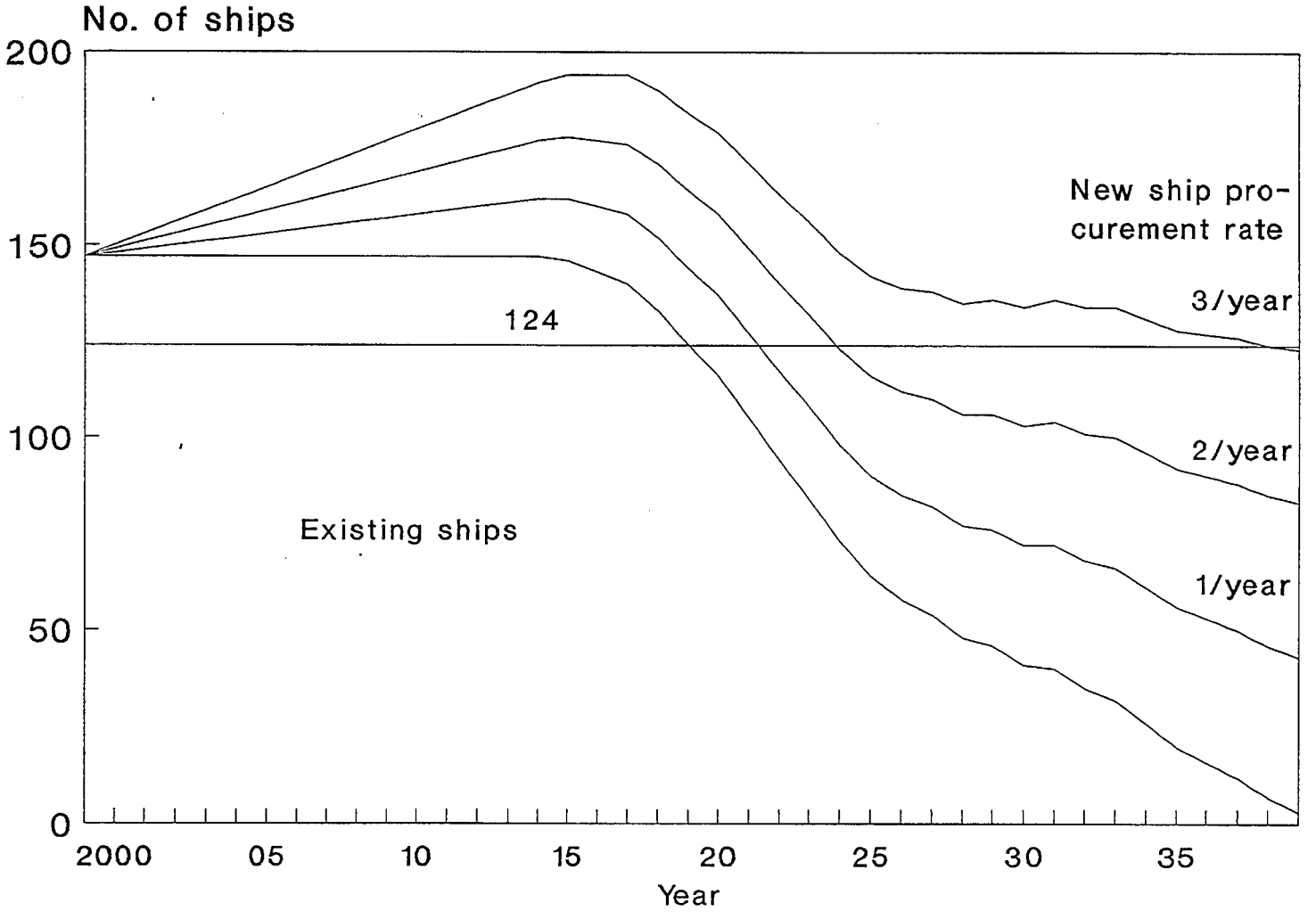
Source: Prepared by CRS, 2/94, based on U.S. Navy data.

Figure 8

Surface combatant force levels

Using 40-year life

(No early retirements, further procurement as shown)



Source: Prepared by CRS, 2/94, based on U.S. Navy data.

by examining requirements for either day-to-day forward deployments (i.e., presence/deterrence operations) or wartime use in major regional conflicts (MRCs).[29] The discussion below looks at both lines of analysis.

For presence/deterrence

The issue of surface combatant forces required for presence/deterrence operations can be divided into five questions:

- What level of presence/deterrence is required or desired?
- To what extent can or should Army units, Air Force units, or allied military forces contribute toward this goal?
- To what extent can or should U.S. naval forces other than surface combatants contribute toward this goal?
- What level of presence would 114 active surface combatants maintain?
- To what extent are higher-capability ships needed for presence/deterrence operations?

The first of these questions deals with the issue of overall U.S. national strategy and is largely beyond the scope of this report.[30] In general, however, it can be said that setting the desired level of presence and deterrence is inherently a matter of subjective judgment to some degree, because it involves looking into the minds of foreign political and military leaders and making

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[29] Naval Forward Deployments and the Size of the Navy. CRS Report 92-803 F, by Ronald O'Rourke. Washington, 1992. (Nov. 13, 1992, with minor technical corrections of Dec. 11, 1992) p. 1-3.

[30] For discussions of overall U.S. national security strategy, including the role of presence/deterrence operations, see U.S. Department of Defense. Report on the Bottom Up Review. Washington, 1993. (Les Aspin, Secretary of Defense, October 1993) p. 8, 23-25; U.S. Library of Congress. Congressional Research Service. Defense Policy: Threats, Force Structure, and Budget Issues. CRS Issue Brief 90013, by Robert L. Goldich and Stephen Daggett. Washington, 1994 (updated regularly) 15 p.; U.S. Library of Congress. Congressional Research Service. Military Preparedness: Principles Compared With U.S. Practices. CRS Report 94-48 S, by John M. Collins. Washington, 1994 (Jan. 21, 1994) 49 p.; U.S. Library of Congress. Congressional Research Service. The Clinton Foreign Policy: Emerging Themes. CRS Report 93-951 S, by Mark M. Lowenthal. Washington, 1993 (Nov. 1, 1993) 28 p.; The Bottom-Up Review: An Assessment, op. cit., p. 32-36.

subjective assessments about their likely reactions over a substantial future period to the deployments and activities of U.S. military forces.[31]

The second question is similarly beyond the scope of this paper, and is treated in a previous CRS report.[32] Consequently, the discussion below focuses on the final three questions from the list above.

To what extent can or should U.S. naval forces other than surface combatants contribute toward this goal?

For purposes of presence/deterrence operations, naval forces other than surface combatants would include aircraft carriers, amphibious ships, and attack submarines.

Aircraft carriers. Given its size, striking power, cost, and relative scarcity, a forward-deployed aircraft carrier under most circumstances generates a larger political/psychological impact than a forward-deployed surface combatant. A large political/psychological impact, however, may not always be necessary; indeed, in some situations, it could be counterproductive. In such cases, the lesser political/psychological impact of one or a few surface combatants may suffice. Another factor to consider is that the deterrent value of a Tomahawk-armed surface combatant may have been increased following the use of Tomahawks in Desert Storm and in two 1993 punitive strikes against Iraq.

Carriers are particularly beneficial for maintaining presence/deterrence operations in areas of high potential air threat, since the fighters in the carrier's air wings can provide long-range air defense. The air threat in some areas, however, might not always be high enough to require the long-range air defense provided by fighter aircraft. In such cases, the medium-range air defense provided by surface combatants, together with the short-range self-defense systems on each ship, may suffice. In near-to-shore operations, moreover, restrictions on entering the nearby country's territorial air space may reduce or eliminate the potential for using the carrier's fighters to provide long-range air defense.

A carrier can threaten sustained attacks against inland targets. In some situations, however, a threat to conduct a limited attack against inland targets

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[31] For a discussion on the inherent difficulty of accurately measuring the political/psychological effects of forward-deployed naval forces on foreign leaderships, see Naval Forward Deployments and the Size of the Navy, op. cit., p. 39-44.

[32] Ibid., p. 45-56.

may be adequate. In such cases, the strike threat posed by Tomahawk-armed surface combatants may suffice.[33]

Carriers need surface combatants to defend against attack by submarines, by surface craft, and by missiles or aircraft that penetrate or are launched inside the outer ring of air defense provided by the carrier's fighters. In the future, carriers might also need surface combatants to defend against attack by accurate (possibly terminal-homing) theater ballistic missiles.

Given these considerations, it would appear that surface combatants can complement or substitute for carriers in presence/deterrence operations, depending on the circumstances, and that deploying a carrier to areas of potential danger without at least some accompanying surface combatants is unlikely.

Amphibious ships. Amphibious ships pose the threat of a landing ashore by some number of Marines. The credibility of that threat, however, may depend on or benefit from the threat posed by one or more accompanying surface combatants to conduct supporting attacks on coastal targets with guns or inland targets with Tomahawk missiles. And like carriers, amphibious ships need surface combatants for antisubmarine warfare, anti-surface warfare, medium-range anti-air warfare, and in the future possibly theater ballistic missile defense as well.

Given these considerations, it would appear that surface combatants may complement amphibious ships in presence/deterrence operations, and that deploying amphibious ships to areas of potential danger without at least some accompanying surface combatants is unlikely.

Attack submarines. When submerged, forward-deployed submarines can have a latent or implied presence that might generate a political/psychological impact. They can surface to become visible, but submarines in general are more vulnerable to attack when on the surface. Attack submarines can threaten to launch Tomahawks from surprise locations, but have no guns for threatening coastal targets. When submerged, they generally do not depend on surface combatants (or any other kinds of ships) for protection, but neither can they conduct anti-air warfare to help defend other ships.

Given these considerations, it would appear that submarines can be forward-deployed by themselves for presence/deterrence operations, but that surface combatants are better suited for operations requiring a visible presence and would be needed to help provide air defense for other ships in the area.

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[33] For a short discussion of the relative merits of cruise missiles and manned aircraft for attacking land targets, see U.S. Library of Congress. Congressional Research Service. Persian Gulf War: Defense-Policy Implications for Congress. CRS Report 91-421 F, coordinated by Ronald O'Rourke. Washington, 1991 (May 15, 1991) p. 27-29.

In summary, it would appear that in areas of potential danger where U.S. naval forces are to maintain a visible presence, those forces might not include any carriers or amphibious ships, but will almost certainly include some number of surface combatants.

What level of presence would 114 active surface combatants maintain?

Active duty surface combatants are regularly forward-deployed for presence/deterrence operations to the Mediterranean, the Indian Ocean, the Persian Gulf, and the Western Pacific. Typically, several surface combatants are forward deployed to each of these areas, mostly as part of integrated naval task forces.

Additional duties requiring ongoing or periodic deployments of surface combatants include drug-interdiction operations in the Caribbean and the Eastern Pacific, which has involved up to about 7 deployed surface combatants, periodic UNITAS exercises with Latin American navies, which might require 2 or 3 deployed surface combatants, and U.S. participation in NATO's Standing Naval Force Atlantic (SNFL) and Standing Naval Force Mediterranean (SNFM). These are multilateral surface combatant squadrons; the United States normally contributes one deployed surface combatant to each.

As discussed in a previous CRS report, due to limits on sailors' time away from home port, plus requirements for maintenance and training and time lost in transit to and from the operating area, it takes several ships of a given kind to keep one ship of that kind continuously deployed in an overseas operating area.[34] The table below shows the number of surface combatants needed to keep one surface combatant continuously on station at specific locations in the Mediterranean, the Indian Ocean, the Persian Gulf, and the Western Pacific, depending on whether the ship is a cruiser/destroyer or a frigate, and on whether it is homeported on the Atlantic Coast (Norfolk) or the Pacific Coast (San Diego). For example, the table shows that 5.3 Norfolk-homeported cruisers or destroyers are needed to keep one such cruiser or destroyer continuously forward-deployed to a particular location in the Indian Ocean.

As can be seen in the table, it takes roughly 4 to 7 U.S.-based surface combatants to keep 1 such surface combatant forward-deployed in an overseas operating area. A number of Navy ships, including several surface combatants, are forward-homeported in Japan. This has the effect of reducing the figures in the Western Pacific column of the table from 4.9 to 1 and from 4.5 to 1.[35]

The previous CRS report examined a notional option that would keep 6 surface combatants forward-deployed in the Mediterranean, 6 in the Indian Ocean, 6 in the Western Pacific, and 7 in the Persian Gulf. Accounting for the effect of having 6 surface combatants forward-homeported in Japan, this level

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[34] Naval Forward Deployments and the Size of the Navy, op. cit, p. 13-18.

[35] Ibid., p. 20-21.

TABLE 7. SURFACE COMBATANT STATION-KEEPING MULTIPLIERS FOR CONTINUOUS FORWARD DEPLOYMENTS

Ship type	Home port	Deployment station			
		Med	IO	PG	WestPac
Cruiser-destroyer	Norfolk	4.3	5.3	5.5	
	San Diego		7.1	7.2	4.9
Frigate	Norfolk	4.0	5.0	6.0	
	San Diego		6.5	6.7	4.5

Source: CRS Report 92-803 F, Naval Forward Deployments and the Size of the Navy, p. 14. Data from U.S. Navy Office of Legislative Affairs, Sep. 10, 1992. **Deployment stations:** Med = a point in the East-central Mediterranean at 35°N, 20°E; IO = a point in the Northern Arabian Sea (Indian Ocean) at 20°N, 65°E (via Suez for Norfolk-homeported ships); PG = a point in the central Persian Gulf at 27°N, 51°E (via Suez for Norfolk-homeported ships); WestPac = a point in the Western Pacific at 20°N, 125°E. **Shaded cells:** Not applicable: West-coast homeported ships would not be used for regular forward deployments to the Mediterranean, and East Coast-homeported ships would not be used for regular forward deployments to the Western Pacific.

of forward deployment would require a total of 114 surface combatants,[36] which happens to be the Navy's force-level goal for active duty surface combatants. No ships would be available for additional duties such as drug-interdiction operations, UNITAS exercises, SNFL/SNFM duties, or other operations.

These additional duties, if performed at a relatively high level, could require 65 additional ships. A total of 179 surface combatants could therefore be required to sustain continuous forward-deployments of 25 surface combatants in the four main operating areas and carry out additional surface combatant duties.[37]

By reducing the amount of time spent in the four main deployment areas, as well as the level of activities for additional duties, the previous CRS report generated alternative lower force structure requirements. One of these reduced the number of surface combatants forward-deployed to the Persian Gulf from 7 down to 4, reduced the amount of time that surface combatants would be present in the Mediterranean and Indian Ocean from 12 months out of 12 to 9 months out of 12, and scaled back additional duties to five-eighths of the level

[36] Author's calculations for notional force structure 1A from CRS Report 92-803 F.

[37] Ibid., p. 27.

sustained by the 179-ship force. This reduced the required number of surface combatants from 179 to 120.[38]

The CRS report also examined the option of establishing a second forward homeporting arrangement in the Mediterranean. Applying this option to the 120-ship surface combatant force reduced the requirement to 104 ships while permitting surface combatants to be present in the Mediterranean 12 months out of 12.[39] Forward homeporting, however, requires overseas base access, and forward-homeported ships are subject to potential host-nation limits on use and other limitations.[40]

The Navy's calculations employ less stringent geographical definitions for deployments to the four regular operating areas[41] and a more circumscribed collection of additional duties,[42] but are otherwise similar. The Navy calculates that a force of 175 surface combatants would be enough to keep 33 ships continuously forward-deployed in the four main operating areas and carry out additional surface combatant duties.

In 1991, the Navy switched from a policy of maintaining continuous forward deployments to a more relaxed forward-deployment policy, first known as "flexible presence" and now known as the "tether" policy, under which ships forward deployed to a particular overseas operating area can sometimes actually be a few steaming days away from that area. (Ships, that is, would sometimes be "tethered" to a region rather than actually in it.)[43] The Navy calculates that by reducing the number of surface combatants forward-deployed to the four main operating areas from 33 to 27, and by switching from a policy of continuous presence to one of tethered presence, the force level requirement can

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[38] Ibid., p. 25 and 27 (notional force structure 4A).

[39] Ibid., p. 27 (notional force structure 4B).

[40] Ibid., p. 21.

[41] For example, the Navy counts a ship as being forward-deployed in the Mediterranean when it is on the Mediterranean side of the strait of Gibraltar. This is more than 1,200 miles closer to the United States than the East-central Mediterranean point of 35°N, 20°E used in CRS Report 92-803 F, which was chosen to reflect the fact that Mediterranean threats to U.S. interests in recent years have been concentrated in the Eastern and Central portions of the Mediterranean.

[42] The Navy's additional duties included the previously mentioned drug-interdiction operations, UNITAS exercises, and SNFL/SNFM duties. CRS Report 92-803 F included these duties, plus an independent antisubmarine warfare squadron in the Pacific, 6th Fleet (Mediterranean) flagship duties, and use of surface combatants in developmental and operational tests.

[43] Naval Forward Deployments and the Size of the Navy, op cit., p. 8.

be reduced from 175 ships down to about 134 or 135. By reducing drug-interdiction operations by 70 percent from previous levels, it then calculates, the requirement can be reduced from 134 or 135 to about 114.

In summary:

- A force of 114 active-duty ships would be sufficient to keep about 27 surface combatants on tethered forward deployments to the four main operating areas, and to carry out a reduced level of additional duties, including a much-reduced level of drug-interdiction operations. Ships on tethered deployments might be less responsive for regional emergencies than ships on continuous forward deployments.

- Restoring continuous forward deployments would increase the force-level requirement by about 40 ships.

- Restoring the previous level of drug-interdiction operations would increase the force level requirement by as many as 20 ships.

- Forward homeporting a squadron of surface combatants in the Mediterranean would reduce the force-level requirement by about 15 to 20 ships but would require overseas base access and could create difficulties in areas such as host-nation limits on use.

To what extent are higher-capability ships needed for presence/deterrence operations?

In areas of low or no potential threat, most any ship with sufficient endurance and logistic support -- even a lightly armed or unarmed ship -- might be sufficient to maintain a basic physical presence for the United States. In areas of potential threat, however, maintaining a physical presence might require an adequate capability for self defense. This could include capabilities for AAW (including defense against anti-ship cruise missiles), anti-surface warfare, anti-submarine warfare (including defense against torpedoes), and mine avoidance. Depending on the kind of enemy missiles and potential reaction times involved, adequate defense against anti-ship cruise missiles might require an AAW system with a capability for rapidly detecting and reacting to incoming missiles, such as the Aegis system.

To have a deterrent effect -- that is, to affect the views of regional political and military leaders -- a forward-deployed ship arguably should be capable not just of defending itself, but of affecting events in the region. Forward-deployed ships can affect events in their region by conducting maritime intercept operations, protecting other ships in the region, and influencing events ashore. A surface combatant ship can influence events ashore by striking land targets with Tomahawk missiles, providing naval surface fire support (NSFS) for friendly forces ashore, or providing theater missile defense (TMD) for ports, airfields, other military facilities, or cities. As with ship self-defense, depending on the kind of enemy missiles and potential reaction times involved, providing

anti-ship missile defense for other ships in the region might require the Aegis system. To have a capability for firing more than 8 Tomahawks without reloading, a surface combatant would likely need VLS.[44] VLS might also be important in the future for improving the ability of U.S. surface combatants to provide NSFS.[45] And to provide TMD, a surface combatant would require the Aegis system and VLS.[46]

In summary, for maintaining a physical presence in a higher-threat area, the Aegis system might be necessary for adequate defense against anti-ship cruise missiles, while to have a deterrent effect, the Aegis system and VLS are potentially important because they are either helpful or mandatory to demonstrate a capability to protect other ships or influence events ashore.

For major regional contingencies

The Navy's position is that a single major regional contingency (MRC) would require 46 in-theater surface combatants -- 34 DDG-51s and 12 lower-capability ships (specifically, 3 DD-963s, and 9 FFG-7s).[47] An ability to fight

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[44] On U.S. surface combatants, Tomahawks can be fired either by VLS or bolt-on armored box launchers (ABLs). The now-retired Iowa (BB-61) class battleships, in their modernized form, were each equipped with 8 ABLs and could therefore fire 32 Tomahawks before reloading. ABL-equipped cruisers and destroyers, however, were typically equipped with 2 ABLs and could therefore fire 8 Tomahawks before reloading. A VLS-equipped DD-963 class ship can fire as many as 61 before reloading; a DDG-51 can fire up to 90 (96 for Flight IIA ships); a VLS-equipped CG-47 class ship can fire up to 122. It should be noted, however, that unlike ABLs, which can fire only Tomahawks, VLS is designed to fire surface-to-air missiles and anti-submarine rockets as well as Tomahawks. Surface combatants would normally carry a mix of these weapons in their vertical launch systems. The number of Tomahawks on a VLS-equipped surface combatant is thus normally only some fraction of total VLS capacity. The difference in Tomahawk loadouts between ABL- and VLS-equipped ships thus might not be as large as suggested by the difference in potential Tomahawk capacity of ABL- and VLS-equipped ships.

[45] LeSueur, Stephen C. Funding Cuts Restrict Firepower Alternatives. Defense News, Nov. 1-7, 1993: 14; Navy Will Begin to Judge Naval Version of Loral ATACMs. Inside the Navy, Jan. 31, 1194: 7-8; OSD Paid Lincoln Lab to Study ATACMS, Standard Missile Fire Support. Inside the Navy, Mar. 7, 1994: 6-7.

[46] A powerful phased-array radar, such as the Aegis system's SPY-1, is needed to track high-speed ballistic missiles at long ranges. VLS is needed to carry the missile that the Navy intends to use to intercept ballistic missiles -- a modified version of the Navy's Standard surface-to-air missile.

[47] Using only DDG-51s, the Navy's position is that this equates to 41 DDG-51s.

two nearly simultaneous MRCs (the warfighting standard established by the Defense Department's Bottom-Up Review [BUR] of U.S. defense policy) would therefore require 92 in-theater ships -- 68 DDG-51s and 24 lower-capability ships. Accounting for ships transiting to and from the theater, ships in depot maintenance, and ships in training, the Navy calculates that 80 percent of its surface combatants can be in the MRC theaters. Applying this 80 percent availability factor, a total of 115 surface combatants -- 85 DDG-51s and 30 lower-capability ships -- are required for 2 MRCs.

The issue of surface combatant forces required for major regional contingencies can be divided into five questions:

- Is the BUR's 2-MRC strategy excessive?
- Are the MRC scenarios and enemy forces and capabilities overstated?
- Are the roles and missions of U.S. naval forces in MRCs overstated?
- Are the roles and missions of surface combatants (relative to other naval forces) in MRCs overstated?
- Accepting the above, is a force of 124 surface combatants, including about 80 higher-capability ships, appropriate?

The first of these questions deals with the issue of overall U.S. military strategy and is largely beyond the scope of this report.[48] Consequently, the discussion below focuses on the final four questions from the list above.

Are the MRC scenarios and enemy forces and capabilities overstated?

To determine the number of surface combatants needed for a single MRC, the Navy analyzed a Persian Gulf scenario in the year 2002 in which the objective of the adversary (Iran) was to control shipping through contested straits and drive U.S. and Western forces from contested areas.[49] The scenario assumed minimum in-region basing for access and stationing of U.S. and Western forces, and adopted the perspective of a U.S. joint task force

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[48] For a discussion of this issue, see Report on the Bottom-Up Review, op. cit., p. 7-8, 13-15, 19; Defense Policy: Threats, Force Structure, and Budget Issues. CRS Issue Brief 90013, op cit.; Military Preparedness: Principles Compared With U.S. Practices. CRS Report 94-48 S, op. cit; Krepinevich, Andrew F. The Bottom-Up Review: An Assessment. Washington, 1994 (Defense Budget Project, February 1994) p. 21-28.

[49] Source for details on the Navy's Persian Gulf 2002 scenario: Unclassified slides from U.S. Navy briefings to the author entitled Surface Combatant Force Structure Requirements, dated June 6, 1993, and Required Force Structure, undated but received by the author Oct. 25, 1993.

commander who would command Army and Air Force units as well as U.S. naval forces.

The scenario assumed that the adversary at the outset of the conflict would:

- have some number of theater ballistic missiles
- could pose an anti-ship cruise missile (ASCM) threat throughout most of the theater
- could mount attacks of 2 to 4 aircraft throughout the theater, using aircraft such as the Russian-made Su-24, Su-25, Su-27, and MiG-29
- could mount attacks of 1 Russian-made Kilo-class non-nuclear-powered submarine throughout the theater
- have fast patrol boats, including some armed with missiles

The initial ASCM threat was characterized as forcing a ship to defend against as many as 4 ASCMs in a 20-second period. The ASCMs would feature high-technology seekers and low observable/very low observable (i.e., stealth) technology, and include both high-flying missiles such as Russian-made AS-11s and AS-17As, and low-flying or sea-skimming missiles such as the French-made Exocet and the Russian-made Styx and SS-N-22.

The Navy's Persian Gulf MRC scenario, which focuses on potential aggression by Iran, involves a greater enemy-held coastline and adjoining sea area than the Persian Gulf scenario highlighted in the BUR, which focuses on potential aggression by Iraq.[50] The Navy's Iran-focused version, however, is not necessarily more or less plausible than the Iraq-focused version.[51]

Iran's forces in 2002 as assumed in the Navy's analysis are fairly consistent with the BUR's description of the enemy's forces in a major regional contingency, which stipulates that the enemy's forces will include, among other things, 100 to 1,000 Scud-class theater ballistic missiles, 500 to 1,000 combat aircraft, and 100 to 200 naval vessels (primarily patrol craft armed with surface-

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[50] The report on the Bottom-Up Review states: "While a number of scenarios were examined, the two that we focused on most closely in the Bottom-Up Review envisioned aggression by a remilitarized Iraq against Kuwait and Saudi Arabia, and by North Korea against the Republic of Korea." Report on the Bottom-Up Review, op. cit., p. 14.

[51] For a discussion of Iran's current military buildup and potential Iranian threats to U.S. and Western interests, see U.S. Library of Congress. Congressional Research Service. Iran: Current Developments and U.S. Policy. CRS Issue Brief 93033, by Kenneth Katzman. Washington, 1994 (updated regularly) 16 p.

to-surface missiles, and up to 50 submarines). Iran's forces in 2002 as assumed in the Navy's analysis also represent a plausible extension of current Iranian forces and capabilities[52] and Iran's recent efforts to acquire new weapons.

In assessing the Navy's MRC scenarios and its description of enemy forces and capabilities, two issues can be considered. One concerns the rate of proliferation of ballistic missiles, ASCMs, modern combat aircraft, and modern submarines between now and 2002 to potential regional aggressors. Depending on one's assessment of this issue, the Persian Gulf MRC could be either less demanding, more demanding, or about as demanding on U.S. forces as the Navy estimates.

The other issue concerns the second MRC, which focuses on North Korea. The North Korean MRC, like the Navy's Iranian-oriented Persian Gulf MRC, features an extensive coast and adjoining sea area. But the quantity and quality of North Korea's weaponry relative to Iran's in 2002 is unclear. The two theaters also differ in terms of terrain and other factors. Depending on one's assessment of these factors, the demands placed on U.S. forces by the Korean MRC could be either higher, lower, or about the same as the demands placed on them by the Persian Gulf MRC.[53] Thus, it is not clear whether the U.S. surface combatant force required for two MRCs should be twice the Navy's estimated force required for the Persian Gulf MRC -- the Navy's calculation -- or some higher or lower figure.[54]

Are the roles and missions of U.S. naval forces in MRCs overstated?

As articulated by the Navy, the roles and missions of the Navy in MRCs will focus on the "enabling" function that naval forces can play in the early

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[52] For an unclassified summary of Iran's current military forces, see International Institute for Strategic Studies. The Military Balance 1993-1994. London, Brassey's (UK) Ltd., 1993. p. 115-116.

[53] For a discussion of the current Korean military balance, see U.S. Library of Congress. Congressional Research Service. Korean Crisis, 1994: Military Geography, Military Balance, Military Options. CRS Report 94-311 S, by John M. Collins. Washington, 1994. (April 11, 1994) 21 p. For an additional discussion of the Bottom-Up Review's MRC scenarios, see The Bottom-Up Review: An Assessment, op. cit., p. 25-28, 41-44, 49-54.

[54] The report on the Bottom-Up Review states that "For the bulk of our ground, naval and air forces, fielding forces sufficient to [fight and win two MRCS that occur nearly simultaneously] involves duplicating" the forces required for a generic MRC building block. It also states, however, that certain "specialized high-leverage units or unique assets might be 'dual-tasked,' that is, used in both MRCs." Advanced aircraft such as B-2s, F-117s, JSTARS, and EF-111s are listed as examples, and the number of Marine Corps brigades required for two MRCs is the same as the number required for one MRC. Report on the Bottom-Up Review, op. cit., p. 19, 30.

stages of a conflict. The Department of the Navy's new white paper for the post-Cold War era, . . . *From the Sea*, states that

> The Navy and Marine Corps will now respond to crises and can provide the initial, "enabling" capability for joint operations in conflict -- as well as continued participation in any sustained conflict. . . . Focusing on the littoral area, the Navy and Marine Corps can seize and defend an adversary's port, naval base or coastal air base to allow the entry of heavy Army or Air Force forces. The success of modern U.S. military strategy depends on forces organized, trained, and equipped for this division of combat labor. . . . The Navy and Marine Corps team supports the decisive sea-air-land battle by providing the sea-based support to enable the application of the complete range of U.S. combat power.[55]

The enabling role of U.S. naval forces in the early stages of an MRC is reiterated in this year's Department of the Navy posture statement:

> We have participated closely in dialogue within the Department of Defense and have come to understand the critical contributions the Navy and Marine Corps make to the two MRC scenario. In particular, it is clearly recognized the Navy and Marine Corps provide a special capability for enabling the insertion of heavier forces when a region is threatened. The high-technology weapons we are developing for the future will allow us to establish air defense, conduct maneuver from the sea with our Navy-Marine Corps team, and provide cover during insertion of the Army and Air Force at a time and place of our choosing. Our ability to insert naval forces and enable our sister services, the heavy land and air forces, to be put in place is of extreme importance in addressing two MRCs.[56]

The enabling function of naval forces in the early stages of an MRC is not discussed explicitly in the Defense Department's report on the Bottom-Up Review (BUR) of U.S. defense policy, but the function appears to be broadly consistent with various passages from the BUR report. The BUR report places a high priority on the opening phase of U.S. combat operations in a MRC, which focuses on halting a regional aggressor's invasion of its neighbor so as to "minimize the territory and critical facilities that an invader can capture." It

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[55] U.S. Department of the Navy. . . . From the Sea: Preparing the Naval Service for the 21st Century. Washington, 1993. p. 3, 5, 8-9.

[56] U.S. Department of the Navy. Department of the Navy 1994 Posture Statement: "Revolutionizing Our Naval Forces." Washington, 1994. (A Report by The Honorable John H. Dalton, Secretary of the Navy, Admiral Frank B. Kelso, II, United States Navy, Chief of Naval Operations, and General Carl E. Mundy, Jr., United States Marine Corps, Commandant of the Marine Corps, on the Posture and Fiscal Year 1995 Budget of The United States Navy and The United States Marine Corps) p. 2. For an additional discussion of the Navy's role in enabling operations, see Owens, William A. Living Jointness. Joint Force Quarterly, Winter 1993-1994: 7-14.

also states that the next phase of U.S. combat operations would focus on building up U.S. combat power in the theater while reducing the enemy's. Among the forces important during these first two phases, the report states, will be sea-based aircraft, sea-based surface-to-air missiles, and cruise missiles. Naval forces will also be used to establish maritime superiority, "in order to ensure access to ports and sea lines of communication, and as a precondition for amphibious assaults."[57]

The BUR report notes the Navy's "plans to develop the capability to fly additional squadrons of F/A-18s to forward-deployed aircraft carriers that would be the first to arrive in response to a regional contingency. These additional aircraft would increase the striking power of the carriers during the critical early stages of a conflict."[58] At another point, the report states: "As with ground force operations, theater air operations require a careful sequencing of forces in the early stages of conflict. If control of airspace is contested, air superiority must first be established. When airspace is contested in maritime areas or when air bases ashore are not available, Marine and Navy fighter aircraft play a crucial role. In certain circumstances, Marine and Navy air elements, along with long-range bombers, will be the only sources of theater air power available."[59] The report states that "In some circumstances, a naval TMD capability could be in place in the vicinity of a regional conflict, providing protection for land-based targets before hostilities break out or before land-based defenses can be transported to the theater."[60]

The BUR report also notes that sea-based aircraft, sea-based fire support, and amphibious forces will contribute to the combat forces that would be involved in the third phase of operations -- the U.S. and allied counteroffensive.[61]

In assessing the roles and missions of U.S. naval forces in MRCs, one issue that might be considered is the extent to which U.S. forces, including naval forces, will actually be needed to conduct early defense and enabling operations in the opening stages of the conflict. This can be affected by assessments of several factors, including the invaded country's capacity for self-defense, the amount of in-region land-based U.S. forces, the amount of warning time prior to the start of the conflict, and the likelihood that friendly ports and airfields will be overrun before the invasion is halted.

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[57] Report on the Bottom-Up Review, op. cit., p. 15-17.

[58] Ibid, p. 21.

[59] Ibid, p. 87.

[60] Ibid., p. 45.

[61] Ibid, p. 17.

Assessments of these factors might take into account the lessons that potential regional aggressors might have learned from the Gulf War. Operation Desert Shield -- the buildup of U.S. and coalition forces south of Iraq and Kuwait -- was made considerably easier by the fact that Iraq did not seize or destroy any major ports or airfields in northeast Saudi Arabia and did not launch a major attack on coalition forces during the five-month buildup period. Potential future regional aggressors may view these Iraqi decisions as mistakes to be avoided. In the scenarios used in the BUR,

> U.S. forces, most of which were not presumed to be present in the region when hostilities commenced, had to deploy to the region quickly, supplement indigenous forces, halt the invasion, and defeat the aggressor. Such a "short notice" scenario, in which only a modest number of U.S. forces are in region at the outset of hostilities, is both highly stressing and plausible. . . . In such cases, it may also not be possible, prior to an attack, to reach a political consensus on the proper U.S. response or to convince our allies to grant U.S. forces access to facilities in their countries.[62]

If the BUR scenario proves accurate in these respects, there may well be a need for U.S. forces, including naval forces, to conduct significant early defense and enabling operations.

Another issue that may be considered in assessing the roles and missions of U.S. naval forces in the early stages of a MRC is the contribution that can be made in the early stages of a MRC by other U.S. forces capable of influencing events prior to an in-region build-up of U.S. combat power. These would include Air Force long-range bombers and U.S. special operations forces.

In assessing the roles and missions of U.S. naval forces in the latter stages of the MRC, an issue that may be considered is the value of sea-based forces as an adjunct to land-based forces, which by the latter stages of the conflict are to be built up to significant strength. There is often an inefficiency applying military force from a position at sea due to the capital costs of the Navy's ships and the size, weight and other constraints imposed on ship-based equipment. But the mobility of the Navy's ships can be useful in complicating the enemy's military planning. Depending on the theater's geography, the enemy might have to defend against attacks involving sea-based aircraft and missiles launched from numerous positions, or against an amphibious assault at any one of several potential landing areas. For example, in the Persian Gulf War, which featured a relatively limited enemy-held coastline, Iraqi military leaders were said to have tied down 7 of their divisions, including about 2,000 tanks and artillery pieces, to defend against the threat of an amphibious landing by an afloat force of about 17,000 Marines.[63]

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[62] Ibid, p. 15.

[63] U.S. Library of Congress. Congressional Research Service. Persian Gulf War: Defense-Policy Implications for Congress. CRS Report 91-421 F, coordinated by Ronald O'Rourke. Washington, 1991. (May 15, 1991) p. 41.

For all the stages of a MRC, a final issue that might be considered in assessing the roles and missions of U.S. naval forces is the contribution of naval forces from allied or friendly countries other than the one being invaded. As discussed in a previous CRS report, allied and friendly navies may have small aircraft carriers with vertical/short take off and landing (V/STOL) aircraft, lower-capability surface combatants, patrol craft, mine countermeasures ships, and non-nuclear-powered attack submarines, but for the most part lack large-deck carriers capable of operating conventional take-off and landing aircraft, higher-capability surface combatants, land-attack cruise missiles like the Tomahawk, amphibious assault forces, and nuclear-powered attack submarines.[64]

The BUR report states: "We also expect that the United States will often be fighting as the leader of a coalition, with allies providing some support and combat forces. . . . However, our forces must be sized and structured to preserve the flexibility and the capability to act unilaterally, should we choose to do so."[65] The Navy's calculation that 46 surface combatants would be required for a single MRC assumes that maritime intercept (i.e., sanctions enforcement) operations conducted during a MRC are assigned to allied forces.

Are the roles and missions of surface combatants (relative to other naval forces) in MRCs overstated?

Assuming that maritime intercept operations in the Navy's calculation are to be assigned to allied naval forces, roles and missions of U.S. Navy surface combatants in MRCs would include close-in surveillance of enemy forces and coastal areas, theater missile defense of friendly ports and coastal areas in the early stages of a conflict, defense of other Navy ships (e.g., aircraft carriers, amphibious ships, mine warfare ships, and auxiliaries), Tomahawk missile strikes against land targets, and naval surface fire support for amphibious operations and support of friendly ground forces ashore.

One issue that might be considered in assessing the role of surface combatants relative to other U.S. naval forces in a MRC is the extent to which surface combatants will be needed to provide theater missile defense for ports and coastal areas. This can be influenced by assessments of how long it would take to establish a land-based (i.e., Army) theater missile defense capability in the MRC theater. The Navy's calculation that 46 surface combatants would be required for a single MRC assumes that the Navy's theater missile defense

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See also U.S. Department of Defense. Conduct of the Persian Gulf War: Final Report to Congress. Washington, 1992. (Pursuant to Title V of The Persian Gulf Conflict Supplemental Authorization and Personnel Benefits Act of 1991 [Public Law 102-25], April 1992) p. 249, 294, 306, 307.

[64] Naval Forward Deployments and the Size of the Navy, op. cit., p. 54-55.

[65] Report on the Bottom-Up Review, op. cit., p. 15.

responsibilities in the theater would be transferred to the Army at the start of the counteroffensive stage of operations.

Another issue that might be considered is the extent to which other Navy ships will need the air-defense services provided by surface combatants. This can be influenced by carrier-based aircraft, which can suppress or diminish the threat posed by enemy aircraft and shore-based missiles, and by the effectiveness of point-defense AAW systems on the carriers, amphibious ships, and some of the auxiliaries.

A third issue that might be considered is the cost-effectiveness of surface combatant Tomahawk strikes relative to attack submarine Tomahawk strikes and strikes by carrier-based aircraft. Attack submarines can launch Tomahawks from surprise locations at sea, but at present generally cannot carry as many Tomahawks as a VLS-equipped surface combatant. The relative merits of cruise missiles vs. carrier-based aircraft is a long-standing issue with many considerations.[66]

Accepting the above, is a force of 124 surface combatants, including about 80 higher-capability ships, appropriate?

If one accepts that the 2-MRC strategy is appropriate, and that the MRC scenarios, enemy forces and capabilities, and the roles and missions of U.S. naval forces and surface combatants are accurately set forth, is the Navy's planned surface combatant force appropriate?

One approach to answering this question would be to employ war games and computer models to test the effectiveness in a MRC scenario of surface combatant forces of various sizes and compositions. Such an approach, however, can require access to both classified information on U.S., allied, and potential enemy military capabilities (for example, the numbers, operational status, and performance characteristics of various weapon systems) and sophisticated wargaming models.

Even then, the results of such analyses can be sensitive to changes in assumptions. For example, although the Navy currently calculates that a single MRC would require 46 surface combatants, including 34 higher-capability ships, an earlier Navy calculation using generally the same analytical approach but with some different assumptions calculated that a single MRC would require 82 to 87 surface combatants, including 29 to 57 higher-capability ships.

Another approach to addressing this question would be to use the Persian Gulf War as a recent, real-world case study for examining the numbers and types of U.S. surface combatants employed in a MRC. As a case study, the Gulf War had some characteristics that would tend to limit the need for naval forces: Iraq's naval forces were limited; the Iraqi-held coastline was relatively short;

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[66] For a short discussion of this issue, see Persian Gulf War: Defense-Policy Implications for Congress, op. cit., p. 27-29.

Iraq did not overrun and occupy key ports and airfields in northeast Saudi Arabia as part of its initial offensive; Iraq permitted U.S. and coalition forces to build up in the theater for a period of five months; and allied countries contributed naval forces, including surface combatants.

At the same time, the Gulf War also had some characteristics that would tend to promote the need for naval forces: Saudi Arabia and the other Gulf Arab states had limited naval forces and limited forces for defending the ports and airfields in northeast Saudi Arabia against a follow-on Iraqi offensive; naval forces were deployed to three different sea areas (the Gulf, the Red Sea, and the Eastern Mediterranean); limited U.S. land-based forces were available in the region, making a buildup of land-based military forces necessary; and there was a potential U.S. amphibious threat, and thus a need for surface combatants to escort amphibious ships and possibly provide naval surface fire support. In addition, the Iranian flank in the Gulf, which was a potential cause of concern for U.S. and coalition forces, ran along one side of the Gulf, the strait of Hormuz, and the approaches to the strait.

With the exception of theater missile defense, a capability for which is still under development for the Navy, U.S. surface combatants in the Gulf War performed generally the same roles and missions that the Navy envisions them performing in a future MRC, including maritime surveillance and intercept, defense of other Navy ships, Tomahawk missile strikes against land targets, and naval surface fire support. Of the 288 Tomahawks launched in the war, 276 were fired from surface combatants:[67] 52 were fired from the two battle ships, 105 from seven Aegis/VLS ships (i.e., CG-52 and higher), 7 from two CGN-38 class ships equipped with armored box launchers, and 112 from five VLS-equipped DD-963s.[68]

The table below shows the numbers and classes of U.S. surface combatants that were in theater during Operation Desert Storm, the number that were in service just prior to the start of the operation, and whether these ships were equipped with the Aegis system, VLS, or both. As can be seen in the table, a total of 36 to 39 surface combatants were in theater during the operation.

As can also be seen in the table, deployments of surface combatants in Desert Storm reflected a marked preference for using ships equipped with both Aegis and VLS, and a lesser but still evident preference for ships equipped with one of these systems but not the other: Of the 11 Aegis/VLS ships (i.e., CG-52 and higher) then in service, 6 or 7, or 55 percent to 64 percent, were in

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[67] The other 12 were fired from two U.S. attack submarines.

[68] These figures are taken from Polmar, Norman. Ships and Aircraft of the U.S. Fleet, Fifteenth Edition. Annapolis, Naval Institute Press, 1993. p. 100-101, 106, 109, 137.

TABLE 8. U.S. SURFACE COMBATANTS IN DESERT STORM
(January 15 to February 28, 1991)

Class	Aegis	VLS	No. in theater	No. in service	% in theater
BB-61			2	3	67%
CG 47-51	X		2	5	40%
CG 52+	X	X	6 or 7	11	55%-64%
other CGN/CG/DDG			9	48	19%
DD-963 VLS		X	3 or 4	11	27%-36%
DD-963 non-VLS			4	20	20%
FFG-7			7	51	14%
FF-1052			3 or 4	46	8%
TOTAL			36-39	195	18%-20%

Source for number of ships in theater: U.S. Department of the Navy. The United States Navy in "Desert Shield" [and] "Desert Storm." Washington, 1991. (Office of the Chief of Naval Operations, 15 May 1991) Appendix B. Number of ships in theater reflects figures for January 15, January 31, February 15, and February 28, 1991. Source for number of ships in service: U.S. Department of the Navy. Program Information Center. Listing of U.S. Naval Ship Battle Forces as of 31 December 1990. Washington, 1990. 44 p.

theater.[69] Of the 5 Aegis ships (i.e., CG 47-51) then in service, 2, or 40 percent, were in theater. And of the 11 VLS ships (i.e., DD-963s which by then had been backfitted with VLS), 3 or 4, or 27 percent to 36 percent, were in theater.[70] In contrast, with the exception of the Iowa (BB-61) class

[69] The percentage in reality might be a bit higher: of the 11 ships in this group, one ship, commissioned on June 16, 1990, had been in service for less than a year at the time of Desert Storm and may not have been ready for an overseas deployment.

[70] The percentage in reality might be somewhat higher: of the 11 ships in this group, one or more may have only recently been backfitted with VLS and might therefore have not been ready for an overseas deployment.

battleships,[71] ships equipped with neither Aegis nor VLS were deployed at rates equal to or below the overall figure of 18 percent to 20 percent.

As a case study for whether a future MRC would require 46 surface combatants, including 34 high-capability ships, Desert Storm has value but is inconclusive. The total number of surface combatants used in Desert Storm suggests that the figure of 46 ships is within the range of plausibility, particularly when one includes theater missile defense as a new, additional role for surface combatants in future MRCs, but the characteristics of Desert Storm also suggest that a future MRC could require either more than or less than 46 ships. The relative preference for using ships equipped with Aegis or VLS, and particularly ships equipped with both, suggests that higher-capability ships are preferable to lower-capability ships in a MRC, but does not necessarily validate the 34 to 12 (2.8:1) ratio of higher- to lower-capability ships in the Navy's calculation.

In summary, the Navy's requirement for a force of 124 surface combatants, including about 80 higher-capability ships by about 2005, has an analytical basis and is not *a priori* unreasonable; it also cannot be conclusively demonstrated or refuted on military grounds. The force-level goal can vary with policy objectives, subjective judgments, and analytical assumptions. Changes in these factors can produce force-level goals either higher or lower than the Navy's force-level goal.

INDUSTRIAL-BASE FACTORS

Is a procurement rate of 3 DDG-51s per year and a total of 28 additional DDG-51s needed for industrial-base reasons? The discussion below focuses on three elements of the DDG-51 industrial base: the private shipyards (Bath Iron Works [BIW] and Ingalls) that build the ships and also participate (along with the government-owned naval shipyards) in overhauling, repairing, and modernizing them; the suppliers that manufacture systems and components installed in the ships or provide materials to the shipyards; and the engineers in private industry and the Navy that are involved in designing the ships and supporting them over their life cycle.

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[71] The exception of the battleships might be explained by three of their characteristics: They carried 32 Tomahawks each in armored box launchers; they were armed with 16-inch guns capable of providing wide-area naval surface fire support (nothing greater than 5-inch guns are available elsewhere in the Navy); and they have very thick armor (not present in more recently built surface combatants) that provided substantial protection from cruise missile impacts.

Shipyards

Should There Be 2 Shipyards or 1?

In addressing the shipyard element of the industrial-base issue, a basic policy question is whether DDG-51 production should be maintained at two yards or consolidated at one of the yards. The Navy's preference is to continue producing DDG-51s at two yards. In addressing this issue, several factors may be considered.

Competition. One factor is the potential benefit of having two yards compete for DDG-51 shipbuilding contracts. In theory, the pressures of competition can bring about lower prices, higher production quality, and greater production innovation. Reducing DDG-51 production to one U.S. shipyard (and barring foreign purchase options) would eliminate the potential for using competition to generate these benefits. On the other hand, with a planned procurement rate of only 3 ships per year or less -- a rate that would probably have to be split roughly fifty-fifty between the two yards over the long run -- the ability of the government to obtain the benefits possible from competition may be limited.

Adequacy of Production Capacity. A second factor is whether consolidating production at one yard would preserve adequate production capacity for steady state production or emergency surge production. Either yard would be adequate by itself to sustain a production rate of up to 3 ships per year. Ingalls could handle a higher rate if needed for surge production. DDG-51s could also be produced by Newport News Shipbuilding (NNS) of Newport News, VA, which currently builds nuclear-powered aircraft carriers and nuclear-powered submarines, and built the CGN-38 and CGN-36 class ships in the 1970s. But NNS has not built any Aegis ships (or any other surface combatants since the CGNs), and time would be needed to start up a DDG-51 production effort at this yard.

Overhead/Efficiency. A third factor is overhead costs and the efficiency of keeping two yards or one yard in production. Splitting 3 or fewer ships per year between BIW and Ingalls will mean that the yards will likely be working well below capacity, even when other types of work at these yards are taken into account. Whether the resulting per-ship overhead costs of a two-yard production strategy are high enough to outweigh the downward price benefit of maintaining a competition between two yards is an issue that might be examined.

Shutdown/Termination Costs. If a decision is made to consolidate production at one yard, costs will be incurred in shutting down the DDG-51 production line at the other yard, and in completing and terminating DDG 51-related work at that yard. The cost to complete DDG-51s currently under production at the eliminated yard could increase. If the shutdown of the DDG-51 production line compels that shipyard to go out of business entirely, these shutdown/termination costs could increase.

Local/State Impact. A final factor to consider is the local and state economic and social impact that would result from a decision to consolidate production at one yard, particularly if that decision compels the eliminated yard to go out of business entirely. BIW and Ingalls are each major employers in their home states. On the other hand, sustaining both of these yards at low rates of production could have the effect, due to reduced production efficiencies, of reducing the amount of funding available for other defense production programs, which could contribute to adverse economic and social impacts in other states and localities.

What Procurement Rate Is Needed for 2 Yards or 1?

A study of the DDG-51 industrial base by the Navy's Aegis program manager that contains business sensitive information[72] suggests that with some amount of additional, non-DDG 51 work, a procurement rate of 3 ships per year would be sufficient to maintain 2 shipyards. The study suggests that for sustaining 2 yards, 3 DDG-51s per year is a relatively low rate that provides the Navy with limited flexibility in the awarding of DDG-51 construction contracts.

The study also suggests, however, that 3 ships per year is not necessarily a rock-bottom rate for sustaining 2 yards. The study suggests that a procurement rate of 2.5 ships per year could sustain 2 yards if the two yards receive a fairly substantial level of additional, non-DDG 51 work. Even then, however, the risk to the survival of the yards may be greater than at a rate of 3 ships per year, and the Navy would have little or no flexibility in awarding DDG-51 construction contracts.

The Navy study suggests that a procurement rate of 2 ships per year could sustain 2 shipyards if the yards received a very substantial amount of non-DDG 51 work, but that the risk to the survival of one or both of the yards could be fairly high. One yard might go out of business, forcing consolidation of DDG-51 construction at the other yard.

The study suggests that a procurement rate of 1.5 ships or 1 ship per year could sustain a single shipyard if the yard receive some amount (possibly a fairly substantial amount) of additional, non-DDG-51 work. At a rate of 1 ship per year, the risk to the survival of the shipyard might still be fairly high.

There are several possibilities for additional, non-DDG 51 work at BIW and Ingalls, but the prospects for some appear uncertain, while pursuing others might require explicit policy decisions that take work away from other private or public shipyards. The possibilities include:

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[72] U.S. Department of the Navy. Arleigh Burke (DDG 51) Class Industrial Base Study. Washington, 1993. (7 Sep[tember] 1993) Approx. 187 p. The cover letter accompanying the report states: "Much of the information in this study is proprietary and should be treated as 'business sensitive.'" Consequently, this report does not quote from the Navy study or discuss its details.

- construction of LHD-7 (i.e., a seventh Wasp [LHD-1] class amphibious assault ship)
- construction of LPD-17 (formerly LX) class amphibious dock landing ships
- construction of military sealift ships
- construction of warships for export to foreign countries
- construction of commercial cargo ships
- routine overhaul and repair of existing surface combatants, including Aegis ships
- upgrading or extending the service lives of existing surface combatants

Since Ingalls has built all six previous LHD-1 class ships, LHD-7, if funded, would almost certainly be awarded to Ingalls. The Administration's FY1995-FY1999 shipbuilding plan contains advanced procurement funding (i.e., a small down payment) for LHD-7 in FY1999; under this plan the bulk of the ship's cost would apparently be funded in FY2000 or FY2001. Some in Congress, including members of the House and Senate defense appropriations subcommittees, support procuring LHD-7 in FY1995, in large part because procuring it in some later year would cause a break in the LHD production line that would significantly increase the cost of LHD-7.[73]

Procurement of LPD-17 class ships is scheduled to begin in FY1996; a total procurement of 12 ships is planned. Awarding some or all of the LPD-17s to one or both of the DDG-51 yards might require an explicit policy decision not to give this work to other yards, notably Avondale Industries of New Orleans, which has been a primary builder of amphibious ships for the Navy in recent years.[74]

As a result of the Mobility Requirements Study, the Navy is currently acquiring 19 new military sealift ships. Five of these will be conversions of existing commercial cargo ships; the other 14 will be new-construction ships.

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[73] The conference report on the FY1994 defense appropriations bill (H.Rept. 103-339) includes $50 million in FY1994 advanced procurement funding for LHD-7 and states: "The conferees expect that the Defense Department will fund the balance of the ship in fiscal year 1995 prior to obligating the advance procurement funds." (page 95)

[74] Avondale built the final 5 ships in the recently completed 8-ship Whidbey Island (LSD-41) class dock landing ship program, and is the builder of all 4 ships in the follow-on Harpers Ferry (LSD-49) class dock landing ship program. (The first 3 LSD-41 class ships were built by Lockheed Shipbuilding of Seattle, which no longer builds Navy ships.)

A contract for three conversions was recently awarded to National Steel and Shipbuilding Company [NASSCO] of San Diego; a contract for the remaining two conversions was recently awarded to NNS. Two contracts for a total of up to 12 new-construction ships were recently awarded to Avondale and NASSCO (each contract is for one new-construction ship with a follow-on option for up to five more ships). Thus, unless the sealift ship acquisition program is increased beyond 19 ships or the Navy chooses not to exercise its follow-on options with Avondale and NASSCO, only the two new-construction ships that have not yet been awarded can potentially go to Ingalls or BIW.

With regard to building warships for export, Ingalls is currently building corvettes (small frigates) for Israel, and Ingalls and BIW are competing against NNS and several foreign warship builders for contracts to build a new class of frigates for the Turkish Navy. Ingalls recently won approval from the Navy to build non-nuclear-powered attack submarines for foreign export; possible customers include Egypt and Taiwan.[75] There may be other export possibilities in addition to these programs, but the size and stability of the warship export market is uncertain.

Several privately owned U.S. shipyards are currently attempting to break into the world market for construction of commercial cargo ships. This highly competitive market has been dominated by foreign shipyards for years, and it is not clear how much work of this kind BIW or Ingalls might be able to win.

Awarding routine surface combatant overhaul and repair work to the DDG-51 construction yards might require an explicit policy decision not to give this work to one or more of the government-owned naval shipyards, which traditionally have received the majority of the Navy's ship overhaul and repair work. The allocation of overhaul and repair work between the naval shipyards and privately owned U.S. shipyards has been a contentious issue in Congress over the last several years.

Supplier Base and Engineering Base

The Navy study suggests that the DDG-51 supplier base and engineering base can be preserved at procurement rates of 2.5 or 2 ships per year, but not without loss of suppliers; disruption, inefficiency and major restructuring of operations at supplier firms; revised acquisition strategies (including life-cycle buyouts of certain components, which could require special procurement authority); and loss of engineering staff. Loss of suppliers can complicate not only construction of DDG-51s, but future repair and overhaul of DDG-51s as well. Future difficulty in obtaining parts for overhaul and repair work could potentially shorten the useful life of DDG-51s. The lower the procurement rate, the greater the degree of supplier loss, disruption, and engineer loss. At rates of 1.5 ships or 1 ship per year, the study suggests that problems with loss of key

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[75] Ingalls Gets Approval to Build Diesel Subs for Export. Associated Press wire story, Apr. 7, 1994.

suppliers and engineers could create substantial difficulties in continuing the DDG-51 program.

Summary

The table below summarizes the potential of various procurement rates to maintain 2 shipyards, 1 shipyard, and the DDG-51 supplier and engineering bases. Maintaining these elements of the DDG-51 industrial base is not required, but if they go out of business, it may become difficult to overhaul, repair, and modernize existing CG-47s and DDG-51s. In addition, it may take considerable time and money to reestablish these elements of the base at some point in the future, should that be necessary to support future procurement of DDG-51s or other surface combatants.

TABLE 9. PROCUREMENT RATE AND INDUSTRIAL BASE

<table>
<tr><td rowspan="2">Policy objective</td><td colspan="7">Procurement rate: number of ships per year</td></tr>
<tr><td>3</td><td>2.5</td><td>2</td><td>1.5</td><td>1</td><td>0.5</td><td>0</td></tr>
<tr><td>Maintain 2 DDG-51 shipyards</td><td>Yes[a]</td><td>Yes, with some risk[b]</td><td>Possible, but high risk[c]</td><td colspan="4">No</td></tr>
<tr><td>Maintain 1 DDG-51 shipyard</td><td colspan="3">Yes[d]</td><td colspan="2">Yes, with some risk[e]</td><td>No</td></tr>
<tr><td>Maintain supplier/ engineering base</td><td>Yes</td><td colspan="2">Yes, but supplier loss, disruption, restructuring</td><td colspan="2">Difficult or problematic due to loss of key suppliers, engineers</td><td>No</td></tr>
</table>

a Would require some additional, non-DDG 51 work.

b Would require a fairly substantial amount of additional, non-DDG 51 work.

c Would require a very substantial amount of additional, non-DDG 51 work, and risk to survival of one or both yards could be high.

d Might require some additional, non-DDG 51 work, particularly at 2 ships per year.

e Would require some (possibly a fairly substantial) amount of additional, non-DDG-51 work at 1.5 ships per year. Would require a fairly substantial or very substantial amount of additional, non-DDG 51 work at 1 ship per year, and risk to survival of yard could be high.

BUDGETARY FACTORS

A final set of factors to consider in assessing the various options presented in the previous chapter concern their potential impact on Navy and Defense Department funding requirements. As noted earlier in the report, interest in reducing the DDG-51 procurement rate to something less than 3 ships per year appears motivated primarily by a desire to reduce the defense budget or make additional funding available for other defense programs. Decisions on options for DDG-51 procurement and upgrading and extending the service lives of older ships can thus be influenced by their potential effect on the defense budget.

A full comparison of the budgetary effects the various options presented in the previous chapter is beyond the scope of this paper. Accordingly, this section instead briefly discusses some of the factors that would come into play in such an analysis.

Spendout Rate

One factor to consider is the relatively slow rate at which changes in DDG-51 procurement budget authority would translate into changes in DDG-51 procurement outlays.[76] Major Navy warships take several years to construct; as a result, reductions (or increases) in shipbuilding outlays can lag years behind reductions (or increases) in shipbuilding budget authority. Depending on one's time horizon for affecting defense outlays, the relatively slow spend-out rate for DDG-51 procurement funding might be an important factor to consider.

Changes in Unit Procurement Cost

Another factor would be the effect that changes in the DDG-51 production rate would have on the unit procurement cost of the DDG-51 design. As a general rule, other things held equal, a reduction in the procurement rate would reduce production economies of scale and lead to an increase in unit procurement cost. Consequently, although DDG-51s currently cost about $900 million each in FY1995 dollars, the net savings from each DDG-51 eliminated from the Administration's proposed 3-per-year plan would be less than $900 million in FY1995 dollars, because the cost of the remaining ships in the plan would increase to something more than $900 million in FY1995 dollars.

In addition to the issue of economies of scale, unit procurement cost can be affected by whether DDG-51 production is maintained at two yards or consolidated at one. Maintaining both yards preserves the potential for using competition to discipline prices. Consolidating production at one yard, however, might reduce total shipyard overhead costs for the program.

Unit procurement cost could also be influenced by decisions made on other types of shipyard work, such as the LPD-17 shipbuilding program, overhaul and

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[76] See U.S. Congress. Congressional Budget Office. Reducing the Deficit: Spending and Revenue Options. Washington, 1994. p. 39.

repair work on the growing number of Aegis ships, and upgrading and extending the service lives of older ships. Adding this work to the business base of the DDG-51 production yards can increase their total business base, which in turn can influence shipyard overhead costs apportioned to each DDG-51.

Upgrade and Service-Life-Extension Costs

Lastly, the budgetary effect of upgrading and extending the service lives of older ships would have to be taken into account. The direct cost of performing this work would, other things held equal, increase defense funding requirements. On the other hand, as mentioned above, giving some or all of this work to the DDG-51 production yards would increase their total business base and thereby possibly reduce overhead costs apportioned to each DDG-51.

Annual Operating and Support Costs

A full comparison of the budgetary effects of the various options presented in this report would consider total life-cycle costs. This would include not only investment costs (i.e., procurement, upgrade, and service-life-extension costs), but annual operating and support (O&S) costs as well. The relative O&S costs of newer vs. older ships, and of larger, more capable ships vs. smaller, less capable ships, could become an important consideration.

Shutdown and Termination Costs

If a reduction in the DDG-51 procurement rate leads to a consolidation of DDG-51 production at one yard, another factor to consider would be the effect this would have on the cost to complete the partially built ships at the yard being phased out of DDG-51 production. If this yard completes these ships without finding other work to maintain its total business base, total overhead costs on these DDG-51s could increase, which would increase their final construction cost. If the loss of future DDG-51 construction work leads to that yard going out of business entirely, the government might have to pay a variety of shutdown and termination costs associated with closing down operations at that yard. How large these costs might be is difficult to estimate, but they could be on the order of several hundred million dollars.[77]

Restart and Ramp-Up Costs

If the DDG-51 procurement rate is reduced for some time and then subsequently increased, costs might be incurred to ramp-up the production rate. This would particularly be the case if production is consolidated at one yard and then subsequently restarted at a second yard. Substantial costs could be incurred to reestablish and qualify suppliers, hire and train new workers, and modernize shipyard production facilities.

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[77] The Congressional Budget Office estimates the cost of closing down a submarine production shipyard at about $330 million. Ibid., p. 35.

APPENDIX A: NOTIONAL DDG-51 PROCUREMENT PROFILES

As mentioned in the chapter on options for Congress, there are numerous options for procuring 28 or fewer than 28 additional DDG-51s during the period FY1995-FY2004. The notional procurement profiles in the tables below were developed using the following bounding assumptions:

- fewer than 3 ships per year could mean 2.5, 2, 1.5, 1, 0.5, or 0 ships per year
- to minimize production disruptions, the difference in the number of ships procured from one year to the next could not be greater than 2
- for affordability reasons, there could be no more than 5 ships per year (about the rate planned during the Cold War)
- the number of ships procured in FY1998 should be minimized (and should not be more than 3) because the Navy plans to fund the lead ship of a new class of attack submarines in that year
- the number of ships procured in FY2003 should be minimized (and should not be more than 3) because the Navy plans to fund the lead ship of the DD21 class[78] in that year

[78] The DD21 -- the "destroyer for the 21st Century" -- is the proposed successor to the DDG-51 class. See the background chapter, including Table 2 on planned DDG-51/DD21 procurement through FY2005.

TABLE 10. NOTIONAL DDG-51 PROCUREMENT PROFILES FOR PROCURING 28 ADDITIONAL DDG-51s

	95	96	97	98	99	00	01	02	03	04	Total
Baseline	3	3	3	3	3	3	3	3	1	3	28
Procure 28: reduce rate during FYDP, increase thereafter											
2.5/year	3	2	3	2	3	3	3	4	2	3	28
2/year	2	2	2	2	2	4	4	4	2	4	28
1.5/year	2	1	2	1	2	4	4	5	3	4	28
1/year	1	1	1	1	2	4	5	5	3	5	28
0.5/year	0	1	0	1	3	5	5	5	3	5	28
0/year	0	0	0	2	3	5	5	5	3	5	28
Procure 28: increase rate during FYDP, reduce thereafter											
2.5/year	4	4	4	3	3	2	3	2	1	2	28
2/year	4	5	4	3	4	2	2	2	0	2	28
1.5/year	5	5	5	3	4	2	2	1	0	1	28
1/year	5	5	5	3	4	3	1	1	0	1	28
0.5/year	5	5	5	3	5	3	1	0	0	1	28
0/year	5	5	5	3	5	3	2	0	0	0	28

TABLE 11. NOTIONAL DDG-51 PROCUREMENT PROFILES FOR PROCURING FEWER THAN 28 ADDITIONAL DDG-51s

	95	96	97	98	99	00	01	02	03	04	Total
Baseline	3	3	3	3	3	3	3	3	1	3	28
Procure fewer than 28: reduce rate during FYDP, restore thereafter											
2.5/year	3	2	3	2	3	3	3	3	1	3	26
2/year	2	2	2	2	2	3	3	3	1	3	23
1.5/year	2	1	2	1	2	3	3	3	1	3	21
1/year	1	1	1	1	1	3	3	3	1	3	18
0.5/year	1	0	1	0	1	3	3	3	1	3	16
0/year	0	0	0	0	0	2	3	3	1	3	12
Procure fewer than 28: maintain rate during FYDP, reduce thereafter											
2.5/year	3	3	3	3	3	2	3	2	1	2	25
2/year	3	3	3	3	3	2	2	2	0	2	23
1.5/year	3	3	3	3	3	1	2	1	0	1	20
1/year	3	3	3	3	3	1	1	1	0	1	19
0.5/year	3	3	3	3	3	1	0	1	0	1	18
0/year	3	3	3	3	2	0	0	0	0	0	14
Procure fewer than 28: Reduce rate for entire period											
2.5/year	3	2	3	2	3	2	3	2	1	2	23
2/year	2	2	2	2	2	2	2	2	0	2	18
1.5/year	2	1	2	1	2	1	2	1	0	1	13
1/year	1	1	1	1	1	1	1	1	0	1	9
0.5/year	1	0	1	0	1	0	1	0	0	0	4
0/year	0	0	0	0	0	0	0	0	0	0	0