CSBA
www.csbaonline.org
Center for Strategic and Budgetary Assessments
BACKGROUNDER

September 20, 2006

KNOW WHEN TO HOLD 'EM: MODERNIZING THE NAVY'S SURFACE BATTLE LINE

By Robert Work

SUMMARY

The 84 guided missile cruiser and destroyers soon to be in commissioned service in the Navy's surface battle line, all equipped with the superb AEGIS anti-air warfare combat system and the flexible vertical launch (missile) system (VLS), will represent perhaps the most powerful surface battle line in naval history. They will also form the foundation for the Navy's transformation plans, and serve as a hedge against problems in the new DDG-1000 and CG(X) programs, or against unexpected shortfalls in future shipbuilding accounts. However, keeping the ships in service to the end of their 35-year expected service lives, as is now planned, will present a difficult challenge for the Navy. Modern surface combatants normally remain in active commissioned service for far less time. Getting a full 35 years of ship life out of all of these ships will therefore require a sustained fleet-wide maintenance program; a thorough mid-life upgrade to the ships' hull, machinery, and electrical systems; and a rolling combat systems upgrade to make sure the ships can keep pace with evolving threats. Planning, budgeting, and executing such a balanced AEGIS/VLS Fleet-wide Sustainment Program is a smart strategy that will protect and maximize the $100 billion investment made in these 84 ships, and help to ensure continued US naval superiority for the next two to three decades.

A NEW "300-SHIP NAVY"

On July 22, 2005, Admiral Michael G. Mullen became the 28th Chief of Naval Operations (CNO). Assuming his post in the midst of ongoing deliberations for the 2005 Quadrennial Defense Review (QDR), Admiral Mullen quickly announced that his three top priorities would be to sustain Navy readiness, build a fleet for the future, and develop 21st century leaders.

As part of building the future fleet, Admiral Mullen promised to come up with a firm, fixed battle fleet target and to craft a stable, 30-year shipbuilding program. Late in 2005, he personally journeyed to Capitol Hill to brief the results of his staff's deliberations and his final decisions. During his visit, he announced a new fleet target of 313 ships, including 14 strategic ballistic missile submarines (SSBNs); 11 nuclear-powered aircraft carriers (CVNs); 48 nuclear-powered attack submarines (SSNs); four cruise missile and special operations transport submarines (SSGNs); 143 surface combatants; 43

expeditionary warships and future maritime prepositioning ships; 30 combat logistic force ships; and 20 support vessels.[1]

With the battle fleet then at 283 ships, Admiral Mullen's plan for a 313-ship battle fleet was roundly cheered both inside and outside the Navy. This reaction was quite unlike the one that followed the 1997 QDR. Then, the announcement of a 305-ship fleet caused great consternation among naval proponents and spurred Navy leaders to spend the next eight years trying to garner support for a larger fleet.[2] However, by 2005, resigned to the fact that such support was not likely to be forthcoming, Admiral Mullen's predecessor, Admiral Vern Clark, told Congress that the future fleet would fall somewhere in a range of 260 to 325 ships, depending upon the extent of technology insertion, overseas home-porting of ships, and rotational crewing.[3] After confronting the prospect of the fleet shrinking further to 260 ships, Admiral Mullen's "300-ship Navy" sounded pretty good to Navy officers and Congressional supporters. Indeed, his 313-ship fleet was near the top end of a range of possible future fleet numbers established by Admiral Clark, which provided naval proponents with an important psychological boost.

PAYING FOR THE "300-SHIP NAVY"

Although the 313-ship fleet target was warmly welcomed by naval advocates, Admiral Mullen accompanied its announcement with a clear caution that achieving the target would require the Navy to make some dramatic adjustments. He decreed that the associated shipbuilding plan be built on the assumption of flat future defense budgets and Department of the Navy "top lines," thereby pointedly avoiding any hint that the execution of the

---

[1] Secretary of Defense, "Report to Congress on the Annual Long-Range Plan for the Construction of Naval Vessels for FY 2007," March 23, 2005, submitted in response to Chapter 9, Section 231 of Title 10 of the US Code, and House Appropriations Committee (HAC) Report 109-119., p. 4.

[2] During the 1997 QDR, and with the fleet at 365 ships and falling, the Navy's leadership worked hard to establish a line below which the fleet should not be allowed to cross. They drew the fleet "red line" at 300 ships, and they developed a battle fleet requirement for approximately 305 vessels of all types. However, Navy leaders proved psychologically incapable of accepting such a "small" fleet, and they spent the next eight years trying to expand it. In 1999, in response to calls to increase the size of the battle fleet using small, cheap *Streetfighter* combatants, the commander of the US Sixth Fleet contemptuously dismissed the potential contributions of small combatants and called for a fleet of 460 large warships. That same year, citing a Joint Chiefs of Staff study on future attack submarine requirements, active duty submariners began publicly lobbying for a fleet of 68-72 boats, one considerably larger than the approved target of 50 submarines. In 2000, in a report to Congress outlining its plans to build a 300-ship fleet, the Navy included a section that outlined a 360-ship "reduced risk fleet." Then, soon after the 2001 QDR—which essentially endorsed the 1997 QDR recommended fleet size, reinforced with five additional SSNs—then-Chief of Operations Admiral Vern Clark unveiled plans for a new Global Concept of Operations (CONOPS) Navy. The associated battle fleet consisted of 375 ships of all types. See Congressional Budget Office, *Options for the Navy's Future Fleet* (Washington, DC: Congressional Budget Office, May 2006), pp. 5-8.

[3] Congressional Budget Office, "Resource Implications of the Navy's Interim Report on Shipbuilding," dated April 25, 2005, a report in response to a request by the Honorable Roscoe G. Bartlett, Chairman, Subcommittee on Projection Forces, House Armed Service Committee, pp. 1.

Navy's plan would depend on an increased allocation of DoD resources. In other words, to build a 313-ship fleet, the Navy would need to reallocate money within its own expected budget top line.[4]

The Navy's own analysts had calculated that building the 313-ship Navy would require yearly average shipbuilding budgets of approximately $15.5 billion a year in Fiscal Year (FY) 2007 dollars (counting nuclear refueling costs). Outside agencies, such as the Congressional Budget Office, put the cost much higher, at over $21 billion a year.[5] Even if its lower numbers prove out to be correct, however, the Navy will still need approximately $4.4 billion more per year in average shipbuilding funds than the Congress had appropriated over the previous 20 years.[6] In order to free up that much additional money within its own top line, the Navy would need to:

- ***Limit real increases in personnel costs***. The average yearly costs for active duty personnel have long risen at rates higher than those for the overall Navy budget. To keep the amount of money spent on personnel flat (adjusted only for inflation), Admiral Mullen plans to continue the aggressive reduction in the Navy's overall active duty end strength started by Admiral Clark. In effect, he intends to offset any real increases in personnel costs by reducing the number of people serving on active duty.

- ***Limit real increases in operations and maintenance (O&M) costs.*** Navy operations and maintenance costs have also been steadily increasing as a share of Navy topline. The shipbuilding plan depends on these costs being frozen at current levels, and then rising only enough to keep pace with inflation.

- ***Reduce research and development (R&D) costs and keep them low***. In line with his predecessor's thinking, Admiral Mullen intends to shift money from R&D toward ship production, and to keep future R&D at much lower levels than in the recent past.

- ***Prevent requirement and cost growth in any Navy shipbuilding program.*** To accomplish this, the CNO resuscitated the moribund Ship Characteristics Board to reinstitute a more vigorous scrub of future ship requirements and identify unnecessary requirements in existing programs. He also instituted stringent cost controls.

- ***"Fence" shipbuilding funds.*** The CNO decreed that maintaining stability in the yearly shipbuilding budgets and construction rates would be among his top procurement priorities. While stating that he

---

[4] See for example Captain J.F. McCarthy, USN, "Recapitalizing the Navy's Battle Line," a PowerPoint presentation given to at a Department of the Navy Media Roundtable on June 8, 2006, slide number 16.

[5] Congressional Budget Office, *Options for the Navy's Future Fleet*, pp. 25-26.

[6] McCarthy, USN, "Recapitalizing the Navy's Battle Line," slide number 18.

intends to better balance the Navy's investment portfolio, protecting the shipbuilding fund from cuts implies that should procurement funding be lower than expected, aviation and other programs would be among his first targets for adjustments.

Taken individually, achieving any of these goals would present a stiff challenge, primarily because they each depend to some degree on factors out of the Navy's direct control. As just one example, if the Congress passes a higher pay raise than one requested by an administration, the Navy would be obliged to pay for it, upsetting their carefully calibrated plans to limit real increases in overall personnel costs. As a result, the chance that all of these objectives will or can be met simultaneously is extremely remote.[7] Nevertheless, the CNO deserves great credit for implicitly telling the Navy's rank and file that if they wanted a "300-ship Navy," everyone in the organization would have to work hard to get it.

AN IMPORTANT ASSUMPTION

A key implicit assumption embedded in the Navy's 30-year shipbuilding plans is that over the next three decades most ships now in commission and all those to be procured will serve to the very end of their expected service lives (or ESLs; see Figure 1).

Figure 1: Planned Expected Service Lives[8]

(in years of active service)

Ship Type	ESL
Nuclear-powered Aircraft Carriers (CVNs)	50
Strategic Ballistic Missile Submarines (SSBNs)	42
Cruise Missile and SOF Transport Subs (SSGNs)	42
Nuclear-powered Attack Submarines (SSNs)	33
Cruisers and Destroyers (CGs, DDGs, and DDs)	35
Littoral Combat Ships (LCSs)	25
Amphibious Warships (LHDs/LHARs/LPDs/LSDs)	35
Mine Countermeasure Ships (MCMs)	30
Auxiliary and support ships	35

When building toward a steady-state battle fleet number, the only way to compensate for ships being retired early is to increase the steady-state ship procurement rate. However, as discussed above, expectations for ship

[7] For example, DFI International Corporate Services recently concluded that "pressures will prevent a wide range of acquisition programs from unfolding as the Navy and DoD desire." See DFI International Corporate Services, "Navy Investment Plans: Plans Versus Reality, and Implications for Market Opportunity," a PowerPoint presentation given to the National Defense Industrial Association, April 26, 2006.

[8] Ronald O'Rourke, "Navy Force Structure and Shipbuilding Plans: Backgrounds and Issues for Congress," Congressional Research Service Report RL 32665, dated February 14, 2004, p. 16, Table 3.

procurement funds are already at the very limit of prudent planning. Therefore, the chances of the Navy being able to dramatically increase future ship procurement rates—at least for the ships now planned for construction—are very low. To keep the battle fleet from falling far below its 313-ship requirement, early ship retirements will need to be curtailed.

As just one indicator of the sharp edge on which current Navy plans are poised, the assumption that ships will serve to the very end of their planned service lives will likely make it increasingly difficult to keep fleet O&M funds at current levels—one of the five things the Navy must do to free up money to pay for new ships. On September 30, 1989, just months before the demolition of the Berlin Wall, the battle fleet stood at 592 warships.[9] With the fall of the Soviet Union and the subsequent dismantlement of the Soviet Navy, the US Navy began a gradual fleet demobilization that ended with the establishment of Admiral Mullen's 313-ship target over a decade-and-a-half later. During the demobilization, attack submarines and large surface combatants—the heart of the battle fleet—were retired well before the end of their expected service lives. For example, the *USS Atlanta*, a *Los Angeles*-class SSN was retired after only 18 years of service. The first five *Ticonderoga* guided missile cruisers (CGs) left the fleet after only 18 to 21 years of commissioned service. The oldest of 31 *Spruance*-class destroyers (DDs) served for only 29 years; some were retired after less than 20.[10] As a result, the average ages of the current front-line submarine and large combatant fleets are relatively low. With the post-Cold War fleet demobilization now over, the average age of both these fleets will naturally begin to climb. Since maintaining older ships is more expensive than maintaining newer ships, the upward pressure on fleet-wide O&M spending for these large classes of ships seems likely to build over time.

Complicating matters, the Navy has little recent experience in maintaining very old front-line submarines and battle line combatants. Few submarines built during the Cold War served in the active fleet for more than 30 years; most served between 23-28 years, with some being decommissioned after only 18 years of service. The oldest serving Cold War guided missile cruiser was the *USS Long Beach*, decommissioned after 34 years of active service; most cruisers served less than 30 years, and some were retired as early as 17-18 years. The oldest DDs and guided missile destroyers (DDGs) served 33 years, while most were in commission for 25-30 years. Moreover, these older ships were among the first ships to be decommissioned in the post-Cold War drawdown.[11] As a result, the most current maintenance planning data is based on a period of time when the average submarine and surface warship were retired after only 18-22 years of service. Said another way, the current generation of naval officers has little experience in keeping submarines and

---

[9] See "US Navy Active Ship Force Levels, 1986-1992," at http://www.history.navy.mil/branches/org9-4.htm#1986.

[10] Ship retirement dates were derived from ship data entries in Norman Polmar, *Ships and Aircraft of the US Fleet*, 18th edition (Annapolis, MD: Naval Institute Press, 2005).

[11] From ship data entries in Polmar, *Ships and Aircraft of the US Fleet*, 18th edition.

surface combatants combat ready and effective during the last five years of a long and arduous 33 or 35-year service life.

MAINTAINING THE SURFACE BATTLE LINE

These officers will gain this experience in the coming decades, especially if the Navy intends to maintain the battle fleet at anywhere near its 313-ship requirement. This will be especially true with the fleet's surface battle line, which consists of large guided missile cruisers, guided missile destroyers, and general purpose destroyers. The 88 such warships found in the 313-ship fleet target—19 CGs and 69 DDGs—represent the single largest battle fleet component, amounting to just over 28 percent of the total fleet ship count. The next two closest fleet components are the small combatant fleet, where 55 LCSs contribute 17.6 percent of the total fleet ship requirement, and the attack submarine fleet, where 48 boats contribute 15.3 percent.[12] The Navy's ultimate success in maintaining a 313-ship fleet will thus rest, to a great degree, on its ability to keep 88 major surface combatants in commissioned service.

Even under the best of circumstances, this will not be an easy task.

In 2004/05, in order to free up resources to pay for new ship construction, the Navy decided to decommission the five oldest *Ticonderoga* CGs and the remaining *Spruance* destroyers—all long before the end of their 35-year ESLs. As a result, the surface battle line is currently well below its 88-ship requirement. On September 1, 2006, the battle line consisted of 71 combatants, all equipped with the same AEGIS anti-air warfare combat system and vertical launch (missile) systems: 22 *Ticonderoga*-class CGs, 28 Flight I and II *Arleigh Burke*-class DDGs, and 21 Flight IIA *Arleigh Burke*-class DDGs.[13] However, this shortfall will soon be substantially reduced. There are an additional 13 Flight IIA *Burkes* in various stages of construction; in 2011, when the last of these ships are commissioned, the surface battle line will consist of 84 AEGIS/VLS combatants, just four ships short of the Navy's 88-ship target for major surface warships.[14]

The Navy is in the process of shifting over production to an entirely new generation of major surface combatants. The first two *Elmo R. Zumwalt*-class guided missile destroyers, also known as DDG-1000s, are being requested in the FY 2007 budget in a unique split funding arrangement. These expensive new DDGs represent a major qualitative leap in surface warship capability, with dramatic decreases in ship signatures such as radar cross-section; a new dual-band radar system and integrated undersea warfare suite; an all-new integrated electric power and propulsion system; two new Advanced Gun

---

[12] Secretary of Defense, "Report to Congress on the Annual Long-Range Plan for the Construction of Naval Vessels for FY 2007," p. 4.

[13] Data taken from the "Naval Vessel Register," found at http://www.nvr.navy. mil, on September 1, 2006.

[14] All references to the Navy's future shipbuilding plan are derived from "PB 07 Battle Force Inventory," slide number 20, in McCarthy, USN, "Recapitalizing the Navy's Battle Line."

Systems, each capable of firing ten 6-inch guided projectiles per minute out to ranges of 83 nautical miles; a new, VLS system capable of handling larger diameter missiles than those now in widespread use; advanced damage control features that will allow the ship to "fight while hurt"; and advanced automation technologies that will allow relatively small crews to operate a large, complex warship with a 14,500-ton full load displacement.[15] Seven DDG-1000s are included in the 313-ship fleet; when combined with the 62 legacy *Arleigh Burke* DDGs, they will give the battle fleet its full complement of 69 guided missile destroyers. If all goes as planned, the fleet will reach this mark in 2018, when the final *Zumwalt* DDG is delivered to the fleet.

After the seven DDG-1000s are built, the Navy plans to shift production to an all-new guided missile cruiser, now known simply as CG(X). These plans assume that the still undefined CG(X) combat system will fit on a DDG-1000 hull, leading to production economies of scale and lower unit costs. Nineteen of the powerful new CG(X)s are to replace the 22 *Ticonderoga*-class CGs now in commission. The first of class is to be authorized in FY 2011 and the last in FY 2023; all 19 ships should be in fleet service by 2029. If the Navy maintains all 22 of its remaining *Ticonderoga* CGs to the end of their 35-year design lives, the Navy should never fall below its stated requirement for 19 guided missile cruisers—assuming it begins building the first replacement for the CG(X) in FY 2046, and builds the follow-on ships at a sustained rate of two per year thereafter.

Unfortunately, the same cannot be said for the DDG fleet. Assuming the *Burke* DDGs remain in service for 35 years, the first of the 62 ships will be decommissioned in 2026. However, because the *Burkes* were commissioned at rates of two to five ships per year from FYs 1994 to 2010, they will begin leaving the fleet in relatively big chunks starting in FY 2029. Indeed, the total number of *Burkes* in commission will fall to only 30 ships in FY 2036.

Due to the constraints in projected ship procurement accounts, the replacement for the *Burkes*, now referred to as the DDG(X) in Navy plans, will not enter production until FY 2023. After that, the sustained shipbuilding rate for the new ship is projected to be only two ships per year—not nearly enough to offset the large numbers of *Burkes* scheduled to retire in the late 2020s and 2030s. Assuming the overall requirement for DDGs remains unchanged at 69, and that the DDG(X) production rate remains at two per year, the Navy will fall below its overall requirement for DDGs in FY 2026, and stay below requirement for three-and-a-half decades. The active DDG fleet will fall to a low of 43 ships in FY 2046—26 ships below requirement—before climbing slowly back up to 69 ships in FY 2062.[16] Over the same time period, assuming

---

[15] See Captain C.H. Goddard and Commander C.B. Marks, USN, "DD(X) Navigates Uncharted Waters," *Proceedings*, January 2005; and "DD(X) Media Roundtable," a PowerPoint presentation developed by the Program Executive Office of Ships and the Program Executive Office for Integrated Warfare Systems, dated June 30, 2005.

[16] These are projections based on "PB 07 Battle Force Inventory," slide 20, in McCarthy, USN, "Recapitalizing the Navy's Battle Line," which goes out only through FY 2036/37. Numbers are projections based on ship commissioning dates by fiscal year and expected ship service lives.

all other battle fleet components are maintained at their stated requirement levels, the overall fleet will decline to about 287 ships in FY 2046 before rebounding to 313 ships in FY 2062,

Even though this scenario is played out over a very long time horizon subject to a host of variables—among them changing ship requirements, new ship designs, increased ship production rates, and the like—the Navy's long-range plan for its surface battle line is quite sobering. What would make the scenario even more so is if the *Ticonderogas* and *Arleigh Burkes* are retired before the end of their 35 ESLs. For example, assuming the ships are retired after only 30 years of service, the battle fleet would fall below its requirement for guided missile cruisers in FY 2018, and not recover until FY 2029, bottoming out at nine ships in FY 2023 (ten below the requirement). Similarly, the already serious DDG requirements shortfall would start in FY 2021, five years earlier than now anticipated, and the overall shortfall would be both steeper and deeper than the one already planned, with the DDG fleet bottoming out at 35 ships (34 below requirement) in FY 2040. Of course, any retirements before 30 years of service would only worsen the extent and duration of the DDG shortfall.

The conclusion seems readily apparent: maintaining a 313-ship fleet depends on each of the 84 CGs and DDGs now either in commission, building, or authorized being operated to the very end of their 35 year expected service lives. Indeed, maintaining these 84 ships in commission for 35 years appears to be the most important component of the Navy's overall battle fleet transformation plan. Look at it this way: in 2006, the seven DDG-1000s and 19 CG(X)s in the current plan together represent 910 years of planned future ship life; in contrast, the 84 major surface combatants now bought and paid for represent approximately 2,400 years of future commissioned service. In other words, these ships will form the foundation upon which the future transformed fleet will be built. Moreover, getting the full design life out of these ships will serve as a key hedge against any future problems that may be encountered with either the DDG-1000 or CG(X), or against the possibility that the average yearly shipbuilding account will fall substantially below the $15.5 billion per year the Navy says it needs to build the 313-ship fleet.

THE 2011 BATTLE LINE: A WINNING HAND

Thinking about the 84 AEGIS/VLS ships as just a hedge, however, obscures the fact that the 2011 surface battle line will represent a potent naval force in its own right. Each of its powerful "ships-of-the-line" come from the ultimate generation of Cold War multi-mission combatants, designed for high-intensity open ocean warfare against a Soviet Navy equipped with high-speed nuclear attack submarines armed with long-range torpedoes and anti-ship cruise missiles (ASCMs), surface combatants with heavy ASCM batteries, and long-range maritime strike aircraft armed with their own deadly anti-ship missiles. In comparison to surface combatants in foreign navies, they are large warships, with full load displacements between 8,300 and 10,000 tons, and built for sustained high-speed combat operations alongside nuclear-powered aircraft carriers. As such, they are equipped with basic engineering and combat systems that remain very much at the cutting edge of naval warfare. These include:

- *The AEGIS AAW combat system*. Although the aforementioned AEGIS system has been in fleet service for over two decades, successive upgrades still make it "the most advanced anti-air system in existence, land-based or naval."[17] The heart of the system is the SPY-1 phased array multi-function radar. Unlike older rotating radars, the SPY-1 has four, fixed, flat- panel arrays that send out numerous "pencil-like" search beams 360 degrees around the ship. When a beam encounters a target, the system's computers immediately divert additional beams to establish a target "track." Additionally, the SPY-1 combines azimuth and height search, target acquisition, classification, and tracking functions, and provides command guidance to missiles. As a result, the AEGIS combat system replaces several single-purpose radars, reducing the number of required system interfaces with the ship's combat systems.[18] Perhaps more importantly, in earlier missile ships, SAMs had to be guided from the time of launch to the time of target impact. The number of missiles a ship could fire and control was limited by the number of separate guidance radars carried by the ship. In contrast, the AEGIS is designed to work with missiles possessing "commandable autopilots." Once the missiles' autopilots are set at launch, the AEGIS system needs only to periodically update them during flight, providing specific radar guidance only during the last seconds before they intercept a target. Consequently, an AEGIS-equipped ship can control up to five outbound missiles per guidance channel—four more than previous missile defense ships. The AEGIS system thus enables a tremendous increase in potential fleet defensive firepower.[19]
- *The SQQ-89(V) integrated ASW combat system*. The SQQ-89 is the first integrated, digital ASW combat system for surface combatants, combining sensors and fire control systems with state-of-the-art digital signal processing and display technology. The system correlates acoustic data provided by hull-mounted sonars, towed arrays, and expendable sonobuoys deployed by MH-60R helicopters; produces tracks of enemy submarines; and then forwards this data to the ship's ASW combat direction and fire control systems. As a result, the AN/SQQ-89 Integrated ASW Combat System suite "is the most advanced ASW system in the world today, and makes the AEGIS

---

[17] Polmar, *Ships and Aircraft of the US Fleet*, 18th edition, p. 134.

[18] Polmar, *Ships and Aircraft of the US Fleet*, 18th edition, pp. 134-35, 552-53; and "AN/SPY-1 Radar," at http://www. fas.org/man/dod-101/sys/ ship/weaps/an-spy-1.htm.

[19] Polmar, *Ships and Aircraft of the US Fleet*, 18th edition, pp. 134-35, 552-53. For more information about AEGIS, see "AEGIS Weapons System Mk-7," at http://www.fas.org/man/dod-101/sys/ ship/weaps/aegis.htm.

[ships] the best equipped anti-submarine warfare platforms in the world today."[20]

- *The SLQ-32(V) ECM system*. The SLQ-32(V) is a short-range, omni-directional; self defense electronic warfare system that evaluates electronic emissions. Depending on the version, the system can provide warning, identification, and bearing for incoming radar-guided anti-ship missiles; actively jam the missiles' seekers; and launch ship decoys.[21]

- *LM2500 Gas turbine propulsion systems.* Unlike the late Cold War battle line which had a heterogeneous mix of steam, nuclear, and gas-turbine powered ships, the entire 2011 battle line will be gas-turbine powered, using different variations of the LM2500 gas turbine engine. The LM2500s have high power-to-weight ratios, can be started in less than a minute, and can be quickly brought to full power. As a result, US ships-of-the-line boast good acceleration and an ability to get underway quickly. An engine module totally encapsulates the LM2500 to provide both thermal and acoustic insulation; the module itself is shock-mounted to prevent shock damage to the engine and to reduce hull-borne noise transmission. Gas turbines are much more reliable, are easier to maintain, and require fewer people to operate than the steam and nuclear propulsion plants of earlier combatants. Another important advantage of gas turbines is that they can be removed from the ship for repair in a relatively short period of time (approximately 72 hours).[22]

In addition to carrying state-of-the-art combat and engineering systems, the 84 ships will also be heavily armed. They will carry a total of 106 5-inch naval guns among them, two on each of the 22 *Ticonderoga* CGs and a single mount on every *Burke* DDG. All will carry two close-in weapons systems to provide a last-ditch defense against incoming missiles or suicide boat attacks. Additionally, all but the Flight I and II *Burkes* can hanger and operate two MH-60R multi-purpose helicopters, and 27 of these 28 early-flight ships can land, refuel, and rearm them. However, the ships' primary combat punch will come from the various types of guided missiles carried in their Mk-41 vertical launch systems, the most flexible and adaptable naval missile system in the world today.

The Mk-41 VLS, first installed onboard US ships-of-the-line in 1986, was specifically designed to take advantage of the AEGIS combat system's ability to control up to five missiles in flight. The system consists of fixed "modules" of eight individual VLS cells. A ship's main battery consists of grouped multiples

---

[20] Polmar, *Ships and Aircraft of the US Flee*t, 18th edition, p. 558; and "AN/SQQ-89 ASW Combat System," at http://www.fas.org/man/dod-101/sys/ship/ weaps/an-sqq-89.htm.

[21] Polmar, *Ships and Aircraft of the US Fleet*, 18th edition, p. 543.

[22] See "LM2500 Gas Turbine Engine," at http://www.fas.org/man/dod-101/ sys/ ship/eng/lm2500.htm.

of these eight-cell modules nestled in the hull of the ship. Since the missile cells serve as both storage magazine and launcher for their missiles, the Mk-41 eliminates the need to move missiles from below-deck rotary magazines to the launch rails on above-deck trainable missile launchers. Missiles launched by the VLS simply shoot straight up from their cell and away from the ship before tipping over and speeding toward their targets. As a result, every missile carried aboard a VLS-equipped ship is essentially in a "ready-to-fire" condition, needing only targeting data to be sent it on its way. A VLS-equipped combatant thus has a far less maintenance intensive and more reliable main missile battery—with much a higher rate of fire—than early Cold War surface combatants.[23]

The introduction of the VLS had several other important advantages. Each VLS cell can be flexibly adapted to carry one *Tomahawk* land attack cruise missile; or one long-range *Standard* surface-to-air missile (SAM); or one anti-submarine rocket (ASROC); or four "quad-packed" short-range *Evolved Sea Sparrow Missile*s (ESSMs). Only two commonly used US naval missiles are *not* stored and fired by the Mk-41: the *Harpoon* anti-ship cruise missile, which is fired from an above-deck fixed canister; and the Rolling Airframe Missile, a short-range SAM fired from an 11- or 21-round trainable box launcher. The adoption of the Mk-41 VLS thus led to a reduction in the number of special-purpose missile launchers required aboard US combatants, which further reduced the fleet's maintenance and logistics load, and allowed US surface warships to quickly change their missile load-outs to account for the most likely threat.[24]

The VLS also makes very efficient use of space in a ship's hull, allowing a ship so equipped to carry over 40 percent more missiles than a legacy missile ship of equal size.[25] This helps to make US VLS-equipped ships-of-the-line among the most heavily armed surface combatants in the world. Each of the 22 *Ticonderogas* carry a minimum of 122 missiles in their VLS batteries (more if carrying quad-packed ESSMs) and eight *Harpoons*;[26] the 28 early-flight *Burkes* each carry a minimum of 90 VLS missiles and eight *Harpoons*; and the 34 Flight IIA *Burkes* will all carry a minimum of 96 VLS missiles, with space and weight to add *Harpoons* if necessary.[27]

---

[23] See Polmar, *Ships and Aircraft of the US Fleet,* 18th edition, pp. 506, 509-09; and "Mk-41 Vertical Launch System," at http://www.globalsecurity.org/ military systems/ ship/systems/mk-41-vls.htm.

[24] Ibid.

[25] The first five "rail-armed" *Ticonderog*a-class cruisers, since retired, carried 88 missiles in their below-deck magazines; the remaining 22 VLS-armed *Ticonderoga*-class cruiser can each carry 128 VLS cells in the same size hull.

[26] Originally, these ships were to have an ability to rearm their VLS cells at sea. A group of three cells in both the forward and after VLS batteries formed "strike-down modules" with a missile handling system, reducing the number of missiles in each magazine from 64 to 61, and total capacity from 128 to 122.

[27] The first 28 *Burkes* carried two 3-cell strike-down modules, reducing their total missile capacity by six missiles. After the Navy gave up on trying to transfer missiles at sea, the 34

With each ship carrying between 90 and 122 individual VLS cells, the 84-ship 2011 surface battle line will form a distributed, guided missile battery with a capacity for 8,868 full-size "battle force" missiles, all but 400 in VLS cells.[28] This is a greater cumulative magazine capacity than that found on 366 major surface combatants in the world's next 17 largest navies.[29] This mobile missile field will be capable of protecting itself from attacks in three dimensions (air, surface, and subsurface) and projecting combat power out to ranges of about 1,000 nautical miles.

Moreover, far from being "over-the-hill," these ships will stack up quite well against the new generation of combatants in terms of combat capability. By the Navy's own reckoning, the DDG-1000s will have better stealth and littoral anti-air warfare capabilities than the Flight IIA *Arleigh Burke* DDGs, while the *Burkes* will be better open ocean air defenders than the newer ships. Depending on the type of threat missile and operational scenario, the two ships run neck and neck as cruise missile defenders, and they are roughly comparable in anti-submarine warfare capabilities.[30] Moreover, while the DDG 1000s' 6-in guns fire more lethal rounds over longer ranges than the legacy ships' smaller 5-inch guns, the 106 smaller guns distributed across 84 ships provide a more flexible gunfire support force than the 14 larger guns found on the seven DDG-1000s.

In any event, as the fleet transitions to distributed, networked operations, and operates less as a traditional battle fleet and more as a new type of lethal naval battle network, side-by-side comparisons between the *Burkes* and DDG-1000s become less useful than in the past. The foundation for these new battle networks will be the transparent sharing of sensor and fire control data among ships and aircraft in a battle force, through new networking schemes such as the cooperative engagement capability (CEC). The CEC is designed to integrate the data of all SPY-1 radars—as well as other radar sensors such as those carried on E-2C air battle management aircraft—into a "single, real-time, fire-control-quality composite track picture."[31] When operating under a single designated commander, CEC-equipped surface combatants should allow a naval task force to operate as a single coherent, defensive combat network. If this network performs as advertised, it will

---

Flight IIA *Burkes* replaced the two strike-down modules with operational VLS cells, resulting in a combat load of 96 full-size VLS missiles.

[28] "Battle force missiles" include long-range SAMs, anti-submarine rockets, anti-ship cruise missiles, and land attack cruise missiles. Ship self-defense missiles such as the ESSM and RAM are not included in this category.

[29] The data represents the magazine capacity found in major warships in rest of world navies on January 1, 2005. See Robert O. Work, *To Take and Keep the Lead: A Naval Fleet Platform Architecture for Enduring Maritime Supremacy* (Washington, DC: Center for Strategic and Budgetary Assessments, December 2005).

[30] As relayed to the author by Dr. Eric J. Labs, Congressional Budget Office, after he had received Navy presentations on the DD(X) program.

[31] "Cooperative Engagement Capability," at http://www.fas.org/man/dod-101/sys/ship/weaps/cec.htm.

extend the range at which any given ship can engage a target to well beyond its own radar horizon; in other words, a ship will be able to fire at a target that would not normally be tracked by its own sensors. This type of combat networking should dramatically improve long-range (area), medium-range (local), and terminal defense missile coverage of naval forces.[32]

Under these conditions, *the question of whether or not a DDG-1000 is more powerful than a* Burke *DDG is less important than what the two ships contribute to the network, and how they complement other network components.* For example, in a straight-up comparison, the DDG-1000's new multi-function radar is better at discriminating and tracking cruise missiles in the littoral than the AEGIS SPY-1 radar. However, the new E2D Advanced Hawkeye air battle management aircraft, equipped with an active electronically scanned array (AESA) radar, will often have a greater range and discrimination capability than either ship. Equipped with a CEC set, the plane may be able to provide them both with tracking data even if their own sensors can't see the target.[33] Therefore, the DDG-1000's apparent radar advantage over the *Burke* may not be as critical as it first appears in full battle network operations.

Another important consideration is that the emerging AEGIS/VLS battle network will likely operate with and be augmented by a growing fleet of allied AEGIS/VLS ships. In Europe, the Spanish Navy will soon operate a minimum of six F-100 guided missile frigates, each equipped with a lightweight version of AEGIS and armed with a 48-cell Mk-41 battery, carrying 32 Standard SAMs and 64 ESSMs. These ships will be joined by five Norwegian *Nansen*-class guided missile frigates, also equipped with a lightweight AEGIS and eight Mk-41 cells carrying 32 ESSMs (and space and weight for an additional eight cells). The Pacific AEGIS/VLS fleet will be even more impressive, with at least six Japanese *Kongou*-class DDGs, three South Korean KDX-III DDGs, and three Australian Air Warfare Destroyers, carrying about 1,000 Mk-41 VLS cells among them. Thus, any improvements made by the US Navy to the basic AEGIS/VLS combat system and to the CEC network will likely be immediately copied by these five allied navies, resulting in excellent fleet interoperability and shared combat capability.

TIME TO DRAW A NEW HAND?

Given the impressive combat capability of the AEGIS/VLS fleet, one can rightfully ask: Why not continue to build AEGIS/VLS combatants? Given the fact that these ships remain among the best and most powerful surface combatants in the world today, why shift to a new generation of ships now? In answering, the Navy offers three principal arguments.

---

[32] Polmar, *Ships and Aircraft of the US Fleet*, 18th edition, p. 136; and Daniel Busch and Conrad J. Grant, "Changing the Face of War—the Cooperative Engagement Capability," at http://www.ccii.co.za/company/press_releases/face_of_ war.html.

[33] See "E-2D Advanced Hawkeye," at http://www.globalsecurity.org/military/ systems/aircraft/e-2d.htm.

The most compelling of the three arguments relates to the spiraling cost of people. As originally designed, the *Ticonderoga* CGs carry a crew (counting the embarked helicopter detachment) of 400 officers and enlisted personnel, while the *Burkes* carry a crew of approximately 340.[34] As the size of the crew is the major contributor to a ship's total life cycle cost, the Navy has made it a top priority to reduce crew sizes through automation. These efforts are seen in the 14,500-ton DDG-1000, which will boast a crew of only about 150 personnel, including helicopter and unmanned aerial vehicle detachments.[35]

A second equally compelling argument revolves around the potential benefits gained from shifting toward an all-new Integrated Power System (IPS), which Navy planners believe will change naval operations as much as did the shift from sail to steam.[36] The DDG-1000's two main and two auxiliary gas turbines that will produce and distribute power for all of the ship's electric needs—including two new electric drive motors that will propel the ship and provide power to its basic operating and combat systems. Together, these four turbines will produce 78 megawatts of power—ten times the electrical capacity than on *Burke* DDGs.[37] This dramatic increase in electrical power has two important implications for future battle line combatants. First, it will facilitate a general move to electric drive propulsion, which will eliminate the requirement for a ship's engine rooms to be in line with the ship's propeller shafts—or even that the ship retain long propeller shafts at all.[38] It may also simplify the propulsion train in other ways, such as eliminating the need for complex reduction gears, resulting in much reduced ship acoustical signatures.[39] Second, the IPS will pave the way toward a variety of new and exotic weapons, such as electrically-powered directed-energy weapons (e.g., lasers) or electromagnetic rail guns.[40]

A third, perhaps less compelling argument is the desire to shift toward a generation of more "stealthy" surface combatants. Full-spectrum stealth was a critical design requirement for the DDG-1000, which aims for an acoustic

---

[34] From ship data entries in Polmar, *Ships and Aircraft of the US Fleet*, 18th edition.

[35] See "DDG-1000 Flight I Design," at http://www.ddg1000.com/overview/ ddg1000_brief.php.

[36] For two excellent and concise descriptions of the IPS, see Gordon I. Peterson, "The Future of Naval Warfare: the Integrated Power System and Revolution in Sea Warfare," *Naval Forces*, Vol. 6, 2004, pp. 46-52; and Rear Admiral Mark Edwards and Rear Admiral Charles Hamilton, "Destroyer That Creates Waves," *Armed Forces Journal*, October 2004, pp. 44-46.

[37] Goddard and Marks, "DD(X) Navigates Uncharted Waters," pp. 32-33.

[38] For example, the long propeller shafts could be eliminated and replaced with propulsion pods outside the ship's hull.

[39] The new electrical propulsion plant, once planned to be a permanent magnet motor, has recently be shifted to an advanced induction motor. See "US Navy Signal Intentions for Provision of DD(X) Propulsion," *Jane's International Defense Review*, June 2005, p. 12.

[40] Hunter Keeter, "Lasers, Rail Gun Could Be Ready For DD(X) By 2010," *Defense Daily*, April 16, 2003, p. 9; Christopher J. Castelli, "Navy Envisions Surface Combatants With Powerful Laser Guns," *Inside the Navy*, December 9, 2002, p. 1; and Lieutenant Commander David Allan Adams, US Navy, "Naval Rail Guns Are Revolutionary," *Proceedings*, February 2003, pp. 34-37.

signature "as quiet as a submarine" (achieved primarily by the shift to electric motors), and similar reductions in magnetic and infrared signatures. Moreover, the ship's radar cross section is expected to be at least 50 times smaller than a *Burke* DDG.[41] To achieve this impressive goal, the ship will have ballast tanks that will be used to lower the ship in the water under battle conditions; a wave-piercing tumblehome hull that deflects incoming radar signals away from their source; and a composite deck house with embedded sensors and antennae that eliminates the numerous shipboard masts and exposed sensors that have in the past acted as radar reflectors. These and other advances will make the DDG-1000 (and, presumably, the follow-on CG(X)s) among the world's most stealthy surface combatants. No one argues that improved surface combatant stealth is undesirable. [42] The only debates are over how much stealth and at what cost, and whether or not the return on dollars spent on stealth now will be worth it over the long term. The high degree of stealth being pursued on the DDG-1000 is a key driver in the ship's overall size and cost, even though the fleet payoff is not nearly as clear as the move toward smaller crew sizes and IPSs.[43]

Whatever the merits of these three key arguments, due to the projected high costs for the DDG-1000s and CG(X)s, the planned shift to the new generation of surface combatants will be a relatively slow one. As mentioned earlier, the last of the seven planned DDGs will not be commissioned until 2018; the last of the 19 CG(X)s will enter the fleet in 2029; and the first of the DDG(X)s will not join the fleet until 2028. As a result, the AEGIS/VLS fleet will make up the heart of the battle fleet for some time to come. Indeed, this powerful grouping of surface warships is relatively young in terms of ship life. Having entered service between 1986 and 2011 at an average rate of 3.32 ships per year (i.e., 10 ships every three years), the 84-ship battle line will boast an average age of just 13 years in 2011. As a result, 15 years from now, there will be 83 older generation AEGIS/VLS ships to five new generation ships (one ship above the 88 ship total requirement); 20 years from now, the numbers will be 75 and 14, respectively (one ship above the requirement); and 25 years from now the numbers will be 46 and 33 (nine ships *below* the requirement). The new generation of ships will not surpass the old one in terms of numbers until FY 2034, and the fleet will be 15 ships below the requirement when they do.

The 84 AEGIS/VLS ships represent a $100 billion taxpayer investment, which argues for the Navy getting the most out of them regardless of their future plans. However, as can be seen, should the US Navy find itself in a serious naval fight or competition over the next several decades, these ships will play the leading role. Maintaining and upgrading the fleet is thus much

---

[41] "DD(X) Media Roundtable."

[42] For an excellent discussion of what stealth provides to surface combatants, see James H. King, "Stealth Means Survivability," *Proceedings*, December 2001, pp. 80-82.

[43] See the discussion on the role of stealth in Navy warships in *Transforming the Navy's Surface Combatant Stealth* (Washington, DC: Congressional Budget Office, March 2003), found online at http://www.cbo.gov/showdoc.cfm?index=4130& sequence=0&from=0#anchor.

more than a common sense maximization of a sunk investment—it is a fundamental battle fleet requirement.

STANDING PAT: MAINTAINING AND UPGRADING THE AEGIS/VLS FLEET

While it may make sense to keep the 84 AEGIS/VLS ships in service for a full 35 years, accomplishing this goal will not be easy. *No surface combatant designed since the end of the Second World War has served as long.* Keeping them in service to the very end of their planned service lives will thus be a difficult task, and will require three key things:

- *A sustained maintenance program.* All complex warships require intensive maintenance. This is especially true for US Navy warships, which spend a great deal of time at sea and on extended deployments. Scrimping on maintenance causes the ships to age far more rapidly than planned, as was seen during the 1980s and 1990s when basic operations and maintenance funds for surface combatants were continually diverted to pay for other fleet requirements. One result was that the aforementioned *Spruance*-class wore out more rapidly than anticipated. By the late 1990s, long-delayed or canceled work had made maintenance of these ships a nightmare, which contributed in no small part to the decision to retire them early.[44] The Navy's plan to freeze their overall O&M funds just as the average age of the AEGIS/VLS fleet begins to climb may thus bode ill for plans to keep the ships in service for 35 years.

- *Thorough mid-life upgrades to the ships' hull, machinery, and electrical (HM&E) systems.* No matter how good or sustained the maintenance program, because of age and high usage rates, US warships will inevitably see their HM&E systems deteriorate over time. As a result, the Navy routinely plans for mid-life upgrades to a ship's basic systems—which involve repairing its hull, replacing outdated equipment, and replacing and upgrading such things as piping and cabling. During the 1980s, when the Navy was expanding toward a battle fleet target of 600 ships, fleet planners were reluctant to decommission any ship before the end of their service lives. They therefore spent considerable sums to upgrade the HM&E of ships commissioned in the 1960s, renovating all their spaces, refurbishing their berthing and food service areas, and completely overhauling their steam engineering plants.[45] Today, the Navy is in the process of upgrading the HM&E on its 30 remaining *Oliver Hazard Perry* frigates to extend their useful service lives, and is also planning similar H&ME upgrade for its 84 AEGIS/VLS ships. Given the Navy's goal to

---

[44] Maintenance problems were by no means the only reason the ships were decommissioned. They had large crews and were a focused mission ASW ship. By retiring the ships early, the Navy was able to divert about $1.25 billion over the Future Years Defense Plan (FYDP) toward other fleet priorities. See "DD-963 *Spruance*-Destroyer," at http://www.globalsecurity.org/military/systems/ship/dd-963.htm.

[45] See for example "CG-16 *Leahy* Class," at http://www.globalsecurity.org/military/systems/ship/cg-16.htm.

cut manpower costs, an important part of these mid-life upgrades will be so-called SMARTSHIP improvements designed to reduce ship manpower requirements.[46] However, these upgrades, as well as other improvements to the ships' HM&E, are paid for out of O&M funds, which are being frozen at current levels. They will therefore have to compete with regular maintenance and combat system upgrades (see below), which may cut the level of funding available.

- *A mid-life upgrade of the ships' combat systems, allowing them to keep up with the pacing threats.* The same question applies to upgrades to the ships' combat systems. Upgrades to a ship's HM&E are often, but not always, accompanied by a thorough upgrade of the ship's combat systems. For example, in the late 1980s, 24 of the original 31 *Spruance*-class destroyers were given an extensive combat systems upgrade which, among other things, exchanged an above-deck eight-round box launcher that fired anti-submarine rockets along with a 16-missile, below-deck rearming magazine (for a maximum ship missile load of 24 ASROCs) with eight, 8-cell VLS modules capable of firing 61 ASROCs, or 61 Tomahawk land attack missiles, or a combination of both.[47] When combined with the addition of a towed array and updates to their ASW combat system, the ship-wide combat system upgrade transformed the *Spruances*, long criticized for being under-armed, into the most powerful destroyers afloat. Around the same time, most non-AEGIS AAW ships were upgraded as part of the New Threat Upgrade (NTU) program. This program included combat system capability improvements to the ships' older rotating air search radars, fire control radars, combat direction centers, and missiles. These improvements enabled the ships to conduct and coordinate missile engagements of multiple air and missile targets with extended-range Standard SAMs, improving their performance against potential Soviet-style bomber and ASCM raids.[48] While highly capable, the 84-ship AEGIS/VLS fleet will need similar combat system upgrades to enable them to operate in the face of future threats.

If history is any guide, it is the combination of all three of these things that will keep the AEGIS/VLS ships in service for 35 years. Neglecting any one of them will likely lead to unwanted early retirements. For example, despite getting a thorough combat system upgrade, the *Spruance*-class destroyers were done in, in part, by a shoddy maintenance regime. The NTU ships were compromised by their large crews and their steam propulsion plants, for which no amount of rehabbing made economic sense. The first five *Ticonderoga* CGs

---

[46] Glen Sturdevant, "AEGIS SMARTSHIP Program," a PowerPoint presentation given to the Marine Machinery Association, found online at http://www.marmach.org/pdf/minutes/arlington010522/smartship.pdf#search=%22Navy%20SMARTSHIP%20personnel%20reductions%22.

[47] Like all early VLS installations, three of the cells were devoted to a missile strike-down module, reducing the actual number of operational VLS cells to 61.

[48] See "CG-16 *Leahy* Class," and "New Threat Upgrade," at http://en.wikipedia.org/wiki/NewThreatUpgrade.

were retired after the Navy concluded that the cost to replace their old rail style launchers with VLS batteries would make their combat system upgrade prohibitively expensive. While the 30 *Perrys* now in commission are getting a mid-life HM&E upgrade, they are receiving a minimal combat systems upgrade. If anything, the ships will be less capable than originally designed, having lost their ability to fire either SAMs or *Harpoons*. In other words, because the ships did not receive a combat system upgrade, they are being transformed into nothing more than 4,000-ton LCS surrogates, but with much larger crews. Unsurprisingly, then, they are to be decommissioned as fast as possible. Ten of the 30 *Perrys* now in commission will be less than 35 years old when the last of the ships is retired in FY 2019. As these examples suggest, without a Fleet-wide Sustainment Program involving sustained maintenance, HM&E upgrades (especially upgrades that lead to crew reductions), and combat system upgrades to keep the ship capable against all current threats, large portions of the 84-ship AEGIS/VLS fleet will likely be retired far before 35 years of commissioned service.

Sustaining a rigorous maintenance regime and updating HM&E systems are relatively straight forward tasks dependent only on good planning and adequate O&M funding. Planning combat system upgrades is more tricky, as they depend on adequate R&D spending, close attention to the expected appearance of new threats, and sufficient O&M funding to make the necessary upgrades. With regard to potential near-term threats to US battle fleet operations, four appear to be especially worrisome: anti-ship *ballistic* missiles armed with maneuverable reentry vehicles;[49] new types of deadly ASCMs like the SS-N-27 *Sizzler*, a very lethal Russian-made supersonic anti-ship cruise missile;[50] very quiet diesel submarines; and swarming suicide boat attacks. There are upgrades to the AEGIS/VLS fleet that can address each of these threats. However, the cost to do them all simultaneously may be prohibitive. This suggests that efforts to keep AEGIS/VLS combatants in service for a full 35 years might depend on a continuous upgrade program that updates combat systems in stages, tied to the appearance of actual threats.

As this discussion suggests, then, getting the full 35 years out of the AEGIS/VLS fleet will require a consistent and likely steadily increasing level of O&M and potentially R&D spending as the average fleet age begins to increase after 2011. Some key questions for the Department of the Navy, Office of the Secretary of Defense, and the Congress are thus:

- Do Navy long-range plans include a coherent Fleet-wide Sustainment Program for the AEGIS/VLS ships-of-the-line? and

[49] See for example Office of Naval Intelligence, *Worldwide Maritime Challenges 2004* (Washington, DC: Department of the Navy, 2005), p. 22; and Norman Polmar, "Anti-ship Ballistic Missiles…Again," *Proceedings*, July 2005, pp. 86-87.

[50] Ronald O'Rourke, "China Naval Modernization: Implications for US Naval Capabilities—Background and Issues for Congress," Congressional Research Service Report RL 33153, dated November 18, 2005, p. 68.

- How can such a plan be implemented if O&M and R&D dollars are frozen?

CURRENT CG/DDG MODERNIZATION PROGRAMS: FOLDING A WINNING HAND?

The answers to these questions are not yet clear. Encouragingly, Navy plans do include both a CG and DDG modernization program. However, as of the FY 2007 budget submission, these plans appear to be heavily weighted toward the 22 *Ticonderoga*-class CGs. At a cost of approximately $228 million apiece, the ships would receive a thorough upgrade to their HM&E, including SMARTSHIP improvements, as well as to their combat systems. However, the plans for the more numerous *Burke* DDGs appear to be far less intensive, and focused primarily on HM&E upgrades. For example, the program does not yet appear to pay for necessary CEC modifications on earlier DDGs, or for upgrading their ASW combat systems, or for improving their ability to defend against anti-ship cruise missile attacks. Failing to make such much-needed improvements will relegate these ships to second-line duty, and may lead to their early retirement, especially if naval threats become more formidable.

The Navy's response to such concerns is that the CG and DDG Modernization programs are a subject of deliberations in the development and review of Program Objective Memorandum (POM) 2008. Fair enough. However, the FY 2008 budget will be the first complete new budget since the CNO's announcement that O&M dollars are to be maintained at current levels and R&D money reduced. As discussed, the former will be sure to make any Fleet-wide Sustainment Program for 84 aging ships difficult to execute, while the latter may make it difficult for the ships to keep up with pacing threats. It is therefore important that the Congress be an early and interested observer when the Navy's FY 08 budget is presented, and that they ask penetrating questions about the full extent of Navy's plans for its AEGIS/VLS fleet. Among the most critical questions to be asked are the following:

- What are the Navy's plans for a balanced AEGIS/VLS Fleet-wide Sustainment Program? Are current Navy plans geared and funded to keep all 84 AEGIS/VLS combatants in service for a full 35 years?

- What are the most likely operational threats to naval battle forces over the next 25 years? Does the Navy have a robust R&D line to make sure the AEGIS/VLS fleet can meet these projected threats? Are the Navy's plans for AEGIS/VLS combat system upgrades consistent with the evolution of likely future threats?

- What necessary HM&E and combat system upgrades are being cut to stay within projected O&M caps? What will the effect of these cuts be on fleet combat capability?

- Irrespective of projected O&M caps, what desirable HM&E and combat system upgrades are not being pursued? How would they improve fleet combat capability? How much would these additional improvements cost?

Getting the answers to these questions will help ensure the US Navy doesn't inadvertently fold a winning hand. The 84 AEGIS/VLS ships soon to be in service represent perhaps the most powerful surface battle line in naval history. They will also form the foundation for the Navy's transformation plans, and serve as a hedge against problems in the DDG-1000 and CG(X) programs, or against unexpected shortfalls in future shipbuilding accounts. However, as the foregoing discussion suggests, keeping the ships in service for a full 35 years of commissioned service, as is now planned, is by no means a done deal. It will require a sustained maintenance program; a thorough mid-life upgrade to the ships' HM&E systems; and a rolling combat systems upgrade to make sure the ships can keep pace with evolving threats. Planning, budgeting, and executing such a balanced AEGIS/VLS Fleet-wide Sustainment Program is a smart strategy that will protect and maximize the $100 billion investment made in these 84 superb ships, and help to ensure continued US naval superiority for the next two to three decades.

For more information, contact Robert Work at (202) 331-7990.

The Center for Strategic and Budgetary Assessments (CSBA) is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's goal is to enable policymakers to make informed decisions in the matters of strategy, security policy and resource allocation. CSBA is directed by Dr. Andrew F. Krepinevich. See our website at www.csbaonline.org