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Navy Attack Submarine Force-Level Goal and Procurement Rate: Background and Issues for Congress

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Summary

The Navy is currently procuring one Virginia (SSN-774) class attack nuclear-powered submarine (SSN) per year. Each submarine currently costs about \$2.4 billion. The FY2007-FY2011 Future Years Defense Plan (FYDP) to be submitted in February 2006 reportedly will propose maintaining the one-per-year procurement rate through FY2011, and then increasing the rate to two per year in FY2012.

As of the end of FY2005, the Navy totaled 282 ships, including 54 SSNs. In December 2005, it was reported that the Navy is planning to maintain future fleet of 313 ships, including 48 SSNs. Submarine supporters are concerned that the Navy and DOD are not placing adequate emphasis on attack submarines in Navy force-structure planning and ship-procurement plans.

Issues for Congress include the following: What should the attack submarine force-level goal be? At what rate should Virginia-class submarines be procured in coming years? Congress's decisions on these issues could significantly affect future Navy capabilities, Navy funding requirements, and the submarine industrial base.

In considering what the attack submarine force-level goal should be, key factors to consider include day-to-day demands for attack submarines, potential wartime demands for attack submarines, submarine-launched unmanned vehicles (UVs), attack submarine homeporting and crewing arrangements, the Trident cruise missile submarine (SSGN) conversion program, and contributions by allied and friendly attack submarines.

In considering the rate at which Virginia-class submarines should be procured in coming years, key factors to consider include the attack submarine force-level goal, attack submarine service lives, the effect of annual procurement rates on unit procurement costs, industrial-base considerations, and funding requirements for other defense-spending priorities.

Section 121 of the conference report on the **FY2006 defense authorization bill (H.R. 1815)** limits the procurement costs of certain Virginia-class attack submarines. Section 215 directs the Navy to initiate a program to develop a next-generation attack submarine that is less expensive than the current Virginia-class attack submarine design, and permits the Navy to meet this objective by modifying the current Virginia-class design to incorporate new technology.

The conference report on the **FY2006 defense appropriations bill (H.R. 2863/P.L. 109-148)** approves the Navy's request for FY2006 procurement and advance procurement funding for the Virginia-class program. This report will be updated as events warrant.

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Introduction

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As of the end of FY2005, the Navy totaled 282 ships, including 54 SSNs. In December 2005, it was reported that the Navy is planning to maintain future fleet of 313 ships, including 48 SSNs.¹ Submarine supporters are concerned that the Navy and DOD are not placing adequate emphasis on attack submarines in Navy force-structure planning and ship-procurement plans.

Issues for Congress include the following:

- What should the attack submarine force-level goal be?
- At what rate should Virginia-class submarines be procured in coming years?

Congress's decisions on these issues could significantly affect future Navy capabilities, Navy funding requirements, and the submarine industrial base.

The next section of this report provides background information on Navy attack submarines and the Virginia-class program. The following section addresses the above issues for Congress.

Background

Submarines in the U.S. Navy

Types of Submarines. Submarines are one of four principal categories of combat ships that traditionally have helped define the size and structure of the U.S.

¹ Christopher P. Cavas, "U.S. Ship Plan To Cost 20% More," *Defense News*, December 5, 2005: 1, 8. See also David S. Cloud, "Navy To Expand Fleet With New Enemies in Mind," *New York Times*, December 5, 2005.

Navy. The other three are aircraft carriers, surface combatants (e.g., cruisers, destroyers, and frigates), and amphibious ships.²

Submarines are powered by either nuclear reactors or non-nuclear power sources such as diesel engines or fuel cells. All U.S. Navy submarines are nuclear-powered.³

U.S. Navy submarines fall into three types — nuclear-powered ballistic missile submarines (SSBNs), nuclear-powered cruise missile submarines (SSGNs), and nuclear-powered attack submarines (SSNs).⁴

Submarine Roles and Missions. The SSBNs' basic mission is to remain hidden at sea with their nuclear-armed submarine-launched ballistic missiles (SLBMs) and thereby deter a strategic nuclear attack on the United States. Although this mission is often associated with the Cold War-era nuclear competition between the United States and the Soviet Union, it has continued, with some modifications, in the post-Cold War era.⁵ As of the end of FY2005, the Navy included 14 Ohio (SSBN-726) class SSBNs, which are commonly called Trident submarines because they carry Trident SLBMs. Each Trident SSBN can carry 24 Trident SLBMs.

² The Navy also includes mine warfare ships and a variety of auxiliary and support ships.

³ An exception for the U.S. Navy is the non-combat auxiliary submarine Dolphin (AGSS-555), a small submarine that the Navy uses for research and development work. As a non-combat research asset, the Dolphin is not included in counts of the total number of submarines (or battle force ships of all kinds) in the Navy. Until the 1950s, the U.S. Navy included many non-nuclear-powered combat submarines. Following the advent of nuclear power in the mid-1950s, construction of new non-nuclear-powered combat submarines ended and the total number of non-nuclear-powered combat submarines in Navy service began to decline. The Navy's last in-service non-nuclear-powered combat submarine was retired in 1990. Most military submarines around the world are non-nuclear-powered. Five countries — the United States, the United Kingdom (UK), France, Russia, and China — operate nuclear-powered submarines. The United States and the UK operate all-nuclear submarine fleets, while the other three countries operate both nuclear- and non-nuclear-powered submarines. A submarine's use of nuclear or non-nuclear power as its energy source is not necessarily an indication of whether it is armed with nuclear weapons. A nuclear-powered submarine can lack nuclear weapons, and a non-nuclear-powered submarine can be armed with nuclear weapons.

⁴ In the designations SSBN, SSGN, and SSN, SS stands for submarine, N stands for nuclear-powered, B stands for ballistic missile, and G stands for guided missile (such as a cruise missile).

⁵ For a discussion of U.S. strategic nuclear weapons policy and force structure, see CRS Report RL31623, *U.S. Nuclear Weapons: Changes in Policy and Force Structure*, by Amy F. Wolff.

The SSGNs are a new addition to the U.S. Navy.⁶ They are former Trident SSBNs that are being converted (i.e., modified) to carry Tomahawk cruise missiles and special operations forces (SOF) rather than SLBMs. A total of four SSGNs are planned; the conversions are scheduled to be completed between November 2005 and September 2007. Upon reentering service as SSGNs, the ships are scheduled to remain in operation for about 20 years.⁷

Each SSGN as converted will retain its 24 large (7-foot-diameter, 44-foot-long) SLBM launch tubes. In one possible configuration, 22 of these tubes would be used to carry a total of 154 Tomahawks (7 Tomahawks per tube) while the remaining two would be used as lockout chambers for an embarked force of 66 SOF personnel. In the future, the 24 tubes could be used to carry large numbers of other payloads, such as unmanned vehicles. The SSGNs as converted will also retain their four original 21-inch-diameter torpedo tubes and their internal torpedo magazines. In discussing the SSGNs, Navy officials often express a desire to take maximum advantage of the very large payload volume on each SSGN by developing new unmanned vehicles or other advanced payloads.

The SSNs — the focus of this report — are general-purpose submarines that perform a variety of peacetime and wartime missions, including the following:

- covert intelligence, surveillance, and reconnaissance (ISR), much of it done for national-level (as opposed to purely Navy) purposes;
- covert insertion and recovery of special operations forces;
- covert strikes against land targets with the Tomahawk cruise missiles;
- covert offensive and defensive mine warfare;
- anti-submarine warfare (ASW); and
- anti-surface ship warfare.

During the Cold War, ASW against the Soviet submarine force was the primary stated mission of U.S. SSNs, although covert ISR and covert SOF insertion/recovery operations were important on a day-to-day basis as well.⁸ In the post-Cold War era, although maintaining a capability for conducting anti-submarine warfare against the Russian submarine force remains a mission, the Navy has placed increased emphasis

⁶ The Navy in the late 1950s and early 1960s built and operated two non-nuclear-powered cruise missile submarines (or SSGs — the Grayback [SSG-574] and the Growler [SSG-577]) and one nuclear-powered cruise missile submarine (the Halibut [SSGN-587]). The submarines could each carry two Regulus II strategic nuclear cruise missiles. In the mid-1960s, following the deployment of the Navy's initial SSBNs, the Regulus cruise missile was removed from service and the Grayback, Growler, and Halibut were converted into attack and auxiliary transport submarines.

⁷ For more on the Navy's SSGN conversion program, see CRS Report RS21007, *Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress*, by Ronald O'Rourke.

⁸ For an account of certain U.S. submarine surveillance and intelligence-collection operations during the Cold War, see Sherry Sontag and Christopher Drew with Annette Lawrence Drew, *Blind Man's Bluff* (New York: Public Affairs, 1998).

on missions that contribute to U.S. military operations in littoral (near-shore) areas against regional adversaries other than Russia.

Although the four planned SSGNs differ somewhat from SSNs in terms of mission orientation (with the SSGNs being strongly oriented toward Tomahawk strikes and SOF support, while the SSNs are more general-purpose in orientation), SSGNs are sometimes included in counts of the projected total number of Navy attack submarines.

Attack Submarine Force-Level Goal

Previous Administrations. The Reagan-era plan for a 600-ship Navy included an objective of achieving and maintaining a force of 100 SSNs. The George H. W. Bush Administration's proposed Base Force plan of 1991-1992 originally called for a Navy of more than 400 ships, including 80 SSNs.⁹ In 1992, however, the SSN goal was reduced to about 55 boats as a result of a 1992 Joint Staff force-level requirement study (updated in 1993) that called for a force of 51 to 67 SSNs, including 10 to 12 with Seawolf-level acoustic quieting, by the year 2012.¹⁰

The Clinton Administration, as part of its 1993 Bottom-Up Review (BUR) of U.S. defense policy, established a goal of maintaining a Navy of about 346 ships, including 45 to 55 SSNs.¹¹ The Clinton administration's 1997 QDR supported a requirement for a Navy of about 305 ships and established a tentative SSN force-level goal of 50 boats, "contingent on a reevaluation of peacetime operational requirements."¹² The Clinton administration later amended the SSN figure to 55 boats (and therefore a total of about 310 ships).

The reevaluation called for in the 1997 QDR was carried out as part of a Joint Chiefs of Staff (JCS) study on future requirements for SSNs that was completed in December 1999. The study had three main conclusions:

⁹ For the 80-SSN figure, see Statement of Vice Admiral Roger F. Bacon, U.S. Navy, Assistant Chief of Naval Operations (Undersea Warfare) in U.S. Congress, House Armed Services Committee, Subcommittee on Seapower and Strategic and Critical Materials, *Submarine Programs*, Mar. 20, 1991, pp. 10-11, or Statement of Rear Admiral Raymond G. Jones, Jr., U.S. Navy, Deputy Assistant Chief of Naval Operations (Undersea Warfare), in U.S. Congress, Senate Armed Services Committee, Subcommittee on Projection Forces and Regional Defense, *Submarine Programs*, June 7, 1991, pp. 10-11.

¹⁰ See Richard W. Mies, "Remarks to the NSL Annual Symposium," *Submarine Review*, July 1997, p. 35; "Navy Sub Community Pushes for More Subs than Bottom-Up Review Allowed," *Inside the Navy*, Nov. 7, 1994, pp. 1, 8-9; *Attack Submarines in the Post-Cold War Era: The Issues Facing Policymakers*, op. cit., p. 14; Robert Holzer, "Pentagon Urges Navy to Reduce Attack Sub Fleet to 50," *Defense News*, Mar. 15-21, 1993, p. 10; Barbara Nagy, "Size of Sub Force Next Policy Battle," *New London Day*, July 20, 1992, pp. A1, A8.

¹¹ Secretary of Defense Les Aspin, U.S. Department of Defense, *Report on the Bottom-Up Review*, Oct. 1993, pp. 55-57.

¹² Secretary of Defense William S. Cohen, U.S. Department of Defense, *Report of the Quadrennial Defense Review*, May 1997, pp. 29, 30, 47.

- “that a force structure below 55 SSNs in the 2015 [time frame] and 62 [SSNs] in the 2025 time frame would leave the CINC’s [the regional military commanders-in-chief] with insufficient capability to respond to urgent crucial demands without gapping other requirements of higher national interest. Additionally, this force structure [55 SSNs in 2015 and 62 in 2025] would be sufficient to meet the modeled war fighting requirements;”
- “that to counter the technologically pacing threat would require 18 Virginia class SSNs in the 2015 time frame;” and
- “that 68 SSNs in the 2015 [time frame] and 76 [SSNs] in the 2025 time frame would meet all of the CINCs’ and national intelligence community’s highest operational and collection requirements.”¹³

The conclusions of the 1999 JCS study were mentioned in discussions of required SSN force levels, but the figures of 68 and 76 submarines were not translated into official DOD force-level goals.

George W. Bush Administration. The George W. Bush Administration’s report on the 2001 QDR revalidated the amended requirement from the 1997 QDR for a fleet of about 310 ships, including 55 SSNs. In revalidating this and other U.S. military force-structure goals, the report cautioned that as DOD’s “transformation effort matures — and as it produces significantly higher output of military value from each element of the force — DOD will explore additional opportunities to restructure and reorganize the Armed Forces.”¹⁴

DOD and the Navy conducted studies on undersea warfare requirements in 2003-2004. One of the Navy studies — an internal Navy study done in 2004 — reportedly recommended reducing the attack submarine force level requirement to as few as 37 boats. The study reportedly recommended homeporting a total of nine attack submarines at Guam and using satellites and unmanned underwater vehicles (UUVs) to perform ISR missions now performed by attack submarines.¹⁵

In March 2005, the Navy submitted to Congress a report projecting Navy force levels out to FY2035. The report presented two alternatives for FY2035 — a 260-

¹³ Department of Navy point paper dated Feb. 7, 2000. Reprinted in *Inside the Navy*, Feb. 14, 2000, p. 5.

¹⁴ U.S. Department of Defense, *Quadrennial Defense Review*, Sept. 2001, p. 23.

¹⁵ Bryan Bender, “Navy Eyes Cutting Submarine Force,” *Boston Globe*, May 12, 2004, p. 1; Lolita C. Baldor, “Study Recommends Cutting Submarine Fleet,” *NavyTimes.com*, May 13, 2004.

ship fleet including 37 SSNs and 4 SSGNs, and a 325-ship fleet including 41 SSNs and 4 SSGNs.¹⁶

In May 2005, it was reported that a newly completed DOD study on attack submarine requirements called for maintaining a force of 45 to 50 boats.¹⁷

As mentioned earlier, in December 2005, it was reported that the Navy is planning a 313-ship fleet, including 48 SSNs.¹⁸ Under this plan, SSNs would account for about 15% of the fleet.

Attack Submarine Force Levels

Historical. During the first half of the Cold War, attack submarines (both nuclear- and non-nuclear-powered) accounted for an increasing percentage of the total size of the Navy, increasing from roughly 10% of total battle force ships in the early 1950s to about 17% by the late 1970s. Since that time, attack submarines have accounted for roughly 17% to 22% of total battle force ships. At the end of FY2005, they accounted for about 19% (54 ships of 282).

The SSN force included more than 90 boats during most of the 1980s, peaked at 98 boats at the end of FY1987, and then began to decline. The force included 85 to 88 boats during the early 1990s, 79 boats at the end of FY1996, 65 boats at the end of FY1998, 57 boats at the end of FY1999, and 56 boats at the end of FY2000. It has since numbered 53 to 56 boats.

As of End of FY2005. The 54 SSNs in service at the end of FY2005 included the following:

- 50 Los Angeles (SSN-688) class boats;
- 3 Seawolf (SSN-21) class boats; and
- 1 Virginia (SSN-774) class boat.

Los Angeles (SSN-688) Class SSNs. A total of 62 Los Angeles-class submarines, commonly called 688s, were procured between FY1970 and FY1990 and entered service between 1976 and 1996. They are equipped with four 21-inch diameter torpedo tubes and can carry a total of 26 torpedoes or Tomahawk cruise missiles in their torpedo tubes and internal magazines. The final 31 boats in the class (SSN-719 and higher) are equipped with an additional 12 vertical launch system (VLS) tubes in their bows for carrying and launching another 12 Tomahawk cruise

¹⁶ U.S. Department of the Navy, *An Interim Report to Congress on Annual Long-Range Plan for the Construction of Naval Vessels for FY 2006*. The report was delivered to the House and Senate Armed Services and Appropriations Committees on Mar. 23, 2005.

¹⁷ Robert A. Hamilton, "Delegation Calls Report on Sub Needs Encouraging," *The Day (New London, CT)*, May 27, 2005; Jesse Hamilton, "Delegation to Get Details on Sub Report," *Hartford (CT) Courant*, May 26, 2005.

¹⁸ Christopher P. Cavas, "U.S. Ship Plan To Cost 20% More," *Defense News*, December 5, 2005: 1, 8. See also David S. Cloud, "Navy To Expand Fleet With New Enemies in Mind," *New York Times*, December 5, 2005.

missiles. The final 23 boats in the class (SSN-751 and higher) incorporate further improvements and are referred to as Improved Los Angeles class boats or 688Is. As of the end of FY2005, 12 of the 62 boats in the class had been retired.

Seawolf (SSN-21) Class SSNs. The Seawolf class was originally intended to include about 30 boats, but Seawolf-class procurement was stopped after three boats as a result of the end of the Cold War and associated changes in military requirements. The three Seawolf-class submarines are the Seawolf (SSN-21), the Connecticut (SSN-22), and the Jimmy Carter (SSN-23). SSN-21 and SSN-22 were procured in FY1989 and FY1991 and entered service in 1997 and 1998, respectively. SSN-23 was originally procured in FY1992. Its procurement was suspended in 1992 and then reinstated in FY1996. It was commissioned into service on February 19, 2005. Seawolf-class submarines are larger than Los Angeles-class boats or previous U.S. Navy SSNs,¹⁹ and are equipped with eight 30-inch-diameter torpedo tubes and can carry a total of 50 torpedoes or cruise missiles.

Virginia (SSN-774) Class Program

General. The Virginia-class attack submarine was designed to be less expensive and better optimized for post-Cold War submarine missions than the Seawolf-class design. The Virginia-class design is slightly larger than the Los Angeles-class design,²⁰ but incorporates newer technologies. Virginia-class boats currently cost about \$2.4 billion each to procure, but the Navy hopes to reduce that cost in coming years in real (i.e., inflation-adjusted) term by increasing the procurement rate to two boats per year and using new technologies to reduce the cost of certain parts of the Virginia-class design.

Procurement Through FY2006. The first Virginia-class boat was procured in FY1998 and entered service on October 23, 2004. As shown in **Table 1** below, a total of eight Virginia-class boats have been procured through FY2006.

Table 1. Virginia-Class Procurement, FY1998-FY2006

FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006
1	1	0	1	1	1	1	1	1

Planned Procurement Rates. The FY2004-FY2009 FYDP that the Administration submitted to Congress in February 2003 projected increasing the Virginia-class procurement rate to two per year starting in FY2007. The amended FY2005-FY2009 FYDP submitted in February 2004 delayed this projected increase two years, to FY2009. The FY2006-FY2011 submitted in February 2005 delayed it

¹⁹ Los Angeles-class boats have a beam (i.e., diameter) of 33 feet and a submerged displacement of about 7,150 tons. Seawolf-class boats have a beam of 40 feet. SSN-21 and SSN-22 have a submerged displacement of about 9,150 tons. SSN-23 was built to a configuration. It is 100 feet longer than SSN-21 and SSN-22 and has a submerged displacement of 12,158 tons.

²⁰ Virginia-class boats have a beam of 34 feet and a submerged displacement of 7,800 tons.

further, to a year beyond FY2011. The FY2007-FY2011 Future Years Defense Plan (FYDP) to be submitted in February 2006 reportedly will propose maintaining the one-per-year procurement rate through FY2011, and then increasing the rate to two per year in FY2012. **Table 2** below compares planned Virginia-class procurement in these FYDPs.

Table 2. Proposed Virginia-Class Procurement

FYDP	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
FY2004-FY2009 FYDP (2/03)	1	1	1	2	2	2		
FY2005-FY2009 FYDP (2/04)		1	1	1	1	2		
FY2006-FY2011 FYDP (2/05)			1	1	1	1	1	1
FY2007-FY2011 FYDP (2/06)			1	1	1	1	1	1

Source: Prepared by CRS using Navy data. Figures for FY2007-FY2011 are based on press reports of the anticipated content of the FY2007-FY2011 FYDP.

Joint Production Arrangement. Virginia-class boats are built jointly by General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI, and Northrop Grumman's Newport News Shipbuilding (NGNN) of Newport News, VA.²¹ Under the arrangement, GD/EB builds certain parts of each boat, NGNN builds certain other parts of each boat, and the yards take turns building the reactor compartments and performing final assembly of the boats. GD/EB is building the reactor compartments and performing final assembly on boats 1, 3, and so on, while NGNN is doing so on boats 2, 4, and so on. The arrangement results in a roughly 50-50 division of Virginia-class profits between the two yards and preserves both yards' ability to build submarine reactor compartments (a key capability for a submarine-construction yard) and perform submarine final assembly work.

The joint production arrangement is a departure from past U.S. submarine construction practices, under which complete submarines were built in individual yards. The joint production arrangement is the product of a debate over the Virginia-class acquisition strategy within Congress, and between Congress and DOD, that occurred in 1995-1997 (i.e., during the markup of the FY1996-FY1998 defense budgets). The goal of the arrangement is to keep both GD/EB and NGNN involved in building nuclear-powered submarines, and thereby maintain two U.S. shipyards capable of building nuclear-powered submarines, while minimizing the cost penalties of using two yards rather than one to build a submarine design that is being procured at a low annual rate.

Multiyear Procurement (MYP) for FY2004-FY2008. As part of its proposed FY2004 budget submitted to Congress in February 2003, the Navy

²¹ GD/EB and NGNN are the only two shipyards in the country capable of building nuclear-powered ships. GD/EB builds submarines only, while NGNN also builds nuclear-powered aircraft carriers and is capable of building other types of surface ships. The submarine industrial base also includes scores of materials and parts suppliers, and laboratories and research facilities, in various parts of the country.

requested multiyear procurement authority (MYP) to procure a total of seven Virginia-class boats during the five-year period FY2004-FY2008 (i.e., one boat per year for FY2004-FY2006, then two boats per year for FY2007-FY2008, as shown in the top line in the table above). Congress, as part of its action on the FY2004 defense budget, granted authority in appropriation bill language for a five-boat MYP during this period (i.e., one boat per year for FY2004-FY2008). The Navy estimates that the five-boat MYP arrangement will reduce the total cost of the five boats by a total of about \$400 million, or an average of \$80 million per boat.²²

The five-boat MYP authority was accompanied by appropriation conference report language that the Navy and other observers interpreted as strongly cautioning the Navy against including funding in future budgets to support the procurement of a second boat in either FY2007 or FY2008.²³ Consistent with this interpretation, the Administration's amended FY2005-FY2009 FYDP includes funding for only one Virginia class boat per year for the period FY2005-FY2008.

Option for Procuring Second Boat in FY2007 or FY2008. Although the FY2004 appropriation bill and report language may effectively discourage the Navy from requesting funding in its budgets for a second boat in FY2007 or FY2008, they do not necessarily prevent a future Congress from funding a second boat in FY2007 or FY2008 that the Navy has not requested funding for, if a future Congress wants to fund such a boat and determines that there is sufficient funding available for the purpose. A future Congress could alter the Virginia-class MYP authority to permit a second boat procured in FY2007 or FY2008 to be covered under the MYP contract. Alternatively, it might be possible to build a second boat procured in FY2007 or FY2008 under a non-MYP contract (i.e., a regular, single-boat construction contract) that is separate from the MYP contract.

In restructuring its budget to support the procurement of five (rather than seven) Virginia-class submarines in FY2004-FY2008, the Navy eliminated advance procurement (AP) funding in FY2005-FY2007 for long-leadtime nuclear-propulsion components for second boats procured in FY2007 and FY2008. The absence of AP funding in FY2005-FY2007, however, would not prevent a future Congress from procuring a second boat in either year. It simply means that the interval between the year of procurement and the year the boat enters service would be two or three years longer than usual (i.e., eight or nine years rather than the usual six years).

Congress can, and has, fully funded the procurement of nuclear-powered ships for which there was no prior-year AP funding for long-leadtime components. Doing so involves funding the entire procurement cost of the ship in the year of procurement, including the funding that normally would have been provided in prior

²² The Navy estimated that a seven-boat MYP arrangement would have reduced the cost of the seven boats in question by an average of about \$115 million per boat.

²³ Section 8008 of the bill approves MYP authority for the Virginia-class program "Provided, That the Secretary of the Navy may not enter into a multiyear contract for the procurement of more than one Virginia Class submarine per year." For the bill and report language on Congress's decision, see H.Rept. 108-283 (FY2004 defense appropriations bill, H.R. 2658/P.L. 108-87) pp. 20, 185-186.

years as AP funding. For example, Congress in FY1988 fully funded the procurement of the aircraft carriers CVN-74 and CVN-75 as a two-ship buy, even though there had been no prior-year AP funding for the ships.²⁴

Submarine Construction Industrial Base

The Base in General. In addition to GD/EB and NGNN, the submarine construction industrial base includes scores of supplier firms in numerous states. By dollar value of what they provide, more than 80% of these supplier firms are the sole sources of what they make for the U.S. submarine program. Observers in recent years have expressed concern for the continued survival of many of these firms.

The submarine construction industrial base went through a period of significant stress due to very low levels of work in the 1990s, after procurement of Seawolf submarines was terminated and before procurement of Virginia-class submarines began. The situation appears to have stabilized in recent years under one-per-year procurement of Virginia-class boats. For nuclear-propulsion component suppliers, an additional source of stabilizing work is the Navy's nuclear-powered aircraft carrier construction program.²⁵ In terms of work provided to these firms, a carrier nuclear propulsion plant is roughly equivalent to five submarine propulsion plants.

Current Concern for Design and Engineering Portion. The part of the submarine industrial base that some observers are currently most concerned about is not the construction portion, but the design and engineering portion, much of which is resident at GD/EB and NGNN. With Virginia-class design work now winding down and no other submarine-design projects underway, the submarine design and engineering base is facing the near-term prospect, for the first time in more than 40 years, of having no major submarine-design project on which to work.

Some Navy and industry officials are concerned that unless a major submarine-design project is begun soon, the submarine design and engineering base will begin to atrophy through the departure of experienced personnel. Rebuilding an atrophied submarine design and engineering base, these Navy and industry officials believe, could be time-consuming, adding time and cost to the task of the next submarine-design effort, whenever it might begin. Concern about this possibility among some Navy and industry officials has been strengthened by the UK's recent difficulties in designing its new Astute-class SSN. The UK submarine design and engineering base atrophied for lack of work, and the subsequent Astute-class design effort has

²⁴ The Administration's FY1988 budget and FY1988-FY1992 FYDP proposed procuring CVN-74 in FY1990, with advanced procurement funding in FY1988 and FY1989, and CVN-75 in FY1993, with advance procurement funding in FY1989-FY1992. Following Congress's decision in FY1988, construction of long-leadtime components began right away, construction of CVN-74 itself began about two years later, and construction of CVN-75 began about two years after that. CVN-74 entered service in 1995, 7 years after the year of procurement (a typical time to build a carrier), and CVN-75 entered service in 1998, 10 years after the year of procurement.

²⁵ For more on this program, see CRS Report RS20643, *Navy CVN-21 Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

experienced considerable delays and cost overruns. Submarine designers and engineers from GD/EB were assigned to the Astute-class project to help the UK overcome these problems.²⁶

On December 6, 2005, GD/EB announced that it would reduce its workforce by 1,900 to 2,400 people by the end of 2006.²⁷ Included in this planned reduction are 300 to 400 employees who belong to the Marine Draftsmen Association (MDA), the union that represents submarine designers at GD/EB.

Recent Procurement Rates and Congressional Concern

The post-Cold War downturn in procurement began sooner and was proportionately deeper for attack submarines than for most other kinds of Navy ships. As a result, achieving and maintaining certain potential future attack submarine force levels in future years could be particularly challenging.

The rate of attack submarine procurement has been a concern in Congress since the mid-1990s. It has been discussed by CRS in testimony to Congress in 1995, 1997, 1999, 2000, 2002, and 2004, in a 1997 CRS presentation to a Defense Science Board task force on the submarine of the future, which issued its report in 1998;²⁸ in a 1999-2000 CRS report,²⁹ in a 2002 CRS report,³⁰ and in this report since its inception in 2004. The discussion here is updated to take into account DOD's FY2006-FY2011 FYDP and the Navy's reported plan for a fleet of 313 ships, including 48 SSNs.

The FY2006-FY2011 FYDP, if implemented, would result in the procurement of 16 SSNs during the 22-year period FY1990-FY2011. These 16 boats include the final Los Angeles class boat (in FY1990), the second and third Seawolf class boats (in FY1991 and FY1996), and the first 13 Virginia class boats (one each in FY1998, FY1999, and FY2001-FY2011). A total of 16 boats in 22 years would equate to an

²⁶ See, for example, Andrew Chuter, "U.K. Spending Mounts for U.S. Help on Sub," *Defense News*, September 13, 2005: 4; Richard Scott, "Electric Boat Provides Project Director for Astute Class," *Jane's Navy International*, May 2004: 33; Richard Scott, "Astute Sets Out on the Long Road to Recovery," *Jane's Navy International*, Dec. 2003, pp. 28-30; Richard Scott, "Recovery Plan Shapes Up for Astute Submarines," *Jane's Defence Weekly*, Nov. 19, 2003, p. 26.

²⁷ Christopher P. Cavas, "Electric Boat To Lay Off Up To 2,400 Workers," *NavyTimes.com*, December 6, 2005; Geoff Fein, "Lack Of Sub Work Leads To Layoffs At Electric Boat," *Defense Daily*, December 7, 2005; Renae Merle, "General Dynamics May Lay Off 2,400," *Washington Post*, December 7, 2005: D2.

²⁸ U.S. Department of Defense, Office of the Under Secretary of Defense For Acquisition & Technology, *Report of the Defense Science Board Task Force on [the] Submarine of the Future*, July 1998, pp. 7, 19-20.

²⁹ CRS Report RL30045, *Navy Attack Submarine Programs: Background and Issues for Congress* (out of print; for a copy, contact the author at 707-7610), by Ronald O'Rourke.

³⁰ CRS Report RL31372, *Navy Shipbuilding in the FY2003 Defense Budget: Issues for Congress* (out of print; for a copy, contact the author at 707-7610), by Ronald O'Rourke.

average procurement rate of about 0.73 boats per year for two-thirds of the SSN fleet's 33-year replacement cycle.

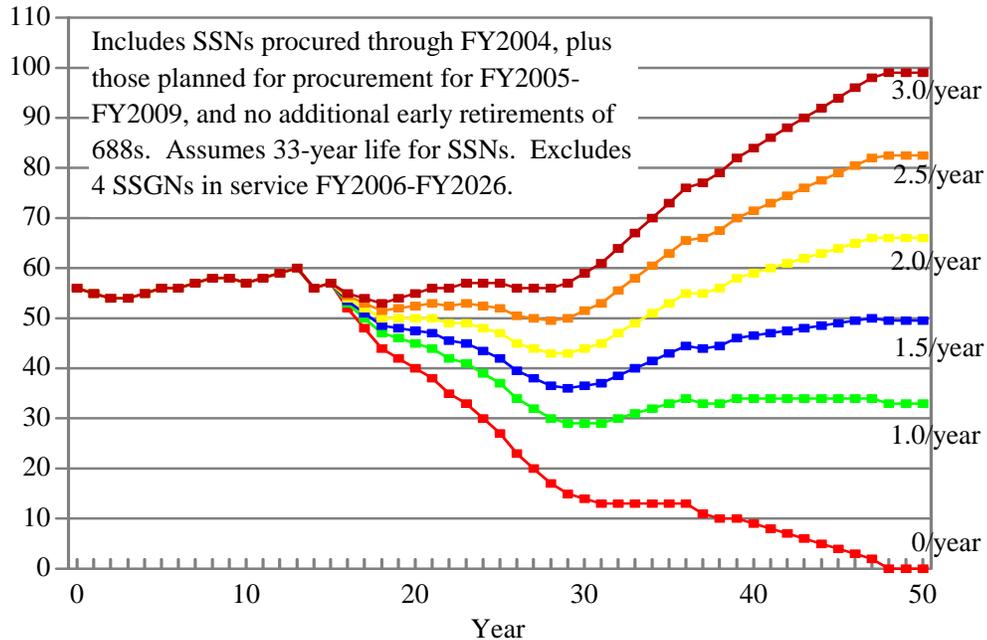
If, during this 22-year period, SSNs were instead procured at an average rate of 1.45 boats per year, which is the steady-state replacement rate for a force of 48 boats with 33-year service lives,³¹ a total of 32 SSNs would be procured. The FY2006-FY2011 FYDP, if implemented, would thus create an SSN procurement backlog, relative to the steady-state replacement rate, of 16 boats (32 minus 16) for the period FY1990-FY2011. This 16-boat backlog in procurement, which is equivalent to about 33% of the 48-boat force-level objective, will be masked between now and about 2015 by the large numbers of SSNs procured during the 1980s. After about 2015, however, SSNs procured during the 1980s will reach retirement age and begin to leave service, and the FY1990-FY2011 backlog in SSN procurement relative to the steady-state procurement rate, if not by then redressed, will begin to become apparent.

The figure below shows the consequences on the size of the SSN force out to the year 2050 of various constant SSN procurement rates after FY2009, assuming two boats are procured in FY2009 (as under the amended FY2005-FY2009 FYDP) and a 33-year life for existing SSNs. The graph assumes no early retirements of SSNs beyond those that occurred through 2003 (i.e., the refueling of all 688s that became or will become available for refuelings since 2003). The graph excludes the four SSGNs that are scheduled to be in service between FY2006 and FY2026. As shown in the graph, the attack submarine force under various constant future procurement rates would reach a minimum level in the late 2020s.

³¹ The steady-state replacement rate is the average procurement rate that would be needed, over the long run, to maintain a force at a given size over the long run. It is equal to the force-level goal divided by expected service life — in this case, 48 boats divided by 33 years, or 1.45 boats per year.

Potential SSN Force Levels, 2000-2050

Notional projections resulting from post-FY2009 SSN procurement rates ranging from 0 per year to 3 per year



Oversight Issues for Congress

The current situation regarding attack submarines poses at least two potential oversight issues for Congress:

- What should the attack submarine force-level goal be?
- At what rate should Virginia-class submarines be procured in coming years?

Each of these issues is addressed below. **Appendix B** discusses supplementary oversight issues for Congress.

Attack Submarine Force-Level Goal

What should the attack submarine force-level goal be?

For a more in-depth discussion of this issue, see **Appendix A**. Key points arising from this discussion include the following:

- Some Navy submarine officers in recent years have argued that an attack submarine force of roughly 55 boats — the approximate number in the force in recent years — is insufficient to meet day-to-day demands for attack submarines from U.S. regional military

combatant commanders, at least not without operating attack submarines at higher-than-desired operational tempos. Much of the day-to-day demand for attack submarines appears to be for performing ISR missions. A force of 70 or more submarines, Navy submarine officers and DOD officials have argued or implied, would be needed to meet all day-to-day demands for attack submarines, at least not without operating attack submarines at an elevated operational tempo.

- Recent major U.S. warfighting operations have used relatively small numbers of attack submarines — about a dozen or less in each case. Certain potential future major U.S. warfighting scenarios, such as a conflict on the Korean Peninsula or a conflict with China, may feature a greater maritime component and consequently require a larger number of attack submarines.
- Submarine-launched unmanned underwater vehicles (UUVs), by permitting each submarine to perform a greater number of underwater missions at the same time, could, other things held equal, be used to argue in favor of having fewer attack submarines. On the other hand, submarine-launched unmanned air vehicles (UAVs), by permitting attack submarines to perform overhead and deep-inland ISR operations now performed by satellites or by aircraft launched from land bases and surface ships, could, other things held equal, be used to argue in favor of having more attack submarines.
- Homeporting up to eight additional attack submarines at Guam (beyond the three already homeported there) and operating attack submarines with dual or multiple crews — both suggested by the Congressional Budget Office (CBO) in a March 2002 report³² — could, other things held equal, reduce the number of attack submarines needed to perform a given set of submarine missions and consequently could, other things held equal, be used to argue in favor of having fewer attack submarines.
- Converting two or four additional Trident SSBNs into SSGNs (beyond the four already planned for conversion) could, other things held equal, reduce at the margin the number of attack submarines needed to perform a given set of submarine missions and consequently could, other things held equal, be used to argue in favor of having fewer attack submarines. The opportunity to convert two or four additional Trident SSBNs into SSGNs would depend on a decision to reduce the SSBN force from the currently planned total of 14 ships to 12 or 10 ships.

³² U.S. Congressional Budget Office, *Increasing the Mission Capability of the Attack Submarine Force*, Mar. 2002.

- Submarines from allied and friendly countries, particularly the United Kingdom (UK) and Australia, might occasionally be able to perform missions that might otherwise be performed by U.S. attack submarines and thereby reduce requirements for U.S. attack submarines. The reduction in requirements for U.S. attack submarines, however, might be fairly small, and planning U.S. forces on the assumption that foreign submarines will be available to perform these missions entails some risk, given inherent uncertainty over the future policies of foreign governments.

Future Virginia-Class Procurement Rate

At what rate should Virginia-class submarines be procured in coming years?

In considering the rate at which Virginia-class submarines should be procured in coming years, key factors to consider include the following:

- the attack submarine force-level goal;
- attack submarine service lives;
- the effect of annual procurement rates on unit procurement costs;
- industrial-base considerations; and
- funding requirements for other defense-spending priorities.

Attack Submarine Force-Level Goal. The attack submarine force-level goal, once determined, is a primary factor to consider in assessing at what rate Virginia-class boats should be procured in coming years.

Long-Term Steady-State Replacement Rate. One potential starting point in relating a force-level goal to required procurement rates is to calculate the steady-state replacement rate, which is the average procurement rate that would be needed over the long run to maintain a force of a given size over the long run.³³ The table below shows steady-state replacement rates for submarine forces varying in size from 30 to 80. The table assumes a 33-year service life for attack submarines.

³³ As mentioned in the Background section, the steady-state replacement rate equals the desired force level divided by the expected service life of the platforms in question.

Table 3. Steady-State Replacement Rates
(assuming 33-year life for attack submarines)

Planned force size	Steady-state replacement rate (ships per year)
30	0.91
40	1.21
48	1.45
50	1.52
55	1.67
60	1.82
70	2.12
80	2.42

Steady-state replacement rates are averages that must be met over the long term (in this case, over a 33-year period). Over shorter periods, the actual procurement rate can be either above or below the steady-state rate, depending on factors such as the age distribution of the existing force, available funding, and industrial-base considerations. If the actual procurement rate is below the steady-state rate for some number of years, though, it must eventually be elevated above the steady-state rate, so that the average rate, calculated over the entire period in question, comes back to the steady-state rate.

Force-Level Consequences Of Steady Procurement Profiles. Table 4 presents the force-level consequences through FY2050 of steady attack submarine procurement rates of 1, 1.5, and 2 boats per year. The table also shows the 30-year procurement profile from the December 30, 2005, draft version of the Navy's report to Congress on the Navy's 30-year shipbuilding plan, which increases the procurement rate to 2 boats per year in FY2012, and then decreases it to 1.5 boats per year for FY2029-FY2036.³⁴

The force-level consequences of these procurement rates reflect the age distribution of the SSN force. The SSN force is not evenly distributed in age because it includes a large number of boats procured in the 1980s and a relatively small number procured since FY1990.

The table shows, among other things, that none of these procurement profiles — not even 2 boats per year starting in FY2007 — is sufficient to avoid dropping below 48 attack submarines for some period of time starting between FY2018 and FY2026.

³⁴ U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2007* (draft version dated December 30, 2005). 12 pp. A copy of the document is posted on the Internet at [<http://www.insidedefense.com/>].

Table 4. Steady Procurement Rates & Resulting Force Levels
(number procured each [left] and number in service that year [right])

FY	1/year		1.5/year starting FY12		1.5/year starting FY09		Draft Navy plan (12/30/05)		2/year starting FY12		2/year starting FY09		2/year starting FY07	
07	1	56	1	56	1	56	1	56	1	56	1	56	2	56
08	1	57	1	57	1	57	1	57	1	57	1	57	2	57
09	1	57	1	57	2	57	1	57	1	57	2	57	2	57
10	1	56	1	56	1	56	1	56	1	56	2	56	2	56
11	1	57	1	57	2	57	1	57	1	57	2	57	2	57
12	1	58	2	58	1	58	2	58	2	58	2	58	2	58
13	1	59	1	59	2	59	2	59	2	59	2	59	2	59
14	1	55	2	55	1	55	2	55	2	55	2	55	2	55
15	1	55	1	55	2	56	2	55	2	55	2	56	2	58
16	1	51	2	51	1	52	2	51	2	51	2	53	2	55
17	1	49	1	49	2	51	2	49	2	49	2	52	2	54
18	1	46	2	47	1	48	2	47	2	47	2	50	2	52
19	1	45	1	46	2	48	2	47	2	47	2	50	2	52
20	1	44	2	46	1	47	2	47	2	47	2	50	2	52
21	1	43	1	45	2	47	2	47	2	47	2	50	2	52
22	1	41	2	44	1	45	2	46	2	46	2	49	2	51
23	1	40	1	43	2	45	2	46	2	46	2	49	2	51
24	1	38	2	42	1	43	2	45	2	45	2	48	2	50
25	1	36	1	40	2	42	2	44	2	44	2	47	2	49
26	1	33	2	38	1	39	2	42	2	42	2	45	2	47
27	1	31	1	36	2	38	2	41	2	41	2	44	2	46
28	1	29	2	35	1	36	2	40	2	40	2	43	2	45
29	1	28	1	34	2	36	1	40	2	40	2	43	2	45
30	1	28	2	35	1	36	2	41	2	41	2	44	2	46
31	1	28	1	35	2	37	1	42	2	42	2	45	2	47
32	1	29	2	37	1	38	2	44	2	44	2	47	2	49
33	1	30	1	38	2	40	1	46	2	46	2	49	2	51
34	1	31	2	40	1	41	2	48	2	48	2	51	2	53
35	1	32	1	41	2	43	1	49	2	50	2	53	2	55
36	1	33	2	43	1	44	2	51	2	52	2	55	2	57
37	1	33	1	43	2	45	n/a	51	2	53	2	56	2	58
38	1	33	2	44	1	45	n/a	52	2	54	2	57	2	59
39	1	33	1	44	2	46	n/a	52	2	55	2	58	2	60
40	1	33	2	45	1	46	n/a	53	2	56	2	59	2	61
41	1	33	1	45	2	47	n/a	53	2	57	2	60	2	62
42	1	33	2	46	1	47	n/a	54	2	58	2	61	2	63
43	1	33	1	46	2	48	n/a	n/a	2	59	2	62	2	64
44	1	33	2	47	1	48	n/a	n/a	2	60	2	63	2	65
45	1	33	1	47	2	49	n/a	n/a	2	61	2	64	2	66
46	1	33	2	48	1	49	n/a	n/a	2	62	2	65	2	66
47	1	33	1	48	2	50	n/a	n/a	2	63	2	66	2	66
48	1	33	2	49	1	49	n/a	n/a	2	64	2	66	2	66
49	1	33	1	49	2	50	n/a	n/a	2	65	2	66	2	66
50	1	33	2	50	1	49	n/a	n/a	2	66	2	66	2	66

Source: Prepared by CRS using Navy data. n/a = data not available

The projections in **Table 4** assume a 6-year construction period³⁵ and 33-year service life for attack submarines. If service life turns out to be less than 33 years, resulting force levels would be lower than those shown in the table.

Notional Procurement Profiles for Forces of 30 to 80 Boats. **Table 5** presents notional attack submarine procurement profiles for the 25-year period FY2007-FY2031 for supporting attack submarine forces of 30, 40, 48, 50, 55, 60, and 70 boats (excluding any SSGNs). None of the profiles calls for procuring more than four boats per year — the maximum annual rate that was achieved for attack submarines during the Cold War years of the 1980s, when the Navy was working toward achieving and maintaining a force of 100 SSNs.

For the Navy's reported planned force level of 48 SSNs, **Table 5** shows three profiles — A, B, and C — that increase the procurement rate to two boats per year in FY2012, FY2009, and FY2007, respectively. As can be seen from these three profiles, starting to procure two boats per year earlier reduces the number of subsequent years in which three boats need to be procured.

³⁵ Exceptions to the 6-year construction period include the second boats procured in FY2007 and FY2008, which are assumed to enter service 8 years and 7 years after they are procured, respectively, due to lack of advance procurement funding for the FY2007 boat in FY2005 and FY2006 and for the FY2008 boat in FY2006.

Table 5. Notional Procurement Profiles for Various Force Sizes
(Years with 3 or 4 boats shown in bold)

FY	Size of force supported — total number of boats in force																	
	30		40		48						50		55		60		70	
					A (2/year starts FY12)		B (2/year starts FY09)		C (2/year starts FY07)									
07	1	56	1	56	1	56	1	56	2	56	2	56	2	56	2	56	2	56
08	1	57	1	57	1	57	1	57	2	57	2	57	2	57	3	57	3	57
09	1	57	1	57	1	57	2	57	2	57	2	57	2	57	3	57	4	57
10	1	56	1	56	1	56	2	56	2	56	2	56	2	56	4	56	4	56
11	1	57	1	57	1	57	2	57	2	57	2	57	3	57	4	57	4	57
12	1	58	2	58	2	58	2	58	2	58	2	58	3	58	3	58	4	58
13	1	59	2	59	2	59	2	59	2	59	2	59	3	59	3	59	4	59
14	1	55	2	55	3	55	2	55	2	55	2	55	2	55	2	55	4	55
15	1	55	2	55	2	55	2	56	2	58	2	58	2	58	2	60	4	61
16	1	51	2	51	3	51	2	53	2	55	2	55	3	55	3	59	4	60
17	1	49	2	49	3	49	2	52	2	54	2	54	3	55	3	60	4	61
18	1	46	2	47	3	47	3	50	2	52	3	52	3	54	3	59	3	61
19	1	45	2	47	3	47	3	50	2	52	3	52	3	55	3	60	3	63
20	1	44	2	47	3	48	3	50	3	52	3	52	3	55	3	60	4	65
21	1	43	2	47	3	48	3	50	3	52	3	52	3	55	3	60	3	67
22	2	41	2	46	3	48	3	49	3	51	3	51	3	55	3	60	3	68
23	2	40	2	46	2	49	2	49	2	51	2	51	2	56	2	61	2	70
24	1	38	1	45	1	49	1	49	1	50	1	51	1	56	1	61	1	70
25	1	36	1	44	1	49	1	49	1	49	1	51	1	56	1	61	1	70
26	0	33	0	42	0	48	0	48	0	48	0	50	0	55	0	60	0	70
27	0	31	0	41	0	48	0	48	0	48	0	50	0	55	0	60	0	70
28	0	30	0	40	0	48	0	48	0	48	0	50	0	55	0	60	0	70
29	0	30	0	40	0	48	0	48	0	48	0	50	0	55	0	60	0	70
30	0	30	0	40	0	48	0	48	0	48	0	50	0	55	0	60	0	70
31	1	30	1	40	1	48	1	48	1	48	1	50	1	55	1	60	1	70

Source: Prepared by CRS using U.S. Navy data.

The following points arise from the figures in the table and the data underlying the figures:

- **For a 30-boat force.** Supporting a force of 30 boats could involve maintaining an average procurement rate of about 1 boat per year into the 2020s. If all SSNs are operated to the end of their expected 33-year lives, then the force would decline to 30 boats by 2028 and remain there after that. The force could be reduced to 30 boats much sooner by accelerating the retirement of older SSNs.

- **For a 40-boat force.** Supporting a force of 40 boats could involve maintaining an average procurement rate of 2 boats per year from FY2012 to FY2023. If all SSNs are operated to the end of their expected 33-year lives, then the force would decline to 40 boats by 2028 and remain there after that. The force could be reduced to 40 boats much sooner by accelerating the retirement of older SSNs.
- **For a 48-boat force.** Supporting the Navy's reportedly planned force of 48 boats could involve procuring a total of 35 boats during the 16-year period FY2007-FY2022, or an average of about 2.2 boats per year. If all SSNs are operated to the end of their expected 33-year lives, then the force would decline to about 48 boats by 2018 (Profile A) or FY2026 (Profiles B and C) and remain about there after that. As stated earlier, starting to procure two boats per year earlier reduces the number of subsequent years in which three boats need to be procured. The force could be reduced to 48 boats sooner by accelerating the retirement of older SSNs.
- **For a 50-boat force.** Supporting a force of 50 boats could involve procuring a total of 37 boats during the 16-year period FY2007-FY2022, or an average of about 2.3 boats per year. If all SSNs are operated to the end of their expected 33-year lives, then the force would decline to 50 boats by 2026 and remain there after that. The force could be reduced to 50 boats sooner by accelerating the retirement of older SSNs.
- **For a 55-boat force.** Supporting a force of 55 boats could involve procuring a total of 42 boats during the 16-year period FY2007-FY2022, or an average of about 2.6 boats per year.
- **For a 60-boat force.** Achieving and maintaining a force of about 60 boats could involve procuring a total of 47 boats during the 16-year period FY2007-FY2022, or an average of about 2.9 boats per year. The force would reach 60 boats by 2015 and remain about there after that.
- **For a 70-boat force.** Achieving and maintaining a force of about 70 boats could involve procuring a total of 57 boats during the 16-year period FY2007-FY2022, or an average of about 3.6 boats per year. The force would reach 70 boats by 2023 and remain about there after that.

Attack Submarine Service Lives. As mentioned earlier, SSNs have expected service lives of 33 years. The notional procurement profiles outlined above reflect this figure. As also mentioned earlier, however, the current high operational tempo for the attack submarine force could reduce the service lives of SSNs to something less than 33 years by accelerating the rate at which reactor core life is used up. If the service lives of existing SSNs turn out to be less than 33 years due to either higher-than-planned rates of reactor core use or general wear and tear on the ships,

then the procurement rates needed to maintain attack submarine forces of various sizes may need to be greater than shown in the notional profiles outlined above.

Conversely, if the service lives of SSNs can be increased to something greater than 33 years, then procurement rates needed to maintain attack submarine forces of various sizes could possibly be lower than shown in the notional profiles outlined above. If, for example, the service lives of Navy SSNs can be extended to 40 years, then an annual procurement rate of 1 or 1.5 boats per year would, over the long run, be sufficient to maintain a force of 40 to 60 boats, rather than 33 boats.

The feasibility and potential cost of extending the service lives of the Navy's SSNs is not clear. The Navy a few years ago increased the expected service lives of its SSBNs (including the four being converted into SSGNs) from 30 years to 42 years, with the new 42-year life to consist of two 20-year operating periods with a two-year refueling in between. The typical mission profile of an SSBN, however, may be less stressful on the boat than is the typical mission profile of an SSN. Compared to SSBN operations, SSN operations can involve submerging and surfacing more frequently (placing more frequent cyclic stress on the submarine's pressure hull) and more frequent high-speed runs (which can lead to higher rates of wear and tear on propulsion machinery).

Unlike earlier Navy SSNs, which were built with reactor cores intended to last about 15 years, Seawolf- and Virginia-class boats have cores that are intended to last the 33-year expected life of the ship. Extending the lives of Seawolf- or Virginia-class boats 40 years, if feasible, could thus involve changing their life-cycle maintenance plans to include a refueling at about age 33 or earlier.

Annual Procurement Rates and Unit Procurement Costs. A third factor to consider in determining the rate at which Virginia-class submarines should be procured in future years is the effect of annual procurement rates on unit procurement costs. Due to increased spreading of fixed overhead costs at the shipyards and supplier firms, and reduced loss of learning between ships at the shipyards and possibly also at supplier firms, procuring attack submarines at higher annual rates can reduce their unit procurement cost by several percent.³⁶ Cost figures in the FY2004 and FY2005 budget submission, for example, suggest that increasing the procurement rate from one boat per year to two per year can reduce unit procurement cost by more than \$100 million, and possibly more than \$200 million.³⁷

³⁶ For a discussion of improved economies of scale in Navy shipbuilding due to increased spreading of fixed overhead costs and reduced loss of learning between ships, see CRS Report 96-785, *Navy Major Shipbuilding Programs and Shipbuilders: Issues and Options for Congress*, by Ronald O'Rourke. The report is out of print and is available directly from the author.

³⁷ In the FY2005 budget submission, the two Virginia-class boats programmed for FY2009 have an estimated total procurement cost of \$4,940.1 million, or an average of \$2,470.0 million per boat, while the one Virginia-class boat programmed for FY2008 has an estimated total procurement cost of \$2,593.5 million. The difference in unit procurement costs between the two years is \$123.5 million. The FY2008 boat, moreover, is being
(continued...)

Industrial-Base Considerations. A fourth factor to consider in determining the rate at which Virginia-class submarines should be procured in future years is the submarine construction industrial base, which currently includes something more than one complete submarine production line divided between two shipyards (GD/EB and NGNN),³⁸ plus an array of material and component suppliers, many of which are sole sources. Industrial-base considerations include the following:

- the minimum annual production rate for maintaining the submarine construction industrial base;
- the maximum annual production rate that could be achieved by the submarine construction industrial base; and
- potential inefficiencies resulting from certain kinds of year-to-year changes in the annual submarine procurement rate.

Minimum Production Rate. The current one-per-year Virginia-class procurement rate appears to have been sufficient, in conjunction with other supporting forms of work (including aircraft carrier procurement and SSGN

³⁷ (...continued)

procured under a MYP arrangement that is reducing its cost by roughly \$80 million, while the estimated procurement cost for the two FY2009 boats may not reflect an assumed follow-on MYP. If so, then increasing the cost of the FY2008 boat to set aside differences due to use or non-use of MYP, and thereby arrive at a more apples-to-apples comparison, would increase the cost of that boat (and consequently the difference in unit procurement costs between that boat and the FY2009 boats) by about \$80 million, for a total difference of more than \$200 million. (This figure might be increased by another 2%, reflecting an average 2% difference in purchasing power between the then-year dollars used to build a boat procured in FY2008 vs. the then-year dollars used to build boats procured in FY2009.) The cost difference might then be adjusted downward to reflect the later position on the production learning curve of the FY2009 boats compared to the FY2008 boat.

In the FY2004 budget submission, on the other hand, the two Virginia-class boats programmed for FY2007 had an estimated procurement cost of \$4,424.0 million, or an average of \$2,212.0 million per boat, while the one Virginia-class boat programmed for FY2006 had an estimated total procurement cost of \$2,220.8 million. In this case, moving from one boat per year to two boats per year did not appear to produce a significant apparent reduction in unit procurement cost.

The FY2004 and FY2005 budget submissions can also be compared against one another to examine differences in estimated unit costs for procuring one boat per year in FY2007 and FY2008 (as in the FY2005 submission) vs. two boats per year in FY2007 and FY2008 (as in the FY2004 submissions). This comparison is more difficult to make because the two submissions appear to reflect different understandings of what Virginia-class boats would cost to procure at any annual rate (with estimated costs in the FY2005 submission generally higher). Attempting to adjust for the different understandings, however, suggests that increasing the procurement rate from one ship per year to two ships per year might reduce unit procurement cost by more than \$100 million, and possibly more than \$200 million.

³⁸ Under the current joint-production arrangement for the Virginia class, the two yards each maintain facilities for building submarine reactor compartments and for carrying out final assembly and testing of submarines.

conversions),³⁹ to maintain the submarine construction industrial base in recent years. The submarine construction industrial base also appears to have managed the one-year hiatus in Virginia-class procurement in FY2000, suggesting the industrial base might be able to manage occasional one-year gaps in the future. In contrast, the submarine construction industrial base appears to have had greater difficulty managing the longer gaps in submarine procurement that occurred in the 1990s.

This experience suggests that the minimum annual procurement rate for sustaining the submarine construction industrial base in its current form might be one boat per year, or perhaps something a bit less than one per year (as a result of occasional single-year gaps in procurement), provided that other supporting forms of work, including aircraft carrier construction, are also funded.

A procurement rate of significantly less than one per year, in contrast, might not be sufficient to maintain the submarine construction industrial base in its current form. Under this scenario, critical supplier firms might be at risk of going out of business, and shipyard workers with skills critical to submarine construction might need to be laid off. Navy and industry officials have cautioned on many occasions since the 1990s that reconstituting parts of the submarine construction industrial base following a period of very-low-rate procurement could require substantial time and cost due to the need to create and certify replacement supplier firms and hire and train new submarine construction workers.

Maximum Annual Production Rate. In the mid-1990s, GD/EB officials stated that their shipyard could build a maximum of three attack submarines per year, while officials at Newport News Shipbuilding (now NGNN) stated that their shipyard could build a maximum of four attack submarines per year, making for a combined maximum production capability of seven attack submarines per year.⁴⁰

In the years since then, the two shipyards have streamlined their operations to bring them more into alignment with the current one-per-year submarine procurement rate. In doing so, however, the two yards do not appear to have taken any steps (such as selling critical parcels of land that would be needed for additional production

³⁹ Procurement of aircraft carriers results in additional nuclear-ship construction work at NGNN and additional work for nuclear-propulsion component suppliers. The SSGN conversion program includes manufacturing of components for the SSGN conversions. The SSGN conversions are being carried out at government-operated naval shipyards at Norfolk, VA, and Bremerton, WA.

⁴⁰ Source: CRS Report 96-785, *Navy Major Shipbuilding Programs and Shipbuilders: Issues and Options for Congress*, by Ronald O'Rourke. The figures were based on interviews with officials from the two shipyards. The figure for GD/EB pertained to its Land Level Construction Facility (LLCF); additional submarines could be built at GD/EB's older inclined building ways. The figure for Newport News Shipbuilding pertained to its Modular Outfitting Facility (MOF); additional submarines could be built at the yard's graving docks. As noted in the 1996 CRS report, achieving and maintaining these maximum rates could require the yards to curtail or eliminate other forms of work, or result in levels of employment at the yards that could strain the managerial and supervisory capabilities of the yards. The figures also did not take into account possible capacity limitations in critical supplier firms that could prevent these rates from being achieved.

facilities) that would prevent them from returning to higher rates of production. Officials at both yards state that they could return to a combined rate of four or more submarines per year.⁴¹

The supplier base for submarine construction was reduced during the 1990s to bring it into alignment with the current one-per-year submarine procurement rate. Building the supplier base back up to support a procurement rate of three or four boats per year is possible. It would, however, require time and money, particularly for nuclear propulsion plant component suppliers. Increasing the production capacity of the nuclear component supplier base to support a procurement rate of three or four submarines per year starting FY2011 would require roughly \$100 million (for a rate of three submarines per year) or \$200 million (for a rate of four submarines per year). This additional funding would be required over the next several years, with the first increment required in FY2005. If the procurement rate is increased to three or four per year prior to FY2011 (as it would be under some of the notional profiles shown in **Table 5**), some of the submarines procured in those years would take a year or more longer to build than usual due to nuclear component supplier bottlenecks.⁴²

Inefficiencies from Certain Year-to-Year Rate Changes. Moving abruptly from a lower annual production rate to a higher rate (i.e., moving from one boat in a given year to three or four boats the following years) can lead to transitional strains at the shipyards and suppliers as they attempt to increase their production facilities and hire and train large numbers of new workers. Such strains can lead to production inefficiencies and higher costs. The notional procurement profiles in **Table 5** avoid such abrupt jumps by increasing the procurement rate from one year to the next by no more than one boat per year.

Procurement profiles that, within a period of a few years, reduce the procurement rate significantly and then increase it again (even by no more than one boat per year) can lead to production inefficiencies and higher costs due to the need to either keep skilled workers on the payroll during the period of decline, or to hire and train new workers during the subsequent period of increase. Notional examples of such “roller coaster” procurement profiles might be 2-0-1-2, 3-1-2-3, or 4-2-1-2-3. The notional procurement profiles in **Table 5** attempt to avoid such profiles, though they all drop to zero boats per year by the late 2020s.

Other Defense Spending Priorities. A fifth factor to consider in determining the rate at which Virginia-class submarines should be procured in future years is the need for the Department of the Navy, and DOD generally, to provide funding for various programs other than submarine procurement within a budget of a certain size. Starting within the Navy’s shipbuilding budget and moving outward, examples of such defense spending priorities include, among other things, the following:

⁴¹ Source: CRS telephone conversations with General Dynamics and Northrop Grumman officials, May 4, 2004.

⁴² Source: Information provided to CRS by Naval Nuclear Propulsion Office (NAVSEA-08H), May 5, 2004.

- procurement of other kinds of Navy ships, including aircraft carriers, DD(X) destroyers, CG(X) cruisers, Littoral Combat Ships (LCSs), amphibious ships, Maritime Prepositioning Force (Future) ships, and other auxiliary and support ships;
- procurement of Navy and Marine Corps aircraft such as F/A-18E/F strike fighters, F-35 Joint Strike Fighters (JSFs), V-22 tilt-rotor aircraft, and helicopters;
- procurement of Navy and Marine Corps unmanned vehicles;
- procurement of Marine Corps ground combat equipment;
- procurement of Navy and Marine Corps missiles and other munitions;
- Navy and Marine Corps research and development programs;
- Navy and Marine Corps operation and maintenance (O&M) funding;
- pay and benefits for Navy and Marine Corps personnel;
- analogous spending priorities for the Army, the Air Force, and the Missile Defense Agency;
- national ISR systems; and
- programs, otherwise not included above, that support the war on terrorism.

In considering these other defense spending priorities, a key question is how the risks of procuring fewer SSNs than preferred might compare to the risks of providing less funding than desired for one or more of these other priorities.

Legislative Activity for FY2007

DOD's proposed FY2007 budget and FY2007-FY2011 Future Years Defense Plan (FYDP) are scheduled to be submitted to Congress in early February 2006.

Letter to Chief of Naval Operations. Anticipating that the FY2007-FY2011 FYDP will call for procuring one Virginia-class submarine per year through FY2011, and for increasing the rate to two boats per year starting in FY2012, seven Members of Congress sent a letter dated January 13, 2006 to Admiral Michael Mullen, the Chief of Naval Operations, asking the Navy to increase the Virginia-class procurement rate to two boats per year starting in FY2009 rather than FY2012. The letter states in part:

Production of two Virginia Class submarines per year beginning in FY 2009 will lower risk in the shipbuilding plan, decrease unit cost to the Navy, maximize warfighting capabilities, and enhance stability in the defense industrial base. This increased work volume is critical to the shipbuilders' ability to meet your \$2 billion ship cost goal.

The long-time objective of building two SSNs per year by 2009 will lower operational risk to U.S. national security. Navy testimony and intelligence community assessments indicate that DOD must accelerate SSN production immediately in order to meet the global threat. The U.S. Combatant Commanders, for instance, request 150 percent of the submarine days currently available to execute priority operations.

Building two SSNs per year in 2009 instead of 2012 will yield a larger submarine fleet, boosting warfighting capability in an escalating threat environment. The current schedule shows the submarine force dropping to a low of 40 by 2028. If the Navy requires 48 nuclear attack submarines, as you have suggested, then the shipbuilding plan should hold as close to that number as possible for as many years as possible. The alternative is higher risk and less stability for our U.S. Combatant Commanders.⁴³

Legislative Activity for FY2006

FY2006 Defense Authorization Bill (H.R. 1815/S. 1042)

House (H.R. 1815). Section 121 of H.R. 1815 as reported by the **House Armed Services Committee** (H.Rept. 109-89 of May 20, 2005) limits the procurement cost of the Virginia-class submarines being procured during the period FY2004-FY2008, which is covered by a multiyear procurement arrangement. H.Rept. 109-89 recommends approving the Navy's FY2006 procurement funding request for the Virginia-class program (page 61).

Section 217 of the bill as reported directs the Navy to design and develop a new class of nuclear-powered submarine that would be at least as capable as the Virginia class, but dramatically less expensive. The section states:

SEC. 217. PROGRAM TO DESIGN AND DEVELOP NEXT-GENERATION NUCLEAR SUBMARINE.

(a) Program Required- The Secretary of the Navy shall carry out a program to design and develop a class of nuclear submarines that will serve as a successor to the Virginia class of nuclear submarines.

(b) Objective- The objective of the program required by subsection (a) is to develop, for procurement beginning with fiscal year 2014, a nuclear submarine that meets or exceeds the warfighting capability of a submarine of the Virginia class at a cost dramatically lower than the cost of a submarine of the Virginia class.

(c) Report —

(1) IN GENERAL- The Secretary of the Navy shall include, with the defense budget justification materials submitted in support of the President's budget for fiscal year 2007 submitted to Congress under section 1105 of title 31, United States Code, a report on the program required by subsection (a).

(2) CONTENTS- The report shall include —

⁴³ Letter dated January 13, 2006 to Admiral Michael G. Mullen, Chief of Naval Operations, from Representative Rob Simmons, Representative Jo Ann Davis, Representative Neil Abercrombie, Representative James R. Langevin, Representative Robert A. Brady, Representative Madeleine Z. Bordallo, and Representative Thelma D. Drake; copy provided to CRS on January 18, 2006 by Navy Office of Legislative Affairs.

- (A) an outline of the management approach to be used in carrying out the program;
- (B) the goals for the program; and
- (C) a schedule for the program.

H.Rept. 109-89 states:

This section would require the Secretary of the Navy to carry out a program to design and develop a class of nuclear submarines that will serve as a successor to the Virginia class of nuclear submarines. This section would require the Secretary to commence design of the next generation nuclear submarine to follow the Virginia class, beginning construction in about fiscal year 2014.

The committee is aware that for the first time in 50 years, the Navy does not have a program to develop a nuclear submarine. Nuclear submarines, beginning with the Nautilus, have provided unmatched, important capabilities for this nation, and were instrumental in winning the Cold War.

In the last five decades the United States has developed an unequalled capability to design, develop and manufacture the world's top nuclear submarines. However, the committee is aware that this unique capability to design nuclear submarines is perishable. The recent example of the United Kingdom's problems with its new Astute class nuclear submarine is a clear indication of what happens when the submarine design capability is not maintained.

The committee understands that the only means by which the United States can expect to maintain its design capability is to continue to employ those designers to develop new submarine designs.

The committee is aware that existing submarine designs have emphasized open ocean capabilities. While the Virginia, Seawolf, and Los Angeles classes all operate effectively in the littoral, they were optimized for the open ocean. The committee believes that for the foreseeable future, the littoral rather than open ocean is the area of greatest importance. The committee sees an opportunity to maintain nuclear submarine design expertise developing a new class of nuclear submarine optimized for the littoral. This design shall make maximum use of emerging technologies, including those spawned by the joint Navy-Defense Advanced Research Projects Agency (DARPA) Tango Bravo project to develop a design optimized for littoral operations that dramatically reduces submarine cost while providing applicable warfighting capability equal to or greater than the Virginia class. (Pages 257-258)

Senate (S. 1042). The **Senate Armed Services Committee**, in its report on S. 1042 (S.Rept. 109-69 of May 17, 2005), recommends approving the Navy's FY2006 procurement funding request for the Virginia-class program (page 50). In the section on the Navy's research and development account, the report stated:

The budget request included \$163.0 million in PE [program element] 63562N for advanced submarine system development. Of this amount, \$50.0 million is for the design of a future undersea superiority system alternative to the reduced submarine program to include consideration of new propulsion systems. The committee is aware that this effort was directed by the Department of

Defense shortly before submission of the budget request, and that it was also directed that these funds not just be added to existing systems. No specific plans on the use of these funds have been provided to the committee.

The committee has received a study on Fleet Platform Architecture that was prepared by the Office of Force Transformation in response to section 216 of the National Defense Authorization Act for Fiscal Year 2004 (Public Law 108 — 136), and is aware that this study recommends investigating alternate propulsion systems for submarines.

In written testimony before the Subcommittee on Seapower of the Committee on Armed Services, the Congressional Research Service addressed alternate propulsion systems for submarines. The air-independent propulsion equipped non-nuclear-powered submarine would offer increased low speed submerged endurance over the conventional diesel-electric, but comparable submerged endurance at high speed. The testimony concluded that these alternatives to nuclear-powered submarines are not well suited for submarine missions that require: (1) long, completely stealthy transits from home port to the theater of operation; (2) submerged periods in the theater of operation lasting more than two or three weeks; or (3) submerged periods in the theater of operation lasting more than a few hours or days that involve moving the submarine at something more than low speed. The committee is concerned with the reduced capabilities and lack of operational flexibility the submarine forces would possess with these new propulsion systems.

The committee is also aware of and supports the “Tango Bravo” program, being conducted jointly by the Navy and the Defense Advanced Research Projects Agency (DARPA). The technologies being investigated in this program include shaftless propulsion and weapons external to the pressure hull, all of which could contribute to a smaller, less expensive nuclear-powered submarine with capabilities equivalent to those of the Virginia-class submarine.

Numerous analyses have supported an attack submarine force of at least 55 boats. However, the Secretary of the Navy, in an interim report to Congress on the annual long-range plan for the construction of naval vessels, projects that the number of attack submarines required in the future will be between 37 and 41 boats. The committee is concerned that this reduced number of submarines will fall short of the number required by the combatant commanders. The committee believes that funds at this time should be directed at the class of submarines currently in production, and that the production rate should be increased above that shown in the Future Years Defense Program as soon as possible.

The committee recommends a decrease of \$40.0 million in PE 63562N, specifically in the future undersea superiority system project for development of propulsion alternatives, and that the remaining funding be used to complement the development of technologies being investigated in the Tango Bravo program by DARPA. (Pages 173-174)

The report also recommends increases for other submarine-related research and development programs, including an additional \$30 million for the multi-mission module concept for providing Virginia-class submarines with a more flexible payload (Pages 177-178).

Conference Report. Section 121 of the conference report on H.R. 1815 limits the procurement costs of the five Virginia (SSN-774) class submarines being procured under a multiyear procurement (MYP) arrangement covering the five years FY2004-FY2008.

Section 215 directs the Navy to initiate a program to develop a next-generation attack submarine that is less expensive than the current Virginia-class attack submarine design, and permits the Navy to meet this objective by modifying the current Virginia-class design to incorporate new technology. The provision states:

SEC. 215. INITIATION OF PROGRAM TO DESIGN AND DEVELOP NEXT-GENERATION NUCLEAR ATTACK SUBMARINE.

(a) Program Required. — The Secretary of the Navy shall initiate a program to design and develop the next-generation of nuclear attack submarines.

(b) Objective. — The objective of the program required by subsection (a) is to develop a nuclear attack submarine that meets or exceeds the warfighting capability of a submarine of the current Virginia class at a cost dramatically lower than the cost of a submarine of the Virginia class. The Secretary may meet such objective by modifying the Virginia class of nuclear submarines to incorporate new technology.

(c) Report. —

(1) IN GENERAL. — The Secretary of the Navy shall include, with the defense budget justification materials submitted in support of the President's budget for fiscal year 2007 submitted to Congress under section 1105 of title 31, United States Code, a report on the program required by subsection (a).

(2) CONTENTS. — The report shall include —

(A) an outline of the management approach to be used in carrying out the program;

(B) the goals for the program; and

(C) a schedule for the program.

FY2006 Defense Appropriations Bill (H.R. 2863/P.L. 109-148)

House. The House Appropriations Committee, in its report (H.Rept. 109-119 of June 10, 2005) on H.R. 2863, recommended approving the FY2006 procurement and advance procurement funding request for the Virginia-class program. In a section discussing cost growth in Navy shipbuilding programs, the report noted that the FY2006 budget includes funding to cover cost growth in the Virginia-class program and other programs. The report “directs the Navy to submit, not later than December 31, 2005, a plan for resolving contract cost growth on existing shipbuilding programs such as the Virginia-class submarine and the LPD — 17 [amphibious ship], including the option of possibly converting remaining work to fixed price contracts.” (Page 145)

Senate. The Senate Appropriations Committee, in its report (S.Rept. 109-141 of September 29, 2005) on H.R. 2863, recommended approving the FY2006 procurement and advance procurement funding request for the Virginia-class program. (Page 124) The committee also recommended denying the Navy's \$39.5-million request for advance procurement funding for SSN refuelings, called engineered refueling overhauls (EROs). (Pages 124 and 126) The committee stated:

The Committee remains concerned about the instability in the Navy's SSN Submarine Refueling Overhaul program. The Navy continues to request advance procurement funding for submarine refuelings that never appear in the budget. In fact, the Committee understands that due to budgetary constraints the refuelings planned for fiscal year 2007 and 2008 are no longer planned. The Committee is sensitive to budgetary constraints, but does not agree with decommissioning ships that could be refueled, upgraded and returned to operations for approximately \$250,000,000. Due to the continued instability in the program, the Committee recommends denying the budget request for advance procurement for SSN refuelings. (page 127)

Conference Report. The conference report on H.R. 2863 approves the Navy's request for FY2006 procurement and advance procurement funding for the Virginia-class program.

Appendix A: Attack Submarine Force Level Goal

This appendix provides a more in-depth discussion of the issue discussed in the main body of the report of what the attack submarine force level goal should be.

In considering what the attack submarine force-level goal should be, key factors to consider include the following:

- day-to-day demands for attack submarines in recent years;
- recent and potential wartime demands for attack submarines;
- submarine-launched unmanned vehicles (UVs);
- attack submarine homeporting and crewing arrangements;
- the SSGN conversion program; and
- contributions by allied and friendly attack submarines.

Day-to-Day Demands for Attack Submarines in Recent Years.

In General. Some Navy submarine officers and DOD officials in recent years have argued that an attack submarine force of roughly 55 boats — the approximate number in the force in recent years — is insufficient to meet day-to-day demands for attack submarines from U.S. regional military combatant commanders, at least not without operating attack submarines at higher-than-desired operational tempos. Navy submarine admirals have stated that since the end of the Cold War, demands for attack submarines from regional U.S. commanders have increased, not decreased, that some demands for attack submarines are going unfilled, and that the high operational tempo of the attack submarine force could reduce time available for training and expend submarine reactor core life more quickly than planned, potentially shortening attack submarine service lives.

In November 2004, Admiral Frank Bowman, who was Director of the Navy’s nuclear propulsion program until November 5, 2004, stated that U.S. theater combatant commanders want the equivalent of 15 attack submarines to be on station continuously, but that the 54-boat attack submarine force at that time was sufficient to provide only about 9.⁴⁴

The reference to the Navy being able to provide about nine attack submarines refers to the fraction of the attack submarine force that, on average over the long run, can be maintained on station in overseas operating areas at any given moment. The Navy reported to CRS in 1999 that, on a global basis, an average of 5.8 attack submarines are needed to keep one attack submarine continuously on station in a distant operating area. This attack submarine “stationkeeping multiplier” changed little between 1992 and 2002, and is broadly consistent with the stationkeeping multipliers for other kinds of Navy ships.⁴⁵ Using this multiplier, keeping a total of

⁴⁴ Christopher P. Cavas, “[Interview With] Adm. Frank “Skip” Bowman,” *Defense News*, Nov. 29, 2004, p. 30.

⁴⁵ Source: Navy Office of Legislative Affairs (NOLA) point paper to CRS of March 25, 1999 (record number LA-586-002), and NOLA e-mail to CRS of December 17, 2002, stating (continued...)

about 9 attack submarines continuously on station in overseas operating areas would nominally require a total attack submarine force of about 52 boats, and keeping 15 boats continuously on station would require a total force of 87 boats.

In July 2004, Admiral Bowman stated that the theater commanders wanted the equivalent of 13.5 attack submarines to be on station continuously in six different theaters of operation, but that the 54-boat attack submarine force at that time was sufficient to provide only about 9.⁴⁶ In June 2004, he similarly stated that the theater commanders “asked for a continuous forward presence of more than 13 boats, whereas today’s force structure can only provide around 9.”⁴⁷ Also in June 2004, then-Vice Admiral Kirk Donald, who at the time was the commander of the Navy’s submarine forces, stated: “With our current force structure, depot maintenance workload, and an interdeployment readiness cycle tuned to be as efficient as we can make it, we can provide the Combatant Commanders with about 65% of the ‘presence with a purpose’ they requested.”⁴⁸ (In November 2004, Donald succeeded Bowman as Director of the Navy’s nuclear propulsion program and was promoted to full admiral.)

In March 2004, Admiral Bowman stated that “Today the navy is unable to meet all the combatant commanders’ submarine requirements” and that “only about 65% of requirements can be met.”⁴⁹ In September 2003, John Grossenbacher, a recently

⁴⁵ (...continued)

that the figures in the 1999 point paper had not changed significantly. An NOLA point paper to CRS dated August 8, 1996, stated that the global stationkeeping multiplier for attack submarines was 5.8. An NOLA point paper to CRS dated September 10, 1992, stated that the number was 5.7. The 1992 figure was published by CRS in CRS Report 92-803 F, *Naval Forward Deployments and the Size of the Navy* (out of print; for a copy, contact the author at 707-7610), by Ronald O’Rourke.

⁴⁶ Robert A. Hamilton, “New War Brings New Debate over Size of Submarine Fleet,” *New London (CT) Day*, July 5, 2004. In Aug. 2004, Rear Admiral Paul F. Sullivan, the commander of the submarine force of the U.S. Pacific Fleet, said that “At any given time, roughly eight to 10 of the Navy’s submarines are able to resound to emergent fleet requirements.” (David Rush, et al., “Submarines Vital To Navy’s Fleet Response Plan,” *Navy Newsstand* [<http://www.news.navy.mil>], Aug. 19, 2004.

⁴⁷ “Naval Submarine League Symposium, [Text of] Keynote Address By Admiral F. L. “Skip” Bowman, U.S. Navy, Director, Naval Nuclear Propulsion, June 9, 2004,” *Submarine Review*, July 2004.

⁴⁸ “Naval Submarine League Symposium Remarks by VADM Kirk Donald, 09 June 2004,” *The Submarine Review*, July 2004, p. 83.

⁴⁹ Andrew Koch, “[Interview with] Adm. Frank Bowman, Director of US Naval Nuclear Reactors,” *Jane’s Defence Weekly*, Mar. 31, 2004. The article stated:

[Admiral] Frank Bowman, director of US Naval Nuclear Reactors, the service’s senior submariner, says he “fully supports those studies” if they lead to a reduction in what is being asked of the force. “Today the navy is unable to meet all the combatant commanders’ submarine requirements,” Adm Bowman says, explaining that “only about 65% of requirements can be met. There is prima facie

(continued...)

retired Navy submarine admiral, stated that attack submarines are more in demand than at any time in the Cold War, that the attack submarine force is “about as thin as we can be and still maintain a worldwide deployable and world class submarine force,” and that as the force declines in size, some demands for submarines to perform covert ISR missions may go unmet.⁵⁰

In June 2003, a senior DOD official wrote a letter to the General Accounting Office stating: “Combatant commanders have requested 14.4 SSNs for [calendar

⁴⁹ (...continued)

evidence in the real world that to execute the missions those commanders have been assigned, they need these submarines.

“I would not oppose a finding that said some of the submarine tasking today can be assigned to other [existing] platforms or future platforms because it would ease the tension between the desires of the combatant commanders and the [submarine] inventory and therefore the ability of the navy to meet those requirements,” Adm Bowman says.

One area being considered is whether intelligence, surveillance and reconnaissance (ISR) missions can be performed by other means, such as distributed sensor networks. Adm Bowman says he would like “to perhaps find some relief for our submarines so that missions of higher priority that we are not able to do today because of the ISR [taskings] could be [taken on].”

Except for “[Admiral],” material above in italics and brackets below appears as in the original.

⁵⁰ Robert A. Hamilton, “Lack of Subs Could Slow Pace of Technology, Admiral Warns,” *New London (CT) Day*, Sept. 30, 2003. The article stated:

From almost 100 submarines in the early 1990s, the number has fallen steadily to just over 50, and their services are more in demand than at any time in the Cold War, said Vice Adm. John J. Grossenbacher, who retired as commander of Naval Submarine Forces this month....

Grossenbacher said several studies that have looked at submarine force requirements have set the minimum size of the fleet at 68 to 72 submarines. Studies by other groups have set a smaller number, but he called them “misinformed,” and often don’t allow for sufficient time between deployments....

“The problem we have today is just numbers,” Grossenbacher said. “We don’t have enough. ... In my opinion, we’re about as thin as we can be and still maintain a worldwide deployable and world class submarine force.”

As the size of the force continues to decline — the Navy is building one submarine a year, which will eventually result in a force of 30 boats — Grossenbacher said some requests for the covert surveillance services that submarines provide are going to “drop off the plate.”

“The question becomes, ‘What is it that you don’t want to know?’” Grossenbacher said.

year 2003] for national and combatant commander intelligence, surveillance and reconnaissance (ISR), Tomahawk strike, carrier battlegroup support, and Special Operations Forces equipped SSN missions.” The letter also stated that “Considering the sustainability and training requirements given its current SSN fore structure, the Navy is able to provide 10.0 of the requested 14.4 SSNs deployed annually.”⁵¹

In June 2003, Admiral Grossenbacher (then still on active duty) stated that the attack submarine force was operating at its maximum rate but that this was still insufficient to meet day-to-day demands for attack submarines. He stated that the Navy would need about 70 attack submarines to meet the demands being placed on the force.⁵² Another submarine admiral, in a different article, stated the same month

⁵¹ Hunter Keeter, “DOD Answers Concerns over Virginia-class Multiyear, Details Sub Force Shortfalls,” *Defense Daily*, June 27, 2003. The article stated:

Glenn Lamartin, director of defense programs with the office of the undersecretary of defense, in a June 23 letter to [the General Accounting Office], outlined that “the pre-9/11 demand was 9.9 SSNs and the post 9/11 demand has been 12.9 SSNs.”

“Combatant commanders have requested 14.4 SSNs for [calendar year 2003] for national and combatant commander intelligence, surveillance and reconnaissance (ISR), Tomahawk strike, carrier battlegroup support, and Special Operations Forces equipped SSN missions,” Lamartin wrote.

“Considering the sustainability and training requirements given its current SSN force structure, the Navy is able to provide 10.0 of the requested 14.4 SSNs deployed annually.”...

Citing a 1999 study by the Joint Chiefs of Staff, Lamartin said that dropping below 55 attack submarines in the 2015 time frame and 62 in the 2025 time frame would leave regional warfighting commanders “with insufficient capability to respond to urgent crucial demands without gapping other requirements of high national interest.”

⁵² Jason Ma, “Grossenbacher: Sub Force Is Operating at Fastest, Sustainable Pace,” *Inside the Navy*, June 23, 2003. The article stated:

The submarine force is operating at a maximum rate that still maintains a surge capability, but that is still not enough to meet the needs of operational commanders, said Vice Adm. John Grossenbacher, commander of naval submarine forces.

Instead of the current 54 attack subs, the Navy really needs 70, he said at the Naval Submarine League’s conference June 11 in Alexandria, VA. But with 54, “operational commanders are not getting all that they need” and the sub forces are struggling to support tactical development, operational testing and long-term “self-investments,” he said.

Grossenbacher and Rear Adm. John Padgett, commander of submarine forces in the Pacific Fleet, closely monitor the fuel expenditure of the subs to meet wartime demands or surges. To avoid early depletion of the reactor core,

(continued...)

that attack submarine operational tempo was about 15 percent to 20 percent higher than preferred, and that this could affect the amount of time available for training.⁵³

In March 2003, Admiral Bowman stated that the high operational tempo for attack submarines has been using up reactor core life faster than planned and that as a result, Los Angeles-class submarines may need to be retired earlier than expected.⁵⁴

⁵² (...continued)

they would reduce operations if necessary, he said. “We’re walking that fine line right now,” he added.

“I think we’re getting about as much as we can out of the force and running them at the fastest pace that we can sustain over time, maintain long-term readiness, as well as something in the bank for surges,” Grossenbacher said.

⁵³ Jason Ma, “Admiral: Subs Must Be Both Surge-Ready and Deployed Forward,” *Inside the Navy*, June 16, 2003. The article stated:

In preparing for increased surge capability, the submarine force must also remain deployed forward and should avoid becoming a “garrison force,” said Rear Adm. John Padgett, commander of submarine forces in the Pacific Fleet.

Chief of Naval Operations Adm. Vern Clark’s “Fleet Response Plan” calls for a more responsive fleet that can surge a large number of ships on short notice, requiring new maintenance and training cycles to achieve increased readiness and availability.

Submarines are forward-deployed to support battle space preparations and to ensure that operators understand the battle space, Padgett said at the Naval Submarine League’s annual conference last week in Alexandria, VA.

“I am concerned that the surge mentality might become a bastion mentality,” he said. “I would argue, from my perspective, that we do not need a garrison force submarine force. We need to remain a forward-deployed force.”

Submarines must maintain forward deployment because they conduct much of their training with the navies of allied countries in the Western Pacific like Japan, South Korea, Singapore and Australia, Padgett said. Such training includes scenarios with diesel submarines, a threat that some Navy officials have noted is becoming more sophisticated. ...

Ultimately, force structure dictates the ability to forward deploy subs, and the Navy needs more subs, he said. Having submarine homeports in Guam and Japan partly addresses the lack of enough subs, but the operational tempo is about 15 percent to 20 percent higher than what he would like, affecting training and maintenance, he said. Although the Navy is managing the shortfall in subs, the tendency is to put operational requirements over exercise requirements, which could have a “detrimental effect.” The problem is Navy-wide and not unique to the sub forces, he added.

⁵⁴ Jason Ma, “Industry, Navy Officials Push to Boost Annual Submarine Buy Rate,” *Inside the Navy*, Mar. 3, 2003. The article stated:

(continued...)

And in January 2003, Admiral Grossenbacher stated that demands for submarines to perform covert ISR missions has been high since the terrorist attacks of September 11, 2001, and that the attack submarine force was having to turn down some requests for attack submarines from regional combatant commanders due to insufficient forces.⁵⁵

Articles making similar points have been published since the mid-1990s, and particularly since 1999, when the attack submarine force declined to less than 60 boats.⁵⁶

⁵⁴ (...continued)

The Los Angeles-class subs may retire sooner than expected, [Admiral Frank Bowman] said.... Because demand for subs has increased since the war on terrorism, the submarine fleet has been operating longer and at faster speeds than usual. If that continues, sub reactor cores will not last for the expected 30 years, he said.

Attack submarines are nearing a 90 percent operational tempo and are transiting at 20 knots rather than 16 knots, he said. The ratio of time in port to time deployed is about 2-to-1 instead of 3-to-1 before the war on terrorism, he added.

“Something’s got to give; something will give,” Bowman said. “So we’re trying to make ends meet, but what’s going to give at the end of the day is the reactor core endurance.”

See also Dale Eisman, “Subs Could Be Exhausted Early if Heavy Usage Continues,” *Norfolk Virginian-Pilot*, Feb. 26, 2003; David Lerman, “Attack Subs May Be in Too Deep,” *Newport News Daily Press*, Feb. 26, 2003.

⁵⁵ Matthew Dolan, “Subs in High Demand, Force Commander Says,” *Norfolk Virginian-Pilot*, Jan. 27, 2003. The article stated:

Submarines have been pushed so hard in the war on terrorism that the Navy is having to turn down requests from combat commanders around the world....

The stealthy ability of submarines to engage in surveillance, reconnaissance and intelligence gathering has been in high demand since the Sept. 11 attacks, [Admiral Grossenbacher] said....

“The current operational tempo that we’re operating at is manageable, but I’d like it to be lower. It’s not a crisis.”

⁵⁶ For examples between November 1994 and January 2003, see the following: Jason Ma, “Grossenbacher: Subs Can Maintain Optempo a ‘Couple More Years,’” *Inside the Navy*, Nov. 25, 2002; Vernon Loeb, “Espionage Demands Prod Navy on Sub Construction,” *Washington Post*, July 5, 2002: 19; Randy Woods, “Atlantic, Pacific Admirals Say Subs Cannot Sustain Current Optempo,” *Inside the Navy*, June 17, 2002; Greg Jaffe, “Overuse of Nuclear Submarines Risks Burning up Reactor Cores,” *Wall Street Journal*, June 26, 2002; Andrew Koch, “USN SSN Force Faces Overstretch,” *Jane’s Defence Weekly*, June 19, 2002; Hunter Keeter, “Bowman: Submarine Force Level Inadequate to Meet (continued...)

ISR Operations In Particular. ISR operations appear to form a key part of the discussion over day-to-day demands for attack submarines. As mentioned in the Background section, the 2004 internal Navy study that reportedly recommended reducing the attack submarine force-level goal to as few as 37 boats reportedly recommended using satellites to perform ISR missions now done by attack submarines.

Submarine ISR operations are a sensitive issue that is rarely discussed in public in any detail. Some general comments about the matter, however, can be made.

One set of comments concerns the relative merits of SSNs as ISR platforms. SSNs offer three basic strengths as platforms for performing ISR missions. One is that they can perform such missions without their presence being detected by ISR targets, increasing the chance of getting candid observations of the targets. Potential ISR targets can consult reference sources on satellite orbits to understand when certain satellites are likely to be overhead, or use radar to detect and track aircraft flying nearby. Armed with this information, ISR targets can take steps to conceal objects or to alter or avoid certain activities. In contrast, U.S. Navy submarines operating stealthily are very difficult, if not impossible, for ISR targets to detect, increasing the chance that the targets will behave candidly.

⁵⁶ (...continued)

Requirements,” *Defense Daily*, June 13, 2002; Christian Bohmfalk, “Basing Attack Subs on Guam Expected to Increase Fleet’s Presence,” *Inside the Navy*, Feb. 12, 2001; Robert Holzer, “With Limited Subs, U.S. Navy Looks Westward to Guam,” *Defense News*, August 28, 2000: 4; Robert Burns, “U.S. Considers Increase in Submarine Fleet, Mainly for Spy Role,” *Fort Worth Star-Telegram*, August 18, 2000; David Brown, “Officials Sound Alarm on Sub Shortage,” *Navy Times*, July 10, 2000: 20; Albert H. Konetzni, Jr. “‘Two Diverging Paths’ for Pacific Fleet Submarine Force,” *Sea Power*, July 2000: 29; Frank Wolfe, “Submarine Commanders Want 75 Fast Attack Subs for Missions, Exercises,” *Defense Daily*, June 28, 2000: 5; Hunter Keeter, “Konetzni: Navy Needs Greater Funding Commitment to Submarine Force,” *Defense Daily*, June 16, 2000: 7; Robert Holzer, “Intelligence Operations Suffer as Submarine Fleet Dwindles,” *Defense News*, April 17, 2000: 1, 36; Robert Holzer, “Utility of Subs Rises as Targeting Grows More Precise,” *Defense News*, April 10, 2000: 17; Josh Corless, “Numbers Count as Submarine Commitments Stretch USN,” *Jane’s Navy International*, March 2000: 18-24; Robert A. Hamilton, “Support Growing for More Submarines,” *New London (CT) Day*, March 7, 2000; Mike Gordon, “Opposition Surfaces, ‘Silent Service’ Says No to Further Cuts,” *Navy Times*, January 17, 2000: 14-16; Bradley Graham, “Pentagon Warns Against Cutting Attack Sub Fleet,” *Washington Post*, January 4, 2000: 3; Robert Holzer, “U.S. Submariners Urge Halt to Dwindling Fleet,” *Defense News*, June 28, 1999: 6; David Abel, “Some Say US Sub Force Is Spread Too Thin,” *Boston Globe*, June 28, 1999: 5; Josh Corless, “Problems Beneath the Waves,” *Jane’s Navy International*, June 1999: 10; Robert Holzer, “Overwork Strains U.S. Sub Fleet,” *Defense News*, March 15, 1999: 4, 42; Robert Karniol, “Intelligence Rises for US Pacific Subs,” *Jane’s Defence Weekly*, December 16, 1998: 13; Frank Wolfe, “Navy Fears Drop Below 50 Attack Submarines,” *Defense Daily*, June 15, 1998: 6-7; Bryan Bender, “U.S. Submarine Operations Rise Since End of Cold War,” *Defense Daily*, November 1, 1996: 183; Robert Holzer, “Study Reveals U.S. Sub Force Flaws,” *Defense News*, June 10-16, 1996: 3; “Navy Sub Community Pushes for More Subs than Bottom-up Review Allowed,” *Inside the Navy*, November 7, 1994: 1, 8-9.

A second advantage of SSNs as ISR platforms is persistence on station. Low-orbiting satellites can view a particular area only periodically as they pass overhead, and perhaps only for a few minutes at a time. Aircraft might be able to remain airborne in a viewing position for a matter of hours before needing to return to base. An SSN, in contrast, can remain on station in a viewing location continuously for days, weeks, or even months at a time, permitting the SSN to detect and provide evidence of patterns of behavior that may be discernible only through continuous observation over an extended period of time.

A third advantage of SSNs as ISR platforms is their viewing position offshore and just under the surface of the water. This position permits them to observe certain ISR targets — particularly ports, coastal areas, surface ships, other submarines, and underwater mines — at potentially close ranges, permitting the collection of detailed information on these targets.

SSNs, however, have two basic limitations as platforms for performing ISR missions. One concerns overhead observations, which can be helpful or even critical in understanding the totality of objects or activities being observed in a certain area. Satellites and aircraft are inherently capable of performing overhead observations, but SSNs are not. SSNs observe land targets from the side, but cannot observe the totality of objects or activities in a certain area.

A second disadvantage of SSNs as ISR platforms concerns imaging inland areas. Satellites and aircraft are inherently capable of imaging inland areas, but SSNs have relatively little ability to do this. From their position just below the water's surface, SSNs in general can collect images of objects that are no further inland than the first row of buildings or the first row of hills.

A second general comment about submarine ISR operations concerns how the universe of ISR targets may have changed since the end of the Cold War. The end of the Cold War may have reduced demands for ISR missions against what is now Russia, but may have increased demands for ISR missions against both countries other than Russia and non-state actors such as terrorist organizations.

A third general comment concerns the relationship of ISR missions to the attack submarine force-level requirement. It is plausible that ISR missions by themselves might generate a requirement for a relatively large attack submarine force, particularly if those ISR missions require extended or continuous observations of intelligence targets. Performing such missions brings the attack submarine stationkeeping multiplier into play, and as explained earlier, only nine or 10 missions requiring continuous attack submarine presences in overseas operating areas would be needed to generate an attack submarine force level of about 55.

ISR missions, however, are not necessarily the only day-to-day missions that might require attack submarines to remain on station on an extended or continuous basis. Examples of other missions that might require such operations include protection of forward-deployed Navy surface ships, covert insertion and recovery of special operations forces, and Tomahawk strike (i.e., the mission of keeping a certain number of Tomahawks ready in a given region to be fired on short notice if needed

— a mission that can also be performed, though not with the same level of covertness, by surface ships).

If submarine supporters are generally correct about the existence and findings of the 2004 internal Navy study on attack submarines (see Background section), then one potential implication is that the authors of this study believe that submarine ISR operations represent the “long pole in the tent” in driving the attack submarine force-level requirement — the only mission requiring a force of 55 or more attack submarines.

If this view is held by the authors of the 2004 internal Navy study, however, it is not necessarily shared by all others. For example, Admiral Bowman’s above-cited comments from March 2004 suggest that even if attack submarine ISR missions are reduced, attack submarines will still have other, and possibly even higher-priority, day-to-day missions to perform.⁵⁷ This perspective suggests that a force of 55 or more attack submarines might still be needed on a day-to-day basis even if attack submarine ISR missions are reduced.

Questions for Congress. Potential questions for Congress regarding day-to-day demands for attack submarines include the following:

- If combatant commanders would like to have 13 to 15 attack submarines continuously on station, but the attack submarine force is capable of providing only 9, what kinds of missions are not being performed due to lack of available attack submarines?
- What is the current operational tempo for U.S. attack submarines, and how does this compare with the preferred operational tempo? What effect might current operational tempo have on recruiting and retention of submarine personnel, submarine training, submarine maintenance, and reactor core life?
- What portion of combatant commander requests for SSNs are driven by ISR missions vs. other kinds of missions? Do ISR missions represent the “longest pole in the tent” in generating day-to-day demands for attack submarines? How many SSNs do combatant commanders require on a day-to-day basis for non-ISR missions such as carrier battlegroup support, SOF support, and Tomahawk strike?
- What fraction of the information collected by U.S. ISR operations of all types is collected by U.S. attack submarines? How is the information collected by submarines similar to, or different than, information collected through other means? How important is submarine-collected intelligence to national-level policymakers? How important is it to military commanders? What is the potential

⁵⁷ See the details of Admiral Bowman’s comments in the earlier footnote quoting from the Mar. 2004 article.

risk to the United States if U.S. attack submarines collect less of this information?

- How might submarine-launched UAVs affect submarine ISR missions? What new ISR missions could UAV-equipped submarines perform?
- To what degree can this information be collected through other means such as satellites, aircraft, or human intelligence?

Recent and Potential Wartime Demands for Attack Submarines.

Attack Submarines in Recent Conflicts. The table below summarizes the numbers of U.S. Navy attack submarines reported to have participated in recent major U.S. military operations.

Table 6. U.S. SSNs in Recent Major Military Operations

Year	Location	Number of U.S. SSNs involved	Comments
1991	Persian Gulf War	13	2 US SSNs fired 12 of 288 Tomahawks used. SSNs also performed war-related ISR missions.
1999	Kosovo	6	1 UK SSN, 1 Italian SS,* and 1 Dutch SS were also involved. Submarines were used for sea control. Four SSNs (3 US; 1 UK) fired some portion of 218 Tomahawks used.
2001-2002	Afghanistan	2	1 UK SSN was also involved. 2 U.S. SSNs fired about 1/3 of 82 Tomahawks used by the U.S. Navy. The UK SSN fired additional Tomahawks. Submarines also conducted war-related ISR, antisubmarine warfare, and anti-surface warfare operations.
2003	Iraq	12	2 UK SSNs were also involved. 12 U.S. and UK SSNs fired about 1/3 of 802 Tomahawks used.

Sources: DOD and Navy reports and press reports; see footnotes for discussions printed below.

* SS = non-nuclear-powered attack submarine.

The following discussions elaborate on the information in the above table.

1991 Persian Gulf War (Desert Shield). A total of 13 U.S. attack submarines were deployed to the Gulf region for the 1991 Gulf War. Two of the submarines launched a total of 12 Tomahawks, or about 4% of the 288 Tomahawks fired in the war.⁵⁸ A Navy report on the Navy's participation in the Gulf war stated:

⁵⁸ Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, (continued...)

During Desert Shield/Storm attack submarines not only fired TLAMs, but provided an array of multimission capabilities to battle group commanders. Prior to and during hostilities, eight SSNs were involved in surveillance and reconnaissance operations. They also provided indications and warning [a form of intelligence about impending enemy actions] for the battle groups. After hostilities began, an additional five submarines bolstered Navy forces already on station.⁵⁹

1999 Kosovo Conflict (Operation Allied Force). U.S. and allied naval forces participating in this conflict included six U.S. SSNs, one UK SSN, one Italian non-nuclear-powered attack submarine (SS), and one Dutch SS. The mission of all these submarines was described as sea control,⁶⁰ which means maintaining control of the sea for one's own use while preventing enemy forces from using it for their own purposes. For submarines, this mission typically involves conducting antisubmarine and anti-surface ship operations.⁶¹ A total of 218 Tomahawks were fired in the conflict by six U.S. surface combatants, three U.S. attack submarines, and one UK attack submarine.⁶² The UK submarine fired 21 of the Tomahawks.⁶³

2001-2002 War in Afghanistan (Operation Enduring Freedom). Published reports indicate that two U.S. attack submarines and at least one UK attack submarine participated in the war in Afghanistan, that the U.S. submarines launched about one-third of the 82 Tomahawks fired by U.S. Navy ships, and that the U.S. and UK submarines together launched 37% of the more than 82 Tomahawks that were collectively launched by U.S. and UK ships.⁶⁴ A Navy submarine admiral stated that,

⁵⁸ (...continued)

15th ed. (Annapolis: Naval Institute Press, 1993), p. 63; Norman Polmar, "Going Downtown the Safe Way," *U.S. Naval Institute Proceedings*, Aug. 1992, pp. 105-106.

⁵⁹ U.S. Department of Defense, Department of the Navy, Office of the Chief of Naval Operations, "*The United States Navy in "Desert Shield" [and] "Desert Storm,"*" May 15, 1991, p. 40. Curiously, Appendix B of the report, which presents a list of ships participating in Desert Shield/Storm, includes only five submarines rather than 13.

⁶⁰ Source: Information sheets on Operation Allied Force provided to CRS by the Joint Staff, October 19, 1999.

⁶¹ The Yugoslav navy at the time had a small number of aging diesel-electric submarines that might have posed a threat to U.S. and allied surface ships.

⁶² U.S. Department of Defense, *Kosovo/Operation Allied Force After-Action Report*, Jan. 31, 2000, p. 92.

⁶³ Slide entitled "Operational Firsts" from a package of briefing slides on the Kosovo operation entitled "A View from the Top: Admiral James O. Ellis, U.S. Navy, Commander-in-Chief, U.S. Naval Forces, Europe, Commander, Allied Forces Southern Europe, Commander, Joint Task Force Noble Anvil during Operation Allied Force."

⁶⁴ Bill Gertz and Rowan Scarborough, "Navy Message," *Washington Times*, June 14, 2002, p. 10 [item in the Inside the Ring Column]; Hunter Keeter, "Bowman: Submarine Force Level Inadequate To Meet Requirement," *Defense Daily*, June 13, 2002; Jason Ma, "Grossenbacher: Subs Can Maintain Optempo a 'Couple More Years,'" *Inside the Navy*, Nov. 25, 2002. Of the 82 Tomahawks fired by the Navy in the war, 65 were launched during the first two days of the conflict. Greg Seigle, "Experts Fear Shortage of Missiles for (continued...)"

in addition to firing Tomahawks, the Navy attack submarines during the war in Afghanistan conducted ISR operations, antisubmarine operations, and anti-surface ship operations, such as maritime intercept operations.⁶⁵ Since Afghanistan is a landlocked country with no navy, the anti-submarine operations were presumably tracking operations against third-party submarines operating in the region.

2003 Iraq War (Operation Iraqi Freedom). At the height of the buildup for the Iraq war, a total of 14 attack submarines — 12 U.S. boats and two UK boats — were in the Iraq theater of operations. Ten U.S. boats were in the Red Sea, while two U.S. and two UK boats were in the Persian Gulf.⁶⁶ Twelve of the 14 submarines launched Tomahawks, accounting for about one-third of the 802 Tomahawks fired in the Iraq war.⁶⁷

Potential Demands for Attack Submarines in Future Conflicts.

Although the recent major U.S. military operations discussed above used relatively small numbers of attack submarines, certain potential future conflicts might feature a greater maritime component and consequently require a larger number of attack submarines. Examples of such potential future conflicts include a war on the Korean Peninsula or a conflict with China.

If China invests significantly in naval modernization for a number of years, it could eventually field a sizeable and fairly modern fleet. Such a fleet would represent the first significant naval competitor to the U.S. Navy since the dissolution of the Soviet Union in 1991 and the subsequent collapse of the large and capable Soviet fleet. Estimates of when China might possess a large and capable fleet, should it choose to build one, vary from as early as several years from now to as late as roughly 2030. Another CRS report discusses this issue in greater detail.⁶⁸

⁶⁴ (...continued)

War in Iraq,” *Denver Post*, Jan. 5, 2003, p. 1.

⁶⁵ “Grossenbacher: Subs Can Maintain Optempo a ‘Couple More Years,’” *Inside the Navy*, Nov. 25, 2002. For additional accounts of Navy attack submarine operations in the war in Afghanistan, mostly in connection with firing Tomahawks, see John E. Mulligan, “Fire! Submarine Providence Helps Counter the Attacks,” *Providence Journal*, Sept. 17, 2002; and Scott Bawden, “Call to Action: A Submarine CO’s Account of the First Hours of the War on Terror,” *Undersea Warfare*, Summer 2002, pp. 12-13.

⁶⁶ David Rush and Mark Savage, “Submarine Warriors Return from Operation Iraqi Freedom,” *Undersea Warfare*, Summer 2003, p. 3; “Remarks by CDR Michael Jabaley, Commanding Officer, USS Louisville (SSN 724) to the Naval Submarine League Symposium,” June 11, 2003. *The Submarine Review*, July 2003, p. 66.

⁶⁷ Statement of Honorable Gordon R. England, Secretary of the Navy, in U.S. Congress, House Armed Services Committee, Feb. 12, 2004, p. 3; and David Rush and Mark Savage, “Submarine Warriors Return from Operation Iraqi Freedom,” *Undersea Warfare*, Summer 2003, p. 3; Robert A. Hamilton, “USS Pittsburgh Pave the Way for Submarines to Fire on Iraq,” *New London (CT) Day*, Sept. 21, 2003; Hunter Keeter, “Bowman: Undersea Communications Top Priority for Sub Force Transformation,” *Defense Daily*, June 12, 2003.

⁶⁸ See CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities — Background and Issues for Congress*, by Ronald O’Rourke.

As mentioned in the background section, the 1999 JCS study on requirements for attack submarines concluded that a force of 55 SSNs in 2015 and 62 in 2025 “would be sufficient to meet the modeled war fighting requirements.” One suggestion of this conclusion is that a force of less than 55 boats might not be sufficient to meet the modeled warfighting requirements. If so, this conclusion contrasts with the reported conclusion of the previously mentioned 2004 internal Navy study that a force of as few as 37 submarines would be sufficient to meet warfighting requirements.

Questions for Congress. Potential questions for Congress regarding recent and potential future wartime demands for attack submarines include the following:

- In light of the number of attack submarines that have been used in recent major U.S. military combat operations, and the number that might be used in future major U.S. military combat operations, how many submarines might be needed for conducting two nearly simultaneous major combat operations?
- How many additional attack submarines would the Navy need to have, in addition to those engaged in warfighting operations, for performing other critical operations around the world during time of war, and to account for submarines that would be unavailable for deployed operations at any given time due to maintenance or training requirements? When these additional submarines are added in, is the resulting total number of submarines closer to 55, the number in the 1999 JCS study, or to as few as 37, the number reported to be in the 2004 internal Navy study?

Submarine-Launched Unmanned Vehicles (UVs). Submarine-launched UVs promise to “extend their eyes and ears” of submarines and give them the ability to perform multiple missions at the same time. Submarine-launched UVs could lead to arguments in favor of having either larger or smaller numbers of attack submarines. On the one hand, UVs, by increasing the capabilities of attack submarines, could make attack submarines more cost effective as platforms, which could argue in favor of having more of them in the fleet. On the other hand, UVs, by increasing the capabilities of attack submarines (and SSGNs), could permit a smaller number of attack submarines (in conjunction with SSGNs) to perform a given set of submarine missions, which could argue in favor of having fewer attack submarines in the fleet.

Unmanned Underwater Vehicles (UUVs). As mentioned earlier, a 2004 internal Navy study that reportedly recommended reducing the attack submarine force-level goal to as few as 37 boats reportedly recommended using unmanned underwater vehicles (UUVs) to perform ISR missions now done by attack submarines.

Public comments from Navy officials similarly suggest that the Navy may be focusing on the potential for submarine-launched UUVs to permit a reduction in the number of attack submarines needed to perform a given set of underwater submarine missions. For example, at a hearing before the Projection Forces subcommittee of

the House Armed Services Committee on March 30, 2004, Vice Admiral John Nathman, Deputy Chief of Naval Operations for Warfare Requirements and Programs — that is, the Navy's chief officer for determining Navy requirements — stated the following in answer to a question from Representative Langevin about submarine procurement and the future size of the attack submarine fleet:

I think everyone should appreciate — and I come back to what the chairman has asked before about unmanned, underwater vehicles. But there are a lot of dynamics in how you build force structure requirements for the submarine force.

Right now currently it is built on war-fighting and this compelling need by the intelligence community for a distributed ISR surveillance capability that our submarines bring because of their ability to get into those access areas.

The other debates that I see inside of this is there is a tremendous requirement for intelligence preparation of the battlespace, again because of the submarine's coyness to get into those parts of the battlespace, as they build that battlespace preparation before a conflict. And at the same time, there is this dynamic of adding SSGNs to our budget over the last several years, buying four of those. And then how do you leverage the [payload] volume of SSGN and trying to understand what your total submarine force structure ought to be?

And I will make this point about ISR right now. Submarines do that very well. And they do it for national needs primarily.

But it seems to make sense to me that if you are going to be asked to take a very high value, very expensive, very complex device and — like a submarine — and keep it in a constrained battlespace so that it can detect certain communications and signals intelligence in a very confined area, that we might be better off in the near term looking at investments in leveraging the volume of SSGN to putting unmanned, underwater vehicles in those very same places.

A submarine would probably be the delivery vehicle. But it could be an SSGN or it could be an SSBN.

So why couldn't you leverage the force structure that you need by taking more of this requirement and going offboard into unmanned, underwater vehicles and that potentially leveraging the investment in SSGNs the same way.

So this is part of the debate we are having. We are having that debate now in an underwater sea superiority study with the joint staff and our own significant study, as you would expect, another study that says let's look at our total force structure requirements around the capabilities that we will need in these very specific fights that we have been looking at, that we see in the future.

So this is the kind of rigor that we are trying to get to, sir, to understand what that force structure requirement should be so we don't under- or overinvest in the total size of our submarine force.⁶⁹

⁶⁹ Source: Transcript of hearing as provided by Federal Document Clearing House, Inc. See also Jason Ma, "Navy Mulls UUVs Taking over Attack Subs' Surveillance Missions," (continued...)

Unmanned Air Vehicles (UAVs). Equipping attack submarines with unmanned air vehicles (UAVs) would give attack submarines an ability to conduct deep-inland and overhead observations, potentially permitting attack submarines to perform ISR missions now performed by satellites or by aircraft.

Compared to the option of performing these missions with satellites, the option of performing them with submarine-launched UAVs offers potential advantages in terms of greater persistence over the ISR target (hours for the UAV vs. perhaps minutes for the satellite) and less predictability about when the observations are made.

Compared to the option of performing these missions with manned aircraft or UAVs launched from land bases or surface ships, the option of performing them with submarine-launched UAVs offers three potential advantages:

- **In-theater land bases.** In-theater land bases for U.S. manned aircraft or UAVs may not always be available. When such bases are available, host nations might place restrictions on how U.S. manned aircraft or UAVs launched from the bases could be used. And the launch of manned aircraft or UAVs from such bases might be observable to agents working on behalf of the intended ISR target. Personnel at the ISR target, warned by the agent of the approaching aircraft, could conceal objects, alter their behavior, or make preparations for attempting to shoot the aircraft down. In contrast, submarines could launch UAVs without need for host-nation base access, with no host-nation limits on use, and from locations at sea where there may be less risk of enemy agents observing the launch, particularly if the submarine was not known by others to be in the area.
- **Land bases in the United States.** Manned aircraft or UAVs launched from bases in the United States would likely require many hours to reach the ISR target area, making them potentially unsuitable for transitory ISR targets that could disappear during the aircraft's flight from the U.S. base. UAVs launched from land bases in the United States would need to be large enough to fly long distances to the ISR target area, making them potentially more expensive and easier to detect and shoot down. In contrast, submarines could launch UAVs from in-theater locations, permitting relatively short flight times to the ISR target area and the use of smaller UAVs that might be more difficult to detect and shoot down.
- **Surface ships.** The offshore presence of a surface ship equipped with manned aircraft or UAVs could become known to personnel at

⁶⁹ (...continued)

Inside the Navy, Apr. 5, 2004. For more on Navy UV programs, see CRS Report RS21294, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress*, by Ronald O'Rourke.

the ISR target area, which could prompt them to conceal objects, alter their behavior, or make preparations for attempting to shoot the aircraft down. The offshore presence of an attack submarine, however, is less likely to become known to personnel at the ISR target area, making them less likely to take such actions.

The Navy expressed interest in operating UAVs from attack submarines as early as 1995.⁷⁰ It conducted its first such experiment in 1996, in which the submarine assumed control of a Predator UAV that had been launched from a land base.⁷¹ The Navy publicly expressed further interest in the submarine-UAV concept in 2001.⁷²

Directing a UAV from a submarine could require the submarine to remain close to the surface, so as to keep an antenna exposed to the air, potentially compromising the submarine's stealth. Launching and recovering a UAV from a submarine, moreover, is technically much more complex than doing so from land bases of surface ships, particularly when the submarine is submerged, which may be critical to maintaining the submarine's stealth.

Launching a UAV from a submerged submarine would require a UAV that could rise up through the water after leaving the submarine and then launch itself from the surface. The Navy in the past has accomplished something similar with the submarine-launched versions of the Tomahawk and Harpoon cruise missiles, and with an older weapon, no longer in service, called the Submarine Rocket (SUBROC).

Bringing a UAV back aboard a submerged submarine would require a UAV that could land safely on water and then perhaps be recovered by a grappling mechanism of some kind from the submarine. The technical challenges of recovering the UAV, and the cost of a grappling system, could be avoided by designing the UAVs as expendable assets to be used on one-way missions. This strategy, however, could substantially increase costs for procuring UAVs (due to the need to buy replacement UAVs) and limit the number of UAV ISR missions that a submarine could perform while operating on its own.

Another option would be to launch the UAV from the submarine but land it at a land base or on a surface ship. This would permit the UAV to be reused and avoid the cost of a grappling system, but still limit the number of UAV ISR missions a submarine could perform while operating on its own. In addition, if personnel at the

⁷⁰ John Robinson, "Submarine to Test Linkup with Predator UAV Later this Year," *Defense Daily*, June 7, 1995, p. 345; Robert Holzer, "U.S. Subs Gear for Broader Mission," *Defense News*, June 12-18, 1995, p.3.

⁷¹ Bryan Bender, "Submarine Takes Control of UAV in Demonstration," *Defense Daily*, June 13, 1996, pp. 434-435; Roman Schweizer, "Submarine Force Looks to UAVs, NTACMS to Bolster Littoral Capabilities," *Inside the Navy*, Nov. 11, 1996, pp. 1, 10; Vincent Vigliotti, "Demonstration of Submarine Control of an Unmanned Aerial Vehicle," *Johns Hopkins APL Technical Digest*, vol. 19, no. 4, 1998, pp. 501-512.

⁷² Christian Bohmfalk, "Navy Exploring Large and Small UAVs, Better Comm. Relays for Subs," *Inside the Navy*, Apr. 9, 2001; Robert Wall, "Navy Investigates UAV-Sub Teaming," *Aviation Week & Space Technology*, July 9, 2001.

ISR target learn that a UAV has landed at a land base or on a surface ship, it would alert them to the possibility that their activities had recently been observed, and possibly encourage them to take steps to reduce the effectiveness of any follow-on UAV ISR operations against that site that U.S. commanders might want to conduct.

Questions for Congress.⁷³ Potential questions for Congress regarding submarine-launched UVs include the following:

- What are the Navy's current plans for equipping attack submarines and SSGNs with UUVs? At what point will submarine-launched UUVs be sufficiently numerous to potentially permit a smaller number of submarines to perform a given set of underwater submarine missions?
- What are the Navy's plans for developing UAVs that can be launched from, directed from, and recovered aboard attack submarines? In light of the potential operational advantages of operating UAVs from attack submarines, are these plans adequate?
- What might be the net impact of submarine-launched UUVs and submarine-launched UAVs on required numbers of attack submarines?

Submarine Homeporting and Crewing Arrangements.

Guam Homeporting. The Navy in early 2004 completed an initiative announced in 2001 to transfer three Pacific Fleet attack submarines to the U.S. island territory of Guam in the Western Pacific.⁷⁴ Guam is thousands of miles closer to potential attack submarine operating areas in the Western Pacific and Indian Ocean than are the Navy's other Pacific Fleet attack submarine home ports at Pearl Harbor and San Diego. In addition, attack submarines homeported in Guam use a different operating cycle than attack submarines homeported at Pearl Harbor or San Diego.

As a result of both these factors, Guam-homeported attack submarines can generate significantly more days on station in Pacific Fleet attack submarine operating areas than can attack submarines homeported in the other two locations. Navy officials have stated that in terms of operating days, a Guam-homeported attack submarine is the equivalent of an average of about 2.3 attack submarines homeported

⁷³ For more on Navy programs for Uvs, including UUVs and UAVs, see CRS Report RS21294, *Unmanned Vehicles for U.S. Naval Forces: Background and Issues for Congress*, by Ronald O'Rourke.

⁷⁴ The first attack submarine to be homeported at Guam arrived in 2002, the second in 2003, and the third in early 2004. The third SSN to arrive, the San Francisco, was significantly damaged in a collision with an undersea mountain near Guam in January 2005. The ship was transferred to the Puget Sound Naval Shipyard at Bremerton, WA, for repairs. The San Francisco reportedly will be replaced at Guam by another SSN, the Buffalo, in September 2006. (David V. Crisostomo, "Guam To Receive Third Home-Ported Submarine In 2006," *Pacific Daily News (Guam)*, November 1, 2005.)

in the Third Fleet (i.e., in San Diego or Pearl Harbor).⁷⁵ CBO, in a March 2002 report on the attack submarine force, stated that the ratio might be higher, with a Guam-homeported attack submarine equivalent in operating days to about three attack submarines homeported elsewhere.⁷⁶

In general, homeporting additional attack submarines at Guam could reduce the total number of attack submarines needed to fulfill day-to-day Pacific Fleet attack submarine missions. In its March 2002 report, CBO presented an option for homeporting up to eight additional attack submarines at Guam, for a total of 11.⁷⁷ CBO estimated the construction cost of the additional facilities needed to implement this option at about \$200 million, which is less than 10% of the procurement cost of a Virginia-class submarine. CBO noted that homeporting additional attack submarines posed some potential disadvantages, including reduced opportunities for training with Navy ships based in Hawaii or on the U.S. West Coast. Even so, CBO concluded that homeporting additional attack submarines at Guam was the most cost effective of the various options it explored for increasing the mission capabilities of the attack submarine fleet.⁷⁸ As mentioned earlier, a 2004 internal Navy study that reportedly recommended reducing the attack submarine force-level goal to as few as 37 boats reportedly recommended homeporting a total of 9 attack submarines at Guam.

Crewing Arrangements. The March 2002 CBO report also presented an option for increasing submarine operating days through the use of dual crewing (two crews for each submarine) or multiple crewing (three crews for two submarines). The Navy has long used dual crewing for its SSBNs and plans to do so with its SSGNs. CBO estimated that dual-crewing could produce an 80% increase in an attack submarine's operating days, while multiple crewing could result in a 100% increase.

CBO noted in its report that implementing this option would require additional spending to support the additional crews, and that the Navy raised several concerns about the option, including the time needed to recruit and train the additional crews, the challenge of keeping the crews trained between deployments without access to their boats, and increased wear and tear on attack submarines (which, unlike SSBNs,

⁷⁵ In a "memorandum for interested members of Congress" on the homeporting of attack submarines in Guam dated Jan. 22, 2001, the Navy stated: "Three attack submarines homeported in Guam will provide a total of 300 days (on average) of operations and engagement per year. Those submarines would provide 130 days of operations and engagement per year if they were homeported in [the] Third Fleet [i.e., Eastern Atlantic] and deployed to [the] Seventh Fleet [i.e., Western Pacific] in accordance with current guidelines." 300 divided by 130 is about 2.3. The text of the memo was reprinted in the Feb. 12, 2001 issue of *Inside the Navy* under the headline, "Text: Navy Memo on Subs in Guam." For the accompanying news story, see Christian Bohmfalk, "Basing Attack Subs on Guam Expected To Increase Fleet's Presence," *Inside the Navy*, Feb. 12, 2001.

⁷⁶ U.S. Congressional Budget Office, *Increasing the Mission Capability of the Attack Submarine Force*, Mar. 2002, p. 11.

⁷⁷ *Increasing the Mission Capability of the Attack Submarine Force*, op. cit., pp. xvii, 30-32.

⁷⁸ *Increasing the Mission Capability of the Attack Submarine Force*, op. cit., pp. ix, 32.

are not engineered to be used intensively at sea by more than one crew).⁷⁹ On at least two occasions in 2000, however, Navy officials expressed some interest in the idea.⁸⁰

Questions for Congress. Potential questions for Congress regarding submarine homeporting and crewing arrangements include the following:

- What does the experience to date with the homeporting of three attack submarines at Guam suggest about the potential for homeporting additional attack submarines there? What is the maximum number of additional attack submarines that could be homeported at Guam? What would be the potential construction cost for new facilities needed to homeport additional attack submarines at Guam? How long would it take to build those facilities and otherwise implement a decision to homeport additional attack submarines at Guam?
- In light of recent Navy experiments with new approaches for crewing and deploying surface ships, including the Sea Swap concept for sending ships on long (e.g., 18- or 24-month) deployments and rotating multiple crews out to the ships,⁸¹ should the Navy reexamine options for crewing and deploying attack submarines?

⁷⁹ *Increasing the Mission Capability of the Attack Submarine Force*, op cit, p. xv-xvi, 20-30. For articles expressing Navy concerns with dual- or multiple crewing of attack submarines, see Paul F. Sullivan, "Letter to the Editor," *U.S. Naval Institute Proceedings*, Dec. 2002, pp. 14, 16; and Christian Bohmfalk, "Fages Says Navy Wary Of Double-Crewing Subs To Increase Presence," *Inside the Navy*, May 8, 2000. Sullivan's letter to the editor was in response to an article in the magazine based on the March 2002 CBO report. (See Eric J. Labs, "Countering Attack Sub Shortfalls," *U.S. Naval Institute Proceedings*, Sept. 2002, pp. 46-48, 50.)

⁸⁰ See Christian Bohmfalk, "Submarine Chiefs Willing to Explore Double Crewing for SSNs," *Inside the Navy*, July 3, 2000; and P. J. Skibitski, "Pacific Submariners Consider Basing Nuclear Attack Boats in Guam," *Inside the Pentagon*, July 13, 2000, p. 1. The second article about a Pacific Fleet study on forward-homeporting submarines at Guam stated:

If one sub were based [in Guam], the service could "dual-crew" the boat by shuttling sailors from Hawaii, [Rear Admiral Albert] Konetzni said. One crew could take a sub on a deployment, and when it got back, another crew could take the boat out....

If two or three of the early [Los Angeles-class submarines] were homeported in Guam, sailors and their families could live there and only single-crewing would be necessary. Numerous other arrangements, such as three crews for two ships, are also being looked at in the study, Konetzni said."

⁸¹ For more on Sea Swap, see CRS Report RS21338, *Navy Ship Deployments: New Approaches — Background and Issues for Congress*, by Ronald O'Rourke.

SSGN Conversion Program. SSGNs can perform some missions that might otherwise be performed by attack submarines, particularly Tomahawk strike, support of special operations forces, and, in the future, missions enabled by UVs. Compared to an attack submarine, an SSGN can carry much larger numbers of Tomahawks, SOF personnel, and UVs. SSGNs can also deploy larger-sized UVs than can be deployed by today's attack submarines. The cost-effectiveness of the SSGNs in performing these missions is increased by the Navy's plan to operate these boats with dual crews so as to increase the percentage of time that each SSGN is at sea in an operating area.

In light of the SSGNs' capabilities, the Navy's planned force of four SSGNs may reduce the number of attack submarines needed to perform submarine missions. By the same token, increasing the number of SSGNs in the fleet beyond the four now planned could, other things held equal, further reduce the number of attack submarines needed to perform a given set of submarine missions.

The Navy procured a total of 18 SSBNs between FY1974 and FY1991. The ships entered service between 1981 and 1997. The Clinton Administration's 1994 Nuclear Posture Review (NPR) recommended a strategic nuclear force for the START II strategic nuclear arms reduction treaty that included 14 Tridents rather than 18. The Bush Administration's 2002 NPR retained the idea of reducing the Trident SSBN force to 14 boats. The reduction in the planned Trident SSBN force from 18 boats to 14 made the first four Tridents available for conversion into SSGNs. Any future decision to reduce the SSBN force further — to 12 or 10 boats, for example — could make two or four additional Tridents available for conversion to SSGNs.

Allied and Friendly Attack Submarines. As mentioned earlier in the section reviewing recent wartime demands for attack submarines, allied submarines on occasion have participated in U.S.-led military operations. In theory, allied submarines might also be able to perform day-to-day missions that might otherwise be performed by U.S. attack submarines. In light of the close security relationship that the United States maintains with the UK,⁸² and the apparent growing security relationship that the United States is developing with Australia,⁸³ submarines from

⁸² The United States and the UK have a history of close cooperation on sensitive security issues that dates back to World War II and the wartime effort to develop a nuclear weapon. Following the war, the United States assisted the UK's effort to develop nuclear-powered submarines, which was experiencing technical difficulties, by providing the UK with a complete U.S. submarine reactor plant for installation in the UK's first SSN. The United States closely guards its submarine and naval nuclear propulsion technology and has shared the latter only with the UK. The United States has sold the UK Tomahawk cruise missiles and Trident SLBMs for use on UK SSNs and SSBNs, respectively. U.S. facilities are used to provide life-cycle maintenance support for the UK SLBMs.

⁸³ In 1998-2000, it was reported that Australia's new submarines, which were designed in Sweden and built in Australia by the Australian Submarine Corporation (ASC), were experiencing acoustic problems (i.e., excessive noise), problems with their combat systems, and other difficulties, and that the U.S. Navy was helping to fix the acoustic and combat-system problems. ("Australia Say Serious Problems with New Submarines," *Reuters* wire (continued...))

these two countries might be of particular interest as candidates for performing missions that might otherwise be performed by U.S. attack submarines.

The UK currently operates a force of 11 SSNs, while Australia operates a force of six large diesel-electric submarines. UK submarines might be able to assist the United States in performing attack submarine missions in locations such as the Barents Sea, the Norwegian Sea, the Mediterranean, the Red Sea, and the Indian Ocean/Persian Gulf region. Australian submarines might be able to assist the United States in performing attack submarine missions in locations such as parts of the Indian Ocean and the waters around the Indonesian archipelago.

Given the relatively small sizes of the UK and Australian submarine forces, each country might have only one or two submarines in deployed status at any given time. Deployed UK and Australian submarines, moreover, might spend much of their

⁸³ (...continued)

service, Oct. 10, 1998; Antony Preston, “‘Serious Problems’ Reported With New Australian SSKs,” *Sea Power*, Dec. 1998, pp. 31-32; Gregor Ferguson, “Report Slams Australia’s Project Management,” *Defense News*, July 19, 1999; Norman Friedman, “Sub Problems Down Under Continue,” *U.S. Naval Institute Proceedings*, Sept. 1999, pp. 121-123; “Report Targets Collins Class,” *Jane’s Navy International*, Sept. 1999, p. 4; David Lague, “U.S. Experts In Salvage Efforts For Stricken Subs,” *Sydney Morning Herald*, Mar. 20, 2000; Norman Friedman, “Fixing the Collins Class,” *U.S. Naval Institute Proceedings*, May 2000, pp. 98-100, 102; David Lague, “Sweden Goes to War: Australia Blasted over Submarine Secrets,” *Sydney Morning Herald*, Dec. 29, 2000, p. 1.)

In 2000, it was reported that the U.S. Navy granted GD/EB permission to explore how it might help Australia fix problems with its submarines, and that GD/EB sent a team of experts to Australia. (Gregor Ferguson and Robert Holzer, “U.S. Releases Sub Info to Australian Navy,” *Defense News*, Mar. 6, 2000, pp. 1, 26; Robert A. Hamilton, “EB Looking for Business Down Under,” *New London (CT) Day*, Mar. 1, 2000.)

In 2001, it was reported that the U.S. Navy and the Australian Navy signed a statement of principles for sharing classified technology and otherwise promoting interoperability between the U.S. and Australian submarine fleets. (Robert Garran, “US Threat to Sink Strategic Alliance,” *The Australian*, Dec. 23, 2000; Craig Skehan, “Huge Payout After US Applies Pressure Over Defence Tenders,” *Sydney Morning Herald*, July 10, 2001; Robert Garran, “Navy Ties Up to Uncle Sam,” *The Australian*, July 11, 2001; Jason Sherman, “Australian, U.S. Navies to Share Classified Work,” *Defense News*, Aug. 27-Sept. 2, 2001, p. 6; Ian Bostock, “About Face on RAN’s Collins Combat System,” *Jane’s Navy International*, Sept. 2001, p. 6; Gregor Ferguson, “Australian, U.S. Navies to Sign Agreement Sept. 10,” *Defense News*, Sept. 10-16, 2001; Ian Bostock, “RAN-USN Pact on Submarine Strategy,” *Jane’s Defence Weekly*, Oct. 10, 2001, p. 29.)

In 2002-2003, it was reported that GD/EB had become a “capability partner” to ASC and would provide technical support for Australia’s submarines. (“Australia to Buy Raytheon Submarine Combat System,” *Defense Daily*, Sept. 16, 2002; “Australia Commissions Final Collins-Class Submarine,” *Defense Daily*, Apr. 1, 2003.)

In 2005, it was reported that the United States had agreed to grant Australia increased access to U.S. intelligence. (Janaki Kremmer, “Australia Gains From US Intel,” *Christian Science Monitor*, October 17, 2005.)

deployed time performing missions of specific interest to their own governments, rather than missions that may also be of interest to the United States. And Australia's diesel-electric submarines may not be well suited for performing certain missions of interest to the United States, particularly day-to-day ISR missions that might require long, stealthy transits to the operating area, extended periods of submerged operations in the operating area, and long, stealthy transits back to home port. Non-nuclear-powered submarines are less well suited than SSNs for performing such missions. As a result, the number of occasions when UK or Australian submarines might be able to perform missions of interest to the United States might be fairly small.

The submarine forces of U.S. allies and friendly countries other than the UK and Australia are also rather small. In addition, with the exception of France, some of whose attack submarines are nuclear-powered, the submarine forces of these other countries consist entirely of non-nuclear-powered boats, which may limit their ability to perform certain missions of interest to the United States. The reduction in requirements for U.S. attack submarines that might be possible through use of submarines from U.S. allies and friendly countries other than the UK and Australia consequently would also likely be limited.

On the other hand, as suggested by the earlier discussion of the stationkeeping multiplier for U.S. Navy attack submarines, even the occasional performance of a submarine mission of interest to the United States by a submarine from the UK, Australia, or another allied country could have a somewhat leveraged effect in relieving strain on the U.S. attack submarine force, particularly for performing short-duration missions that are relatively close to the allied country in question but far from the home ports of U.S. attack submarines.

It can also be noted, however, that as a general matter, planning U.S. military forces on the assumption that forces from other countries, even close allies, will be available to perform certain missions of interest to the United States entails some risk, given inherent uncertainty over the future policies of foreign governments. The UK or Australia, for example, might decide at some point to reduce the size of its submarine force for affordability reasons, reducing the contribution that the force could make to performing missions of interest to the United States. The UK in July 2004 announced that, as part of a plan to reduce the size of its Navy, it would reduce its SSN force to eight boats by December 2008.⁸⁴

⁸⁴ "British Plan Smaller Fleet for Future Contingencies," *Defense Daily*, July 27, 2004; Richard Scott, "Navy See Cuts Across Fleet," *Jane's Defence Weekly*, July 28, 2004, pp. 14; Richard Scott, "UK Royal Navy Sees Cuts Across Surface Fleet and Submarines," *Jane's Navy International*, Sept. 2004, p. 5.

Appendix B: Supplementary Oversight Issues

This appendix discusses oversight issues that are supplementary to those presented in the main text of the report.

Joint-Production Arrangement

Should the current joint-production arrangement for building Virginia-class submarines be continued or altered?

Potential Production Approaches. Judgments about the potential procurement rate for Virginia-class submarines in future years could influence views on the approach that should be used to build them. There are at least six potential approaches for building Virginia-class submarines:

- the current two-yard, joint-production approach;
- a variant of the current two-yard, joint-production approach under which certain portions of the process for building each submarine would be competed between the two yards;
- a two-yard, separate-production strategy under which complete Virginia-class submarines would be built at both GD/EB and NGNN, with construction contracts for individual submarines allocated to the yards either competitively or without the use of competition;
- a one-yard production strategy under which construction of Virginia-class submarines would be consolidated at GD/EB;
- a one-yard production strategy, under which construction of Virginia-class submarines would be consolidated at NGNN; and
- a strategy under which parts for each submarine would be built at both GD/EB and NGNN, but final assembly and testing of the submarines would be consolidated at either GD/EB or NGNN.

Navy Statements in 2003 about Potential Alternatives. In March and April 2003, at a time when the Navy was concerned about rising procurement costs for Virginia-class submarines, the Navy suggested that it was not necessarily permanently committed to the current joint-production arrangement and was open to considering alternative approaches that might reduce costs. A March 17, 2003 press report stated:

To control rising costs in the Virginia-class submarine program, the Navy is negotiating down expensive bids submitted by General Dynamics and Northrop Grumman for yet-to-be-built subs and might even start competing work currently shared between the two companies, according to Navy acquisition executive John Young.

In a March 10 interview with *Inside the Navy*, Young indicated the Navy might rethink the current arrangement that divides work between GD's Electric Boat in Groton, CT, and Northrop's Newport News, VA, shipyard. While negotiations with the companies are proceeding well, Young said he would like to see industry's bids for future sub construction decrease even further, below the program office's estimate.

"In my mind, everything is on the table," Young said. "Are there ways to compete any common work between the yards? Does it make sense at these rates of production to continue to have both yards doing final assembly? I've got to look at every tool I have. In the end, we may say, we've got it right. But we are going to . . . work very hard at continuing to bring down the costs because we're doing that in every program."⁸⁵

A follow-on article published March 24, 2003, stated that

a Navy official told [*Inside the Navy*] it could be challenging to inject such competition into the program, because it would mean modifying the 1997 teaming arrangement between the Navy and the companies. Modifying the arrangement is possible, but only with the consent of both companies, said the official.

Further, if the Navy decided to compete specific, common work in the program, it could well mean only one company would retain the capability to do that kind of work once a winner was selected, the official noted.

Young was considering numerous possible options, fully aware some challenges could be involved, the official said.⁸⁶

At an April 3, 2003 hearing before the Projection Forces subcommittee of the House Armed Services Committee, Secretary Young was asked by Representative Simmons to comment on the current two-yard, joint-production arrangement for building Virginia-class submarines. Young stated in response:

I am not prepared [to say] any teaming agreement is in jeopardy. I mean, in fact, as you well know, to build a Virginia class [submarine] right now, it is critical to have both companies providing parts of that submarine.

Having said that, though, as you know also, our initial bids on the next block of Virginia classes was substantially higher than the resources the Navy had available at that point in time. I feel it is incumbent on me and my responsibilities to you and the department to look at every option to build those submarines and build them in a way that makes it more affordable to the department.

⁸⁵ Christopher J. Castelli, "Young Considers Competing Work to Control Rising Sub Costs," *Inside the Navy*, Mar. 17, 2003.

⁸⁶ Christopher J. Castelli, "Navy Acknowledges Adding Competition to Sub Program May Be Hard," *Inside the Navy*, Mar. 24, 2003.

Hopefully, any of those tools that we might apply to the program can be executed within the teaming agreement. But I do have, I think, a requirement to look very hard at trying to get an efficient build process.⁸⁷

An April 11, 2003 press report stated:

The Navy's top weapons buyer wants to re-examine the teaming deal between the nation's only two submarine builders to see whether there's a way to cut costs.

With a contract for a fifth Virginia-class sub still on hold as negotiations continue on a long-term purchase plan, the Navy is looking for "adjustments" in the partnership between Northrop Grumman Newport News and General Dynamics Corp.'s Electric Boat shipyard, which jointly build all attack subs.

"This program has grown 24 percent in cost, and my job is to bring the cost down," said John J. Young, the Navy's assistant secretary for research, development and acquisition. "If the teaming agreement is an impediment to that, we ought to at least talk about it."

Young made clear that the teaming arrangement, begun in 1998, is sure to continue in some form because it's no longer practical to consider building all subs at a single shipyard.

Each yard now specializes in building particular parts of subs. Transferring all that expertise to a single shipyard would be costly, he said.

"Moving total construction to a single yard is not even viable at this point in the program," Young said in an interview Thursday.

But in the first sign of discontent with a teaming deal that has largely escaped criticism, Young said he wanted to know whether different methods of building the subs would cut costs.

Among the options, he said, is ending the practice of alternating the assembly of subs between the two yards. Instead, one yard would be responsible for all assembly work.

"I think there are inefficiencies in the teaming agreement that the companies are trying to work through," he said. "Is there a more efficient way? I'm not prepared to say I have an answer. We're going to at least have the discussion."⁸⁸

⁸⁷ U.S. Congress, House Committee on Armed Services, *Hearing on National Defense Authorization Act for Fiscal Year 2004 — H.R. 1588, and Previously Authorized Programs*. 108th Cong., 1st sess, (Washington: GPO, 2003). (H.A.S.C. No. 108-8, Projection Forces Subcommittee Hearings on Title I — Procurement, Title II — Research Development, Test and Evaluation (H.R. 1588), Hearings Held March 27, and April 3, 2003.) p. 121. See also Nick Jonson, "Navy Is Reviewing Arrangement For Building Virginia-Class Subs," *Aerospace Daily*, Apr. 4, 2003.

⁸⁸ David Lerman, "Navy Wants 'Adjustments' in Sub Pact," *Newport News Daily Press*, (continued...)

An April 16, 2003 press report stated:

The US Navy's strategy for building and acquiring Virginia-class nuclear-powered attack submarines is under review following a 24% cost overrun on the program, senior navy officials said.

The new strategy is based on lowering costs by trying to obtain a multi-year procurement contract and possibly reconsidering whether to build the submarines at a single yard....

In [negotiations with industry aimed at reducing costs], Young has said, "everything is on the table." That, [Vice Admiral Philip] Balisle added, "includes the possibility of competing any common work between the shipyards and doing final assembly at one rather than both yards." However, Young later cautioned, "I'm not prepared to say the teaming agreement is in jeopardy."⁸⁹

Officials from General Dynamics and Northrop Grumman, when asked about the possibility of altering the joint-production approach, stated that the approach was working well and expressed skepticism about introducing competition into the arrangement.⁹⁰

1997 Navy Cost Estimate for Some Approaches. In 1997, when the Navy was seeking congressional approval for the current joint-production arrangement, the Navy testified that the procurement cost of Virginia-class submarines under this arrangement would be greater than under a one-yard production approach, but less than under the two-yard, separate-production approach. Specifically, the Navy testified that the procurement cost of the fifth boat in the class (the boat used to benchmark the cost of follow-on boats in the program), in constant FY1995 dollars, would be as follows:

- about \$1.55 billion under a one-yard production strategy;
- about \$1.65 billion, plus or minus \$50 million, under a two-yard, joint-production strategy; and
- about \$1.8 billion under a two-yard, separate-production strategy.⁹¹

The Navy, in other words, stated in 1997 that, relative to the one-yard approach, the premium for adopting the joint-production approach would be about \$100 million (plus or minus \$50 million) per boat, while the premium for adopting the two-yard,

⁸⁸ (...continued)
Apr. 11, 2003.

⁸⁹ Andrew Koch, "Navy Rethinks Virginia Strategy," *Jane's Defence Weekly*, Apr. 16, 2003.

⁹⁰ Jason Ma, "Industry, Simmons Support Keeping VA Sub Teaming Arrangements," *Inside the Navy*, Apr. 14, 2003.

⁹¹ For a discussion, see CRS Issue Brief IB91098, *Navy Attack Submarine Programs: Issues for Congress*, by Ronald O'Rourke. This Issue Brief is out of print and is available directly from the author.

separate-production approach would be about \$250 million per boat. In percentage terms, these premiums were equivalent to about 6.5% (plus or minus about 3.2 percentage points) and 16%, respectively, in additional procurement costs. When converted into constant FY2005 dollars, these figures become about \$114 million (plus or minus \$57 million) and \$284 million, respectively.

Compared to the one-yard approach, the estimated premium for the joint-production approach was due to costs for maintaining more than one complete submarine production line between the two yards (i.e., some overlapping capabilities in the areas of reactor compartment construction and final assembly and testing), reduced rates of learning at each yard for building the reactor compartments and performing final assembly and testing of each boat, costs of transporting submarine sections and personnel back and forth between the two yards, and costs for the Navy of supervising submarine construction at two yards. The estimated premium for the two-yard, separate-production approach was due to costs for maintaining a complete submarine production line at each yard, reduced rates of learning at each yard for the entire process of building the submarines, and costs for the Navy of supervising submarine construction at two yards.

Estimate for One-Yard Strategy. It was not clear whether the Navy's 1997 estimated cost for a one-yard strategy was based on the one yard being GD/EB or NGNN. The Navy's originally intended production strategy for the Virginia-class, however, was to build at least the first two Virginia-class submarines at GD/EB. In light of this earlier proposed strategy, the Navy's estimate for a one-yard approach might have been based on the one yard being GD/EB. As discussed below, however, a one-yard strategy using NGNN might be less expensive than a one-yard strategy using GD/EB. If so, and if the Navy's 1997 estimate for a one-yard strategy was based on the one yard being GD/EB, then an alternate estimate based on the one yard being NGNN might have led, other things held equal, to a greater difference in estimated costs between the one-yard strategy and the strategies involving two yards.

Estimate for Two-Yard, Separate-Production Strategy. The Navy in 1997 acknowledged that using competition in the awarding of submarine construction costs could help constrain costs and thereby possibly reduce the premium for pursuing the two-yard, separate-production approach. The Navy stated, however, that using competition would not be feasible in the near term because it would be "many years into the future" before the attack submarine procurement rate would rise above one per year.⁹²

The Navy in 1996 testified that the minimum procurement rate for maintaining meaningful competition between the two yards for submarine construction contracts would be 1.5 boats per year. At this rate, the Navy testified, the Navy could hold a competition every other year by combining two years' worth of procurement (i.e., three boats), allocating one boat to each yard, and having the yards compete for the

⁹² Ibid.

third boat.⁹³ A higher procurement rate, such as three boats per year, would be needed to support competition on an annual basis.

At this point, however, even if the submarine procurement rate were increased to 1.5 or more boats per year, it might be difficult to resume the use of competition under a two-yard, separate-production arrangement in a manner that would be fair to both yards, because the joint-production arrangement has been in effect since 1997 and the two yards have now shared many of their submarine production trade secrets with one another.

Real-World Experience Since 1997. Whether the premium for the joint-production arrangement has turned out to be greater than, less than, or about equal to the Navy's 1997 estimate of \$114 million (plus or minus \$57 million) per boat in FY2005 dollars is unclear, because all Virginia-class boats have been built under the joint-production arrangement and no real-world data is available on the cost to build Virginia-class boats under a one-yard arrangement.

Virginia-class boats, however, have turned out to be more expensive to build than originally estimated. The estimated unit cost of \$1.65 billion in constant FY1995 dollars for the joint-production arrangement is equivalent to about \$1.9 billion in FY2005 dollars. The unit procurement cost of the Virginia-class, however, is now about \$2.3 billion in constant FY2005 dollars, or about 21% greater than the \$1.9-billion figure. If the premium for the joint-production arrangement is proportional to other costs for building the submarine, then the premium for the joint-production arrangement may be about 21% higher than originally estimated, or roughly \$138 million (plus or minus \$69 million) in FY2005 dollars.

2005 Navy Statement Regarding Joint-Production Cost. At a June 13, 2005, hearing of the House Armed Services Committee on the submarine force held at the Naval Submarine Base in New London, CT, Rear Admiral John D. Butler stated that building Virginia-class submarines under the joint-production arrangement rather than in a single yard was adding about \$200 million to the cost of each submarine.⁹⁴

Arguments for Alternative Approaches. Below are potential arguments that can be made in favor of each of the six potential production approaches listed above.

⁹³ U.S. Congress, House Committee on National Security, Hearings on National Defense Authorization Act For Fiscal Year 1997 — H.R. 3230 and Previously Authorized Programs, 104th Cong., 2nd sess., March 19, 21, 22, 29, 1996 (Washington: GPO, 1997). [Title I — Procurement, H.N.S.C. No. 104-24] p. 769, 778, 851, 877. (See also p. 890, which refers to the FY1996 DDG-51 class destroyer solicitation, a combined solicitation for the six DDG-51s procured in FY1996 and FY1997); U.S. Congress. Senate. Committee on Armed Services. [Hearings on] Department of Defense Authorization for Appropriations For Fiscal Year 1997 and The Future Years Defense Program (S. 1745), 104th Cong., 2nd sess., Part 2, Seapower, March 19, 21, 26, 27, 28, 1996 (Washington: GPO, 1997). [S. Hrg. 104-532, Pt. 2] p. 130. See also CRS Report RL31400, *Navy Shipbuilding: Recent Shipyard Mergers — Background and Issues for Congress*, by Ronald O'Rourke.

⁹⁴ Spoken testimony of Admiral Butler at the hearing.

Current Two-Yard, Joint-Production Approach. Supporters could argue that the current two-yard, joint-production approach is less expensive than a two-yard, separate-production approach, as indicated in the Navy's 1997 estimate.

Supporters could argue that introducing competition into the current joint-production approach for producing certain submarine parts might not necessarily reduce costs because it could compel the yards to maintain additional production equipment, complicate the yards' ability to plan their production activities, and make the process for building and assembling the submarines less uniform from one boat to the next.

Supporters could argue that, compared to a one-yard approach, the current two-yard, joint-production approach offers the following potential benefits:

- It permits the Navy to use submarine production costs, production quality, and schedule adherence at one yard to be used as a benchmark for evaluating submarine production costs, production quality, and schedule adherence at the other yard, giving the government some leverage in achieving good results in submarine construction work at both yards even though competition is not being used in the awarding of submarine construction contracts.
- It could ease the task of accommodating an increase in the submarine procurement rate by spreading the challenge of hiring, training, and supervising new workers over two companies and two regional labor markets.
- It permits a sustained procurement rate of four submarines per year without compelling GD/EB to put its old inclined building ways back into production (if the alternative would have been to have GD/EB be the sole yard producing submarines), and with less risk of straining supervisory skills at either GD/EB or NGNN.
- It preserves a potential for returning to two-yard, separate-production for submarines, and for using competition in awarding submarine construction contracts, should the submarine procurement rate increase to a level sufficient to support two-yard, separate-production, and to maintain effective competition. (As mentioned earlier, however, even if the procurement rate increases to a level sufficient for effective competition, the sharing of trade secrets between the two yards during the period of joint production may make it difficult to resume competition in a manner that is fair to both yards.)
- It would permit the United States to continue building submarines at one yard even if the other yard is rendered incapable of building

submarines permanently or for a sustained period of time by a catastrophic event of some kind.⁹⁵

- It broadens the geographic base of support for procurement of submarines.

Two-Yard, Joint Production with Some Competition. Supporters could argue that a two-yard, joint-production approach with competition for certain portions of the process for building the submarines would:

- be less expensive than a two-yard, separate-production approach, as implied by the Navy's 1997 estimate,
- preserve all the potential benefits, compared to a one-yard approach, of the current two-yard, joint-production approach, and
- potentially reduce costs for building certain parts, and
- broaden the Navy's ability to use submarine production costs, production quality, and schedule adherence at one yard to be used as a benchmark for evaluating submarine production costs, production quality, and schedule adherence at the other yard.

Two-Yard, Separate Production. Supporters could argue that compared to a one-yard approach, a two-yard, separate-production approach would offer all the potential benefits of a two-yard, joint-production approach, and that compared to a two-yard, joint-production approach, it would offer the following additional potential benefits:

- It would more significantly broaden the Navy's ability to use submarine production costs, production quality, and schedule adherence at one yard to be used as a benchmark for evaluating submarine production costs, production quality, and schedule adherence at the other yard.

⁹⁵ One possibility for such an event would be a large-scale attack on the yard or an adjacent area by a foreign country or terrorist group using a nuclear weapon or a so-called dirty bomb (i.e., a radiological dispersion device). Another possibility is a powerful (i.e., category 4 or 5) hurricane. The National Hurricane Center estimates that Category 4 and 5 hurricanes strike within 75 nautical miles of Newport, RI (which is close to GD/EB's facilities) every 150 and 420 years, respectively, and within 75 nautical miles of the Norfolk, VA area (which is close to NGNN) every 230 and more than 500 years, respectively. (Data taken from CRS Report 96-785 F, *Navy Major Shipbuilding Programs and Shipbuilders: Issues and Options for Congress*, by Ronald O'Rourke. The report is out of print and is available directly from the author.) A third possible catastrophic event is a large-scale radiological accident that spreads radiation over much of the yard. In light of the very high safety standards of the U.S. Navy nuclear propulsion program, such an event might be exceedingly unlikely.

- It could permit the current sharing of trade secrets by the two yards to end, which could make it easier at some point further in the future, should the submarine procurement rate increase to a level sufficient to maintain effective competition, to implement, in a manner that is fair to both yards, a decision to resume using competition in awarding submarine construction contracts.

One-Yard Production at GD/EB. Consolidating submarine production at GD/EB would keep two shipyards involved in building nuclear-powered warships of some kind, with one yard (GD/EB) building submarines and the other yard (NGNN) building aircraft carriers.

Supporters of this approach could argue that it would be less expensive than a two-yard approach for building Virginia-class submarines, as indicated in the Navy's 1997 estimate.

Supporters could argue that, compared to the option of consolidating submarine construction at NGNN, this option offers the following potential benefits:

- It would permit work relating to nuclear propulsion plants at one yard to be used as a benchmark for evaluating somewhat similar work at the other yard, giving the government some potential leverage in maintaining good results in nuclear-propulsion-plant-related work at both yards.
- It would maintain nuclear-propulsion-plant-related skills at both yards, making it possible for one yard to assist the other, when needed, in nuclear-propulsion-plant-related work.⁹⁶
- It would preserve a potential for returning to two-yard, joint-production or two-yard, separate-production for submarines, and (in the latter case) for resuming competition in awarding submarine construction contracts, should the submarine procurement rate increase to a level sufficient to support two-yard production and to maintain effective competition. Restoring submarine production at NGNN, however, could take many years and considerable capital investment, particularly if many years had passed since NGNN had last built submarines.
- It would permit the United States to continue building nuclear propulsion plants at one yard even if the other yard is rendered incapable of doing this work permanently or for a sustained period of time by a catastrophic event of some kind.
- It broadens the geographic base of support for procurement of nuclear-powered warships.

⁹⁶ GD/EB nuclear propulsion engineers are currently assisting NGNN in the design of the nuclear propulsion plant for the new CVN-21 aircraft carrier to be procured in FY2008.

One-Yard Production at NGNN. Since submarine design, engineering, and construction is GD/EB's primary business, consolidating submarine production at NGNN could lead to the closure of GD/EB or to its conversion into a primarily design and engineering activity.

Supporters of this option could argue that it would be less expensive than consolidating submarine production at GD/EB for at least two reasons:

- It would permit the country's nuclear-powered-ship construction capacity to be consolidated into a single facility, reducing the shipyard fixed overhead costs associated with building nuclear-powered ships.
- It would reduce the number of sites at which the U.S. Navy needs to supervise nuclear-propulsion-plant construction work.

Two-Yard Parts Production, One-Yard Final Assembly. Under this approach, production of parts for each submarine would continue at both GD/EB and NGNN, but final assembly and testing of the submarines would be consolidated at either GD/EB or NGNN. If final assembly and testing is consolidated at NGNN, then one potential approach that some observers have mentioned would be to produce GD/EB's parts at GD/EB's hull cylinder section construction facility at Quonset Point, RI and either close down GD/EB's main assembly facility at Groton or convert it into primarily a submarine design and engineering activity.

Supporters of producing submarine parts for each submarine at both yards while consolidating final assembly and testing at either GD/EB or NGNN could argue that it would offer some of the potential cost reductions of a one-yard strategy while preserving some of the benefits of a two-yard strategy.

Questions for Congress. Potential questions for Congress regarding the approach used for building Virginia-class submarines include the following:

- Does the Navy have an up-to-date estimate of the per-boat premium for building Virginia-class boats under the current two-yard, joint-production arrangement rather than under a one-yard approach, and if so, what is it?
- Is the Navy still open, as it appears to have been in 2003, to considering alternatives to the current joint-production arrangement?
- What is the Navy's view on how the potential future submarine procurement rate relates to the kind of production arrangement that should be used, and if so, what is it? What is the Navy's view of how the costs and benefits of potential approaches compare at various potential future procurement rates?

Possibility of Designing a New Kind of Attack Submarine

Should the Navy start design work now on a new kind of attack submarine?

Options for a New-Design Submarine. Since late 2004–early 2005, two options have emerged for designing and procuring a new type of attack submarine. One option involves designing a non-nuclear-powered submarine equipped with an air-independent propulsion (AIP) system that could be procured in tandem with Virginia-class SSNs. The other option involves designing a reduced-cost SSN using new “Tango Bravo” technologies being developed by the Navy that would be procured as a successor to the Virginia-class design. Some or all of \$600-million fund included in the FY2006–FY2011 FYDP for “a future undersea superiority system” could be used to help finance either option.

AIP-Equipped Non-Nuclear-Powered Submarine. A February 2005 report to Congress by DOD’s Office of Force Transformation (OFT) proposed a future Navy consisting of several new kinds of ships, including AIP-equipped non-nuclear-powered submarines.⁹⁷ AIP-equipped submarines are currently being acquired by certain foreign navies.

An AIP system such as a fuel-cell or closed-cycle diesel engine extends the stationary or low-speed submerged endurance of a non-nuclear-powered submarine. A conventional diesel-electric submarine has a stationary or low-speed submerged endurance of a few days, while an AIP-equipped submarine may have a stationary or low-speed submerged endurance of up to two or three weeks.

An AIP system does not, however, significantly increase the high-speed submerged endurance of a non-nuclear-powered submarine. A non-nuclear-powered submarine, whether equipped with a conventional diesel-electric propulsion system or an AIP system, has a high-speed submerged endurance of perhaps 1 to 3 hours, a performance limited by the electrical storage capacity of the submarine’s batteries, which are exhausted quickly at high speed.

In contrast, a nuclear-powered submarine’s submerged endurance, at any speed, tends to be limited by the amount of food that it can carry. In practice, this means that a nuclear-powered submarine can remain submerged for weeks or months at a time, operating at high speeds whenever needed.

AIP submarines could be procured in tandem with Virginia-class boats. One possibility, for example, would be to procure one Virginia-class boat plus one or more AIP submarines each year.

Reduced-Cost “Tango Bravo” SSN. The Virginia class was designed in the early to mid-1990s, using technologies that were available at the time. New

⁹⁷ U.S. Department of Defense, Office of the Secretary of Defense, *Alternative Fleet Architecture Design*. See also Christopher J. Castelli, “Defense Department Nudges Navy Toward Developing Diesel Subs,” *Inside the Navy*, Mar. 7, 2005; Dave Ahearn, “Lawmakers Assail Navy Budget, But Eye Non-Nuke Subs,” *Defense Today*, Mar. 3, 2005.

technologies that have emerged since that time may now permit the design of a new SSN that is substantially less expensive than the Virginia-class design, but equivalent in capability. The Navy and the Defense Advanced Research Projects Agency (DARPA) are now pursuing the development of these technologies under a program called Tango Bravo, a name derived from the initial letters of the term “technology barriers.” As described by the Navy,

TANGO BRAVO will execute a technology demonstration program to enable design options for a reduced-size submarine with equivalent capability as the VIRGINIA Class design. Implicit in this focus is the goal to reduce platform infrastructure and, ultimately, the cost of future design and production. Additionally, reduced platform infrastructure provides the opportunity for greater payload volume.

The intent of this collaborative effort is to overcome selected technology barriers that are judged to have a significant impact on submarine platform infrastructure cost. Specifically, DARPA and the Navy will jointly formulate technical objectives for critical technology demonstrations in (a) shaftless propulsion, (b) external weapons, (c) conformal alternatives to the existing spherical array, (d) technologies that eliminate or substantially simplify existing submarine systems, and (e) automation to reduce crew workload for standard tasks.⁹⁸

Some Navy and industry officials believed in late 2004 and early 2005 that if these technologies are developed, it would be possible to design a new submarine equivalent in capability to the Virginia class, but with a procurement cost of perhaps 75% that of the Virginia class. Such a submarine could more easily be procured within available resources at a rate of two per year, which, as discussed earlier, is a rate that the Navy would need to start in FY2013, and sustain for a period of about 12 years, to avoid having the SSN force drop below 40 boats.

Consequently, as an alternative to the option of procuring AIP submarines, another option would be to start design work now on a new “Tango Bravo” SSN. The goal of such an effort could be to produce an SSN design with capability equivalent to that of Virginia-class and a procurement cost that is 75% that of the Virginia class. The idea of designing a submarine with these features was discussed by Navy and industry officials in late 2004 and early 2005. Under this option, Virginia-class procurement could continue at one per year until the Tango Bravo submarine was ready for procurement, at which point Virginia-class procurement would end, and procurement of the Tango Bravo submarine would begin.

If design work on a Tango Bravo submarine is begun now and pursued in a concerted manner, the first Tango Bravo submarine might be ready for procurement by FY2011. (Some industry officials believed in late 2004 and early 2005 that under

⁹⁸ Navy information paper on advanced submarine system development provided to CRS by Navy Office of Legislative Affairs, Jan. 21, 2005. For additional discussion of the Tango Bravo program, see Aarti Shah, “Tango Bravo Technology Contract Awards Expected This Spring,” *Inside the Navy*, Mar. 14, 2005; Andrew Koch, “US Navy In Bid To Overhaul Undersea Combat,” *Jane’s Defence Weekly*, Mar. 9, 2005, p. 11; Lolita C. Baldor, “Smaller Subs Could Ride Waves Of The Future,” *NavyTimes.com*, Feb. 4, 2005; Robert A. Hamilton, “Navy, DARPA Seek Smaller Submarines,” *Seapower*, Feb. 2005, pp. 22, 24-25.

ideal program conditions, the lead ship could be procured earlier than FY2011; conversely, some Navy officials believed at the time that the lead ship might not be ready for procurement until after FY2011.) If the lead ship were procured in FY2011, then the procurement rate could be increased to two per year starting in FY2013, meeting the time line needed to avoid falling below 40 boats.

By mid-2005, the Navy began de-emphasizing the option of designing a reduced-cost SSN, and began emphasizing the alternative of using Tango Bravo technologies for making cost-reducing modifications to the Virginia-class design.

Factors to Consider in Assessing Options. In weighing these options against one another, and against the option of simply continuing to procure Virginia-class SSNs, potential factors for Congress to consider include cost, capability, technical risk, and effect on the industrial base. Each of these is discussed below.

Cost. The Virginia-class program has a projected total development and design cost (including detailed design and nonrecurring engineering work) of several billion dollars. An AIP submarine or Tango Bravo SSN could similarly require billions of dollars in up-front costs to develop and design. Navy officials have estimated that the cost to develop a Tango Bravo submarine could be equal to the procurement cost of three SSNs.

The OFT report recommended substituting four AIP-submarines for one Virginia-class submarine in each carrier strike group, suggesting that four AIP submarines might be procured for the same cost (\$2.4 billion to \$3.0 billion in the FY2006-FY2011 FYDP) as one Virginia-class submarine. This suggests an average unit procurement cost for an AIP submarine of roughly \$600 million to \$750 million each when procured at a rate of four per year. Although AIP submarines being built by other countries might cost this much to procure, a U.S. Navy AIP submarine might be built to higher capability standards and consequently cost more to procure, possibly reducing the equal-cost ratio of substitution to three to one or possibly something closer two to one. If so, then the annual cost of procuring one Virginia-class SSN plus one, two, or perhaps three AIP submarines could be equal to or less than that of procuring two Virginia-class boats per year.

If the procurement cost of a Tango Bravo SSN were 75% that of a Virginia-class boat, then the annual procurement cost of two Tango Bravo SSNs could be equal to 1.5 Virginia-class SSNs.

Capability. As a consequence of their very limited high-speed submerged endurance, non-nuclear-powered submarines, even those equipped with AIP systems, are not well suited for submarine missions that require:

- long, completely stealthy transits from home port to the theater of operation,
- submerged periods in the theater of operation lasting more than two or three weeks, or
- submerged periods in the theater of operation lasting more than a few hours or days that involve moving the submarine at something more than low speed.

With regard to the first of the three points above, the OFT report proposes transporting the AIP submarines into the overseas theater of operations aboard a transport ship.⁹⁹ In doing so, the OFT report accepts that the presence of a certain number of U.S. AIP submarines in the theater of operations will become known to others. A potential force-multiplying attribute of having an SSN in a carrier strike group, in contrast, is that the SSN can be detached from the strike group, and redirected to a different theater to perform some other mission, without alerting others to this fact. Opposing forces in the strike group's theater of operations could not be sure that the SSN was not in their own area, and could therefore continue to devote resources to detecting and countering it. This would permit the SSN to achieve military effects in two theaters of operation at the same time — the strike group's theater of operations, and the other theater to which it is sent.

With regard to the second and third points above, the effectiveness of an AIP submarine would depend on what kinds of operations the submarine might need to perform on a day-to-day basis or in conflict situations while operating as part of a forward-deployed carrier strike group.

One risk of a plan to begin procuring AIP submarines while continuing to procure Virginia-class submarines at one per year is that financial pressures in future years could lead to a decision to increase procurement of AIP submarines while reducing procurement of Virginia-class submarines to something less than one per year. Such a decision would result in a total submarine force with more AIP submarines and fewer SSNs than planned, and consequently with potentially insufficient capability to meet all submarine mission requirements. This possibility is a principal reason why supporters of the U.S. nuclear-powered submarine fleet traditionally have strongly resisted the idea of initiating construction of non-nuclear-powered submarines in this country.

One risk of a plan to shift to procurement of Tango Bravo SSNs is that financial pressures in future years could lead to a decision to limit procurement of Tango Bravo SSNs to one per year. If the Tango Bravo SSN were equivalent in capability to the Virginia-class, however, this would produce a U.S. SSN force no less capable than would have resulted if Virginia-class procurement were continued at one per year.

Technical Risk. Developing and designing an AIP submarine would entail a certain amount of technical risk, particularly since the United States has not designed and procured a non-nuclear-powered combat submarine since the 1950s.

Developing and designing a Tango Bravo SSN would similarly entail a certain amount of technical risk, particularly with regard to maturing the Tango Bravo technologies and incorporating them into an integrated SSN design. The earlier the

⁹⁹ The strategy of transporting the AIP submarines to the theater using transport ships is not mentioned in the report but was explained at a Feb. 18, 2005 meeting between CRS and analysts who contributed to the OFT report.

target date for procuring the first Tango Bravo SSN, the higher the technical risk might be.

In contrast to either of these options, simply continuing to procure Virginia-class SSNs would likely entail substantially less technical risk, unless an attempt is made to incorporate very substantial changes into the Virginia-class design, in which case the differential in technical risk compared to the two new-design options might not be as great.

Effect on Industrial Base. The potential effect of an AIP submarine procurement program on the U.S. submarine construction industrial base would depend in part on where the submarines would be built. AIP submarines could be built at either GD/EB, NGNN, or a yard that currently does not build submarines, such as the Ingalls shipyard at Pascagoula, MS, which forms part of Northrop Grumman's Ship System (NGSS) division. Ingalls has been associated with proposals in recent years for building non-nuclear-powered submarines for export to foreign countries such as Taiwan.

If financial pressures in future years lead to a decision to increase procurement of AIP submarines while reducing procurement of Virginia-class submarines to something less than one per year, this would benefit the yard building the AIP submarines but reduce Virginia-class construction work at GD/EB and NGNN below levels that might have occurred under the option of simply continuing with Virginia-class procurement.

A Tango Bravo SSN could be built at either GD/EB, NGNN, or both, so the potential effect of a Tango Bravo SSN program on the submarine construction industrial base would depend in part on the acquisition strategy pursued for the program. If Tango Bravo SSNs were procured at a rate of two per year, this could result in a greater total volume of SSN construction work than might have occurred under the option of simply continuing with Virginia-class procurement. Conversely, if financial pressures in future years lead to a decision to limit procurement of Tango Bravo SSNs to one per year, this could result in a lower total volume of SSN construction work than might have occurred under the option of simply continuing with Virginia-class procurement.

Starting design work now on a new submarine could provide near-term support to the submarine design and engineering base and thereby help maintain that base, addressing a concern discussed in the Background section. An AIP submarine could be designed at either GD/EB, NGNN, or a yard that currently does not build submarines, such as the Ingalls. If design work were to be done at GD/EB, NGNN, or both, it would help maintain certain submarine design and engineering skills at one or both of those yards. It would not, however, maintain certain skills at those yards related to the design and engineering of submarine nuclear propulsion plants. If the design were to be done at Ingalls or some other yard, it might not directly support the maintenance of any submarine design and engineering skills at GD/EB or NGNN.

A Tango Bravo SSN could be designed by GD/EB, NGNN, or both, so the potential effect of a Tango Bravo SSN program on the submarine design and engineering base would depend in part on the acquisition strategy pursued for the

program. At the yard or yards doing the design work, it would help to maintain all skills related to the design of nuclear-powered submarines, including the design and engineering of submarine nuclear propulsion plants.

After completing the design of an AIP submarine or Tango Bravo SSN, the submarine design and engineering base could turn to designing the next-generation ballistic missile submarine (SSBN), the lead ship of which might need to be procured around FY2020. After designing this new SSBN, the design and engineering base could turn back to designing a follow-on attack submarine that would take advantage of technologies even more advanced than those available today. This sequence of three successive submarine design projects could help maintain the submarine design and engineering base for the next 15 or so years.