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Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress

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Summary

The Navy has been procuring Virginia (SSN-774) class nuclear-powered attack submarines since FY1998. The two Virginia-class boats requested for procurement in FY2016 are to be the 23rd and 24th boats in the class. The 10 Virginia-class boats programmed for procurement in FY2014-FY2018 (two per year for five years) are being procured under a multiyear-procurement (MYP) contract.

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2016 at \$5,376.9 million or an average of \$2,688.4 million each. The boats have received a total of \$1,613.5 million in prior-year advance procurement (AP) funding and \$416.9 million in prior-year Economic Order Quantity (EOQ) funding. The Navy's proposed FY2016 budget requests the remaining \$3,346.4 million needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2016 budget also requests \$1,663.8 million in AP funding and \$330.0 million in EOQ funding for Virginia-class boats to be procured in future fiscal years, bringing the total FY2016 funding request for the program (excluding outfitting and post-delivery costs) to \$5,340.1 million.

The Navy's proposed FY2016 budget also requests \$167.7 million in research and development funding for the Virginia Payload Module (VPM). The funding is contained in Program Element (PE) 0604580N, entitled Virginia Payload Module (VPM), which is line 123 in the Navy's FY2016 research and development account.

The Navy plans to build Virginia-class boats procured in FY2019 and subsequent years with an additional mid-body section, called the Virginia Payload Module (VPM), that contains four large-diameter, vertical launch tubes that the boats would use to store and fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs). The Navy estimates that building Virginia-class boats with the VPM might increase their unit procurement costs by about 13%. It would increase the total number of torpedo-sized weapons (such as Tomahawks) that they could carry by about 76%. The Navy's FY2016 shipbuilding plan calls for building one of the two Virginia-class boats to be procured in FY2019, and one of the two Virginia-class boats to be procured in FY2020, with the VPM.

The Navy's FY2016 30-year SSN procurement plan, if implemented, would not be sufficient to maintain a force of 48 SSNs consistently over the long run. The Navy projects under that plan the SSN force would fall below 48 boats starting in FY2025, reach a minimum of 41 boats in FY2029, and remain below 48 boats through FY2036.

Potential issues for Congress regarding the Virginia-class program include the Virginia-class procurement rate in coming years, particularly in the context of the SSN shortfall projected for FY2025-FY2034 and the larger debate over future U.S. defense strategy and defense spending.

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Introduction

This report provides background information and issues for Congress on the Virginia-class nuclear-powered attack submarine (SSN) program. The Navy's proposed FY2016 budget requests \$5,340.1 million in procurement, advance procurement (AP), and Economic Order Quantity (EOQ) funding for the program. Decisions that Congress makes on procurement of Virginia-class boats could substantially affect U.S. Navy capabilities and funding requirements, and the U.S. shipbuilding industrial base.

The Navy's Ohio Replacement (SSBN[X]) ballistic missile submarine program is discussed in another CRS report.¹

Background

Strategic and Budgetary Context

For an overview of the strategic and budgetary context in which this and other Navy shipbuilding programs may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

U.S. Navy Submarines²

The U.S. Navy operates three types of submarines—nuclear-powered ballistic missile submarines (SSBNs),³ nuclear-powered cruise missile and special operations forces (SOF) submarines (SSGNs),⁴ and nuclear-powered attack submarines (SSNs). The SSNs are general-purpose submarines that can (when appropriately equipped and armed) 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;

¹ See CRS Report R41129, *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress*, by Ronald O'Rourke.

² In U.S. Navy submarine designations, 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). Submarines can be 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. A submarine's use of nuclear or non-nuclear power as its energy source is not 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.

³ 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. The Navy's SSBNs are discussed in CRS Report R41129, *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress*, by Ronald O'Rourke, and CRS Report RL31623, *U.S. Nuclear Weapons: Changes in Policy and Force Structure*, by Amy F. Woolf.

⁴ The Navy's four SSGNs are former Trident SSBNs that have been converted (i.e., modified) to carry Tomahawk cruise missiles and SOF rather than SLBMs. Although the 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 can perform other submarine missions and are sometimes included in counts of the projected total number of Navy attack submarines. The Navy's SSGNs are discussed in CRS Report RS21007, *Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress*, by Ronald O'Rourke.

- covert insertion and recovery of SOF (on a smaller scale than possible with the SSGNs);
- covert strikes against land targets with the Tomahawk cruise missiles (again on a smaller scale than possible with the SSGNs);
- 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 reportedly important on a day-to-day basis as well.⁵ In the post-Cold War era, although anti-submarine warfare remains a mission, the SSN force has focused more on performing the other missions noted on the list above.

Attack Submarine Force Levels

Force-Level Goal

The Navy wants to achieve and maintain a fleet in coming years of 306 ships, including 48 SSNs.⁶ For a review of SSN force level goals since the Reagan Administration, see **Appendix A**.

Force Level at End of FY2014

The SSN force included more than 90 boats during most of the 1980s, when plans called for achieving a 600-ship Navy including 100 SSNs. The number of SSNs peaked at 98 boats at the end of FY1987 and has declined since then in a manner that has roughly paralleled the decline in the total size of the Navy over the same time period. The 55 SSNs in service at the end of FY2014 included the following:

- 41 Los Angeles (SSN-688) class boats;
- 3 Seawolf (SSN-21) class boats; and
- 11 Virginia (SSN-774) class boats.

Los Angeles- and Seawolf-Class Boats

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 missiles. The final 23 boats in the class (SSN-751 and higher) incorporate further improvements and are referred to as Improved Los

⁵ 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).

⁶ For additional information on Navy force-level goals, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Angeles class boats or 688Is. As of the end of FY2014, 21 of the 62 boats in the class had been retired.

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 entered service in 2005. Seawolf-class submarines are larger than Los Angeles-class boats or previous U.S. Navy SSNs.⁷ They are equipped with eight 30-inch-diameter torpedo tubes and can carry a total of 50 torpedoes or cruise missiles. SSN-23 was built to a lengthened configuration compared to the other two ships in the class.⁸

Virginia (SSN-774) Class Program

General

The Virginia-class attack submarine (see **Figure 1**) 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,⁹ but incorporates newer technologies. Virginia-class boats currently cost about \$2.8 billion each to procure. The first Virginia-class boat entered service in October 2004.

Past and Projected Annual Procurement Quantities

Table 1 shows annual numbers of Virginia-class boats procured from FY1998 (the lead boat) through FY2014, and numbers scheduled for procurement under the FY2016-FY2020 Future Years Defense Plan (FYDP).

Table 1. Annual Numbers of Virginia-Class Boats Procured or Projected for Procurement

FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
1	1	0	1	1	1	1	1	1	1	1	1
FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	
1	2	2	2	2	2	2	2	2	2	2	

Source: Table prepared by CRS based on U.S. Navy data.

⁷ 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.

⁸ SSN-23 is 100 feet longer than SSN-21 and SSN-22 and has a submerged displacement of 12,158 tons.

⁹ Virginia-class boats have a beam of 34 feet and a submerged displacement of 7,800 tons.

Figure I. Virginia-Class Attack Submarine



Source: U.S. Navy file photo accessed by CRS on January 11, 2011, at http://www.navy.mil/search/display.asp?story_id=55715.

Multiyear Procurement (MYP)

The 10 Virginia-class boats shown in **Table 1** for the period FY2014-FY2018 (referred to as the Block IV boats) are being procured under a multiyear procurement (MYP) contract¹⁰ that was approved by Congress as part of its action on the FY2013 budget, and awarded by the Navy on April 28, 2014. The eight Virginia-class boats procured in FY2009-FY2013 (the Block III boats) were procured under a previous MYP contract, and the five Virginia-class boats procured in FY2004-FY2008 (the Block II boats) were procured under a still-earlier MYP contract. The four boats procured in FY1998-FY2002 (the Block I boats) were procured under a block buy contract, which is an arrangement somewhat similar to an MYP contract.¹¹ The boat procured in FY2003 fell between the FY1998-FY2002 block buy contract and the FY2004-FY2008 MYP arrangement, and was contracted for separately.

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 Newport News Shipbuilding (NNS), of Newport News,

¹⁰ For a discussion of MYP contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke and Moshe Schwartz.

¹¹ For a discussion of block buy contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke and Moshe Schwartz.

VA, which forms part of Huntington Ingalls Industries (HII).¹² Under the arrangement, GD/EB builds certain parts of each boat, NNS 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 NNS 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.¹³

Cost-Reduction Effort

The Navy states that it achieved a goal of reducing the procurement cost of Virginia-class submarines so that two boats could be procured in FY2012 for a combined cost of \$4.0 billion in constant FY2005 dollars—a goal referred to as “2 for 4 in 12.” Achieving this goal involved removing about \$400 million (in constant FY2005 dollars) from the cost of each submarine. (The Navy calculates that the unit target cost of \$2.0 billion in constant FY2005 dollars for each submarine translates into about \$2.6 billion for a boat procured in FY2012.)¹⁴

Virginia Payload Module (VPM)

The Navy plans to build Virginia-class boats procured in FY2019 and subsequent years (i.e., the anticipated Block V and beyond boats) with an additional mid-body section, called the Virginia Payload Module (VPM). The VPM, reportedly about 70 feet in length¹⁵ (earlier design concepts for the VPM were reportedly about 94 feet in length),¹⁶ contains four large-diameter, vertical

¹² GD/EB and NNS are the only two shipyards in the country capable of building nuclear-powered ships. GD/EB builds submarines only, while NNS also builds nuclear-powered aircraft carriers and is capable of building other types of surface ships.

¹³ The joint production arrangement is a departure from prior 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 the Department of Defense (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 NNS 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 relatively low annual rate. The joint production agreement cannot be changed without the agreement of both GD/EB and NNS.

¹⁴ The Navy says that, in constant FY2005 dollars, about \$200 million of the \$400 million in the sought-after cost reductions was accomplished simply through the improved economies of scale (e.g., better spreading of shipyard fixed costs and improved learning rates) of producing two submarines per year rather than one per year. The remaining \$200 million in sought-after cost reductions, the Navy says, was accomplished through changes in the ship's design (which will contribute roughly \$100 million toward the cost-reduction goal) and changes in the shipyard production process (which will contribute the remaining \$100 million or so toward the goal). Some of the design changes are being introduced to Virginia-class boats procured prior to FY2012, but the Navy said the full set of design changes would not be ready for implementation until the FY2012 procurement.

Changes in the shipyard production process are aimed in large part at reducing the total shipyard construction time of a Virginia-class submarine from 72 months to 60 months. (If the ship spends less total time in the shipyard being built, its construction cost will incorporate a smaller amount of shipyard fixed overhead costs.) The principal change involved in reducing shipyard construction time to 60 months involves increasing the size of the modules that form each submarine, so that each submarine can be built out of a smaller number of modules. For detailed discussions of the Virginia-class cost-reduction effort, see David C. Johnson et al., “Managing Change on Complex Programs: VIRGINIA Class Cost Reduction,” *Naval Engineers Journal*, No. 4, 2009: 79-94; and John D. Butler, “The Sweet Smell of Acquisition Success,” *U.S. Naval Institute Proceedings*, June 2011: 22-28.

¹⁵ “Navy Selects Virginia Payload Module Design Concept,” *USNI News* (<http://news.usni.org>), November 4, 2013.

¹⁶ Christopher P. Cavas, “Innovations, No-Shows At Sea-Air-Space Exhibition,” *Defense News*, April 18, 2011: 4. See (continued...)

launch tubes that would be used to store and fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs).¹⁷

The four additional launch tubes in the VPM could carry a total of 28 additional Tomahawk cruise missiles (7 per tube),¹⁸ which would increase the total number of torpedo-sized weapons (such as Tomahawks) carried by the Virginia class design from about 37 to about 65—an increase of about 76%.¹⁹ The Navy wants to start building Virginia-class boats with the VPM in FY2019. The Navy's FY2016 five-year shipbuilding plan calls for building one of the two Virginia-class boats to be procured in FY2019, and one of the two Virginia-class boats to be procured in FY2020, with the VPM.

Building Virginia-class boats with the VPM would compensate for a sharp loss in submarine force weapon-carrying capacity that will occur with the retirement in FY2026-FY2028 of the Navy's four Ohio-class cruise missile/special operations forces support submarines (SSGNs).²⁰ Each SSGN is equipped with 24 large-diameter vertical launch tubes, of which 22 can be used to carry up to 7 Tomahawks each, for a maximum of 154 vertically launched Tomahawks per boat, or 616 vertically launched Tomahawks for the four boats. Twenty-two Virginia-class boats built with VPMs could carry 616 Tomahawks in their VPMs.

The Navy in 2013 estimated that adding the VPM would increase the procurement cost of the Virginia-class design by \$350 million in current dollars, or by about 13%.²¹

The joint explanatory statement for the FY2014 DOD Appropriations Act (Division C of H.R. 3547/P.L. 113-76 of January 17, 2014) requires the Navy to submit biannual reports to the congressional defense committees describing the actions the Navy is taking to minimize costs for the VPM.²² The first such report, dated July 2014, is reprinted in **Appendix C**.²³

At a February 25, 2015, hearing before the Seapower and Projection Forces subcommittee of the House Armed Services Committee, Sean Stackley, the Assistant Secretary of the Navy for

(...continued)

also Christopher P. Cavas, "U.S. Navy Eyes Dual-Mission Sub," *Defense News*, October 17, 2011; and Lee Hudson, "New Virginia-Class Payload Module May Replace SSGN Capability," *Inside the Navy*, October 24, 2011.

¹⁷ For an illustration of the VPM, see http://www.gdeb.com/news/advertising/images/VPM_ad/VPM.pdf, which was accessed by CRS on March 1, 2012.

¹⁸ Michael J. Conner, "Investing in the Undersea Future," *U.S. Naval Institute Proceedings*, June 2011: 16-20.

¹⁹ A Virginia-class SSN can carry about 25 Tomahawks or other torpedo-sized weapons in its four horizontal torpedo tubes and associated torpedo room, and an additional 12 Tomahawk cruise missiles in its bow-mounted vertical launch tubes, for a total of about 37 torpedo-sized weapons. Another 28 Tomahawks in four mid-body vertical tubes would increase that total by about 76%.

²⁰ Michael J. Conner, "Investing in the Undersea Future," *U.S. Naval Institute Proceedings*, June 2011: 16-20.

²¹ Lee Hudson, "Virginia Payload Module Cost Estimate Down To \$350 Million Apiece," *Inside the Navy*, July 22, 2013. Previously, the Navy had testified that adding the VPM would increase the procurement cost of the Virginia-class design by \$360 million to \$380 million in current dollars. (Source: Spoken testimony of Sean Stackley, the Assistant Secretary of the Navy for Research, Development, and Acquisition [i.e., the Navy's acquisition executive], at a May 8, 2013, hearing on Navy shipbuilding programs before the Seapower subcommittee of the Senate Armed Services Committee, as shown in the transcript for the hearing. See also Olga Belogolova, "Navy Officials Lay Out Fragility Of Shipbuilding Budget To Congress," *Inside the Navy*, May 10, 2013.) Prior to that, the Navy reportedly had estimated that adding the VPM would increase the procurement cost of the Virginia-class design by \$400 million to \$500 million. (Christopher P. Cavas, "U.S. Navy Eyes Dual-Mission Sub," *Defense News*, October 17, 2011; see also Michael J. Conner, "Investing in the Undersea Future," *U.S. Naval Institute Proceedings*, June 2011: 16-20.)

²² See PDF page 239 of 351 of the joint explanatory statement for Division C of H.R. 3547.

²³ For an article discussing the navy's report, see Lee Hudson, "Stackley Outlines Virginia Payload Module Cost Strategy For Congress," *Inside the Navy*, November 3, 2014.

Research, Development, and Acquisition (i.e., the Navy's acquisition executive), stated that the Navy is examining the feasibility of accelerating the procurement of the first VPM-equipped Virginia-class boat from FY2019 to an earlier year.²⁴

FY2016 Funding Request

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2016 at \$5,376.9 million or an average of \$2,688.4 million each. The boats have received a total of \$1,613.5 million in prior-year advance procurement (AP) funding and \$416.9 million in prior-year Economic Order Quantity (EOQ) funding. The Navy's proposed FY2016 budget requests the remaining \$3,346.4 million needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2016 budget also requests \$1,663.8 million in AP funding and \$330.0 million in EOQ funding for Virginia-class boats to be procured in future fiscal years, bringing the total FY2016 funding request for the program (excluding outfitting and post-delivery costs) to \$5,340.1 million.

The Navy's proposed FY2016 budget also requests \$167.7 million in research and development funding for the Virginia Payload Module (VPM). The funding is contained in Program Element (PE) 0604580N, entitled Virginia Payload Module (VPM), which is line 123 in the Navy's FY2016 research and development account.

Submarine Construction Industrial Base

In addition to GD/EB and NNS, the submarine construction industrial base includes scores of supplier firms, as well as laboratories and research facilities, in numerous states. Much of the total material procured from supplier firms for the construction of submarines comes from single or sole source suppliers. Observers in recent years have expressed concern for the continued survival of many of these firms. 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.

Much of the design and engineering portion of the submarine construction industrial base is resident at GD/EB. Smaller portions are resident at NNS and some of the component makers. Several years ago, some observers expressed concern about the Navy's plans for sustaining the design and engineering portion of the submarine construction industrial base. These concerns appear to have receded, in large part because of the Navy's plan to design and procure a next-generation ballistic missile submarine called the Ohio Replacement Program or SSBN(X).²⁶

²⁴ Source: Spoken testimony of Assistant Secretary Stackley, as reflected in transcript of hearing.

²⁵ For more on this program, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

²⁶ For more on the SSBN(X) program, see CRS Report R41129, *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress*, by Ronald O'Rourke.

Projected SSN Shortfall

Size and Timing of Shortfall

The Navy’s FY2016 30-year SSN procurement plan, if implemented, would not be sufficient to maintain a force of 48 SSNs consistently over the long run. As shown in **Table 2**, the Navy projects under the plan that the SSN force would fall below 48 boats starting in FY2025, reach a minimum of 41 boats in FY2029, and remain below 48 boats through FY2036. Since the Navy plans to retire the four SSGNs by 2028 without procuring any replacements for them, no SSGNs would be available in 2028 and subsequent years to help compensate for a drop in SSN force level below 48 boats.

The projected SSN shortfall was first identified by CRS in 1995 and has been discussed in CRS reports and testimony every year since then.

Table 2. Projected SSN Shortfall

As shown in Navy’s FY2016 30-Year (FY2016-FY2045) Shipbuilding Plan

Fiscal year	Annual procurement quantity	Projected number of SSNs	Shortfall relative to 48-boat goal	
			Number of ships	Percent
16	2	53		
17	2	50		
18	2	52		
19	2	50		
20	2	51		
21	1	51		
22	2	48		
23	2	49		
24	1	48		
25	2	47	-1	-2%
26	1	45	-3	-6%
27	1	44	-4	-8%
28	1	42	-6	-13%
29	1	41	-7	-15%
30	1	42	-6	-13%
31	1	43	-5	-10%
32	1	43	-5	-10%
33	1	44	-4	-8%
34	1	45	-3	-6%
35	1	46	-2	-4%
36	2	47	-1	-2%
37	2	48		
38	2	47	-1	-2%
39	2	47	-1	-2%
40	1	47	-1	-2%
41	2	47	-1	-2%
42	1	49		
43	2	49		
44	1	50		
45	2	50		

Source: Table prepared by CRS based on Navy’s FY2016 30-year shipbuilding plan. Percent figures rounded to nearest percent.

2006 Navy Study on Options for Mitigating Projected Shortfall

The Navy in 2006 initiated a study on options for mitigating the projected SSN shortfall. The study was completed in early 2007 and briefed to CRS and the Congressional Budget Office (CBO) on May 22, 2007.²⁷ At the time of the study, the SSN force was projected to bottom out at 40 boats and then recover to 48 boats by the early 2030s. Principal points in the Navy study (which cite SSN force-level projections as understood at that time) include the following:

- The day-to-day requirement for deployed SSNs is 10.0, meaning that, on average, a total of 10 SSNs are to be deployed on a day-to-day basis.²⁸
- The peak projected wartime demand is about 35 SSNs deployed within a certain amount of time. This figure includes both the 10.0 SSNs that are to be deployed on a day-to-day basis and 25 additional SSNs surged from the United States within a certain amount of time.²⁹
- Reducing Virginia-class shipyard construction time to 60 months—something that the Navy already plans to do as part of its strategy for meeting the Virginia-class cost-reduction goal (see earlier discussion on cost-reduction goal)—will increase the size of the SSN force by two boats, so that the force would bottom out at 42 boats rather than 40.³⁰
- If, in addition to reducing Virginia-class shipyard construction time to 60 months, the Navy also lengthens the service lives of 16 existing SSNs by periods ranging from 3 months to 24 months (with many falling in the range of 9 to 15 months), this would increase the size of the SSN force by another two boats, so that the force would bottom out at 44 boats rather than 40 boats.³¹ The total cost of extending the lives of the 16 boats would be roughly \$500 million in constant FY2005 dollars.³²

²⁷ Navy briefing entitled, “SSN Force Structure, 2020-2033,” presented to CRS and CBO on May 22, 2007.

²⁸ The requirement for 10.0 deployed SSNs, the Navy stated in the briefing, was the current requirement at the time the study was conducted.

²⁹ The peak projected wartime demand of about 35 SSNs deployed within a certain amount of time, the Navy stated, is an internal Navy figure that reflects several studies of potential wartime requirements for SSNs. The Navy stated that these other studies calculated various figures for the number of SSNs that would be required, and that the figure of 35 SSNs deployed within a certain amount of time was chosen because it was representative of the results of these other studies.

³⁰ If shipyard construction time is reduced from 72 months to 60 months, the result would be a one-year acceleration in the delivery of all boats procured on or after a certain date. In a program in which boats are being procured at a rate of two per year, accelerating by one year the deliveries of all boats procured on or after a certain date will produce a one-time benefit of a single year in which four boats will be delivered to the Navy, rather than two. In the case of the Virginia-class program, this year might be around 2017. As mentioned earlier in the discussion of the Virginia-class cost-reduction goal, the Navy believes that the goal of reducing Virginia-class shipyard construction time is a medium-risk goal. If it turns out that shipyard construction time is reduced to 66 months rather than 60 months (i.e., is reduced by 6 months rather than 12 months), the size of the SSN force would increase by one boat rather than two, and the force would bottom out at 41 boats rather than 42.

³¹ The Navy study identified 19 existing SSNs whose service lives currently appear to be extendable by periods of 1 to 24 months. The previous option of reducing Virginia-class shipyard construction time to 60 months, the Navy concluded, would make moot the option of extending the service lives of the three oldest boats in this group of 19, leaving 16 whose service lives would be considered for extension.

³² The Navy stated that the rough, order-of-magnitude (ROM) cost of extending the lives of 19 SSNs would be \$595 million in constant FY2005 dollars, and that the cost of extending the lives of 16 SSNs would be roughly proportional.

- The resulting force that bottoms out at 44 boats could meet the 10.0 requirement for day-to-day deployed SSNs throughout the 2020-2033 period if, as an additional option, about 40 SSN deployments occurring in the eight-year period 2025-2032 were lengthened from six months to seven months. These 40 or so lengthened deployments would represent about one-quarter of all the SSN deployments that would take place during the eight-year period.
- The resulting force that bottoms out at 44 boats could not meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time. The force could generate a total deployment of 32 SSNs within the time in question—3 boats (or about 8.6%) less than the 35-boat figure. Lengthening SSN deployments from six months to seven months would not improve the force's ability to meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time.
- To meet the 35-boat figure, an additional four SSNs beyond those planned by the Navy would need to be procured. Procuring four additional SSNs would permit the resulting 48-boat force to surge an additional three SSNs within the time in question, so that the force could meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time.
- Procuring one to four additional SSNs could also reduce the number of seven-month deployments that would be required to meet the 10.0 requirement for day-to-day deployed SSNs during the period 2025-2032. Procuring one additional SSN would reduce the number of seven-month deployments during this period to about 29; procuring two additional SSNs would reduce it to about 17, procuring three additional SSNs would reduce it to about 7, and procuring four additional SSNs would reduce it to 2.

The Navy added a number of caveats to these results, including but not limited to the following:

- The requirement for 10.0 SSNs deployed on a day-to-day basis is a current requirement that could change in the future.
- The peak projected wartime demand of about 35 SSNs deployed within a certain amount of time is an internal Navy figure that reflects recent analyses of potential future wartime requirements for SSNs. Subsequent analyses of this issue could result in a different figure.
- The identification of 19 SSNs as candidates for service life extension reflects current evaluations of the material condition of these boats and projected use rates for their nuclear fuel cores. If the material condition of these boats years from now turns out to be worse than the Navy currently projects, some of them might no longer be suitable for service life extension. In addition, if world conditions over the next several years require these submarines to use up their nuclear fuel cores more quickly than the Navy now projects, then the amounts of time that their service lives might be extended could be reduced partially, to zero, or to less than zero (i.e., the service lives of the boats, rather than being extended, might need to be shortened).

- The analysis does not take into account potential rare events, such as accidents, that might force the removal an SSN from service before the end of its expected service life.³³
- Seven-month deployments might affect retention rates for submarine personnel.

Issues for Congress

Virginia-Class Procurement Rate More Generally in Coming Years

One potential issue for Congress concerns the Virginia-class procurement rate in coming years, particularly in the context of the SSN shortfall projected for FY2025-FY2036 shown in **Table 2** and the larger debate over future U.S. defense strategy and defense spending.

Mitigating Projected SSN Shortfall

In addition to lengthening SSN deployments to 7 months and extending the service lives of existing SSNs by periods ranging from 3 months to 24 months (see “2006 Navy Study on Options for Mitigating Projected Shortfall” above), options for more fully mitigating the projected SSN shortfall include

- refueling a small number of (perhaps one to five) existing SSNs and extending their service lives by 10 years or more, and
- putting additional Virginia-class boats into the 30-year shipbuilding plan.

It is not clear whether it would be feasible or cost-effective to refuel existing SSNs and extend their service lives by 10 or more years, given factors such as limits on submarine pressure hull life.

Larger Debate on Defense Strategy and Defense Spending

Some observers—particularly those who propose reducing U.S. defense spending as part of an effort to reduce the federal budget deficit—have recommended that the SSN force-level goal be reduced to something less than 48 boats, and/or that Virginia-class procurement be reduced. A June 2010 report from a group called the Sustainable Defense Task Force recommends a Navy of 230 ships, including 37 SSNs,³⁴ and a September 2010 report from the Cato Institute recommends a Navy of 241 ships, including 40 SSNs.³⁵ Both reports recommend limiting Virginia-class procurement to one boat per year, as does a September 2010 report from the Center for American

³³ In January 2005, the Los Angeles-class SSN *San Francisco* (SSN-711) was significantly damaged in a collision with an undersea mountain near Guam. The ship was repaired in part by transplanting onto it the bow section of the deactivated sister ship *Honolulu* (SSN-718). (See, for example, Associated Press, “Damaged Submarine To Get Nose Transplant,” *Seattle Post-Intelligencer*, June 26, 2006.) Prior to the decision to repair the *San Francisco*, the Navy considered the option of removing it from service. (See, for example, William H. McMichael, “Sub May Not Be Worth Saving, Analyst Says,” *Navy Times*, February 28, 2005; Gene Park, “Sub Repair Bill: \$11M,” *Pacific Sunday News (Guam)*, May 8, 2005.)

³⁴ *Debt, Deficits, and Defense, A Way Forward[:] Report of the Sustainable Defense Task Force*, June 11, 2010, pp. 19-20, 31.

³⁵ Benjamin H. Friedman and Christopher Preble, *Budgetary Savings from Military Restraint*, Washington, Cato Institute, September 23, 2010 (Policy Analysis No. 667), p. 9.

Progress.³⁶ A November 2010 report from a group called the Debt Reduction Task Force recommends “deferring” Virginia-class procurement.³⁷ The November 2010 draft recommendations of the co-chairs of the Fiscal Commission include recommendations for reducing procurement of certain weapon systems; the Virginia-class program is not among them.

Other observers have recommended that the SSN force-level goal should be increased to something higher than 48 boats, particularly in light of Chinese naval modernization.³⁸ The July 2010 report of an independent panel that assessed the 2010 Quadrennial Defense Review (QDR)—an assessment that is required by the law governing QDRs (10 U.S.C. 118)—recommends a Navy of 346 ships, including 55 SSNs.³⁹ An April 2010 report from the Heritage Foundation recommends a Navy of 309 ships, including 55 SSNs.⁴⁰

Factors to consider in assessing whether to maintain, increase, or reduce the SSN force-level goal and/or planned Virginia-class procurement include but are not limited to the federal budget and debt situation, the value of SSNs in defending U.S. interests and implementing U.S. national security strategy, and potential effects on the submarine industrial base.

As discussed earlier, Virginia-class boats scheduled for procurement in FY2014 are covered under an MYP contract for the period FY2014-FY2018. This MYP contract includes the procurement of two Virginia-class boats in FY2016. If fewer than two boats were procured in FY2016, the Navy might need to terminate the MYP contract and pay a cancellation penalty to the contractor.

Procurement of VPM-Equipped Virginia-Class Boats

Another issue for Congress concerns procurement of VPM-equipped Virginia-class boats. As discussed above, the Navy testified on February 25, 2015, that it is examining the feasibility of accelerating the procurement of the first VPM-equipped Virginia-class boat from FY2019 to an earlier year. Independent of that option, Navy submarine officials have stated that they would like all Virginia-class boats procured in FY2019 and subsequent years (not just every other such boat) to be equipped with VPM, but will need to verify that doing so would not negatively impact construction of both Virginia-class boats and Ohio replacement (SSBN[X]) ballistic missile submarines.⁴¹ Either of these two options—particularly the second one—would accelerate the date by which VPM-equipped Virginia-class boats would fully offset the loss of strike capability that will occur when the Navy’s four converted Ohio-class cruise missile submarines (SSGNs) retire from service in the late 2020s.

³⁶ Lawrence J. Korb and Laura Conley, *Strong and Sustainable[.] How to Reduce Military Spending While Keeping Our Nation Safe*, Center for American Progress, September 2010, pp. 19-20.

³⁷ Debt Reduction Task Force, *Restoring America’s Future[.] Reviving the Economy, Cutting Spending and Debt, and Creating a Simple, Pro-Growth Tax System*, November 2010, p. 103.

³⁸ For further discussion of China’s naval modernization effort, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O’Rourke.

³⁹ Stephen J. Hadley and William J. Perry, co-chairmen, et al., *The QDR in Perspective: Meeting America’s National Security Needs In the 21st Century, The Final Report of the Quadrennial Defense Review Independent Panel*, Washington, 2010, Figure 3-2 on page 58.

⁴⁰ *A Strong National Defense[.] The Armed Forces America Needs and What They Will Cost*, Heritage Foundation, April 5, 2011, pp. 25-26.

⁴¹ Megan Eckstein, “PEO Subs Would Like Virginia Payload Modules on All Block V Subs; Decision Set for December,” *USNI News*, October 28, 2015.

Legislative Activity for FY2016

FY2016 Funding Request

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2016 at \$5,376.9 million or an average of \$2,688.4 million each. The boats have received a total of \$1,613.5 million in prior-year advance procurement (AP) funding and \$416.9 million in prior-year Economic Order Quantity (EOQ) funding. The Navy's proposed FY2016 budget requests the remaining \$3,346.4 million needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2016 budget also requests \$1,663.8 million in AP funding and \$330.0 million in EOQ funding for Virginia-class boats to be procured in future fiscal years, bringing the total FY2016 funding request for the program (excluding outfitting and post-delivery costs) to \$5,340.1 million.

The Navy's proposed FY2016 budget also requests \$167.7 million in research and development funding for the Virginia Payload Module (VPM). The funding is contained in Program Element (PE) 0604580N, entitled Virginia Payload Module (VPM), which is line 123 in the Navy's FY2016 research and development account.

FY2016 National Defense Authorization Act (H.R. 1735/S. 1376)

House

The House Armed Services Committee, in its report (H.Rept. 114-102 of May 5, 2015) on H.R. 1735, recommends approving the Navy's FY2016 request for procurement and advance procurement (AP) funding for the Virginia-class program (page 421, line 003, and page 422, line 004), and the Navy's FY2016 request for research and development funding for the VPM (page 465, line 123).

H.Rept. 114-102 states:

Virginia Payload Module

The committee notes the retirement of the Ohio-class guided missile submarine in the 2020s will cause a significant shortfall in the strike capacity of the undersea forces. In response to the pending retirement of these guided missile submarines, the Joint Requirements Oversight Council (JROC) supported the inclusion of a Virginia Payload Module (VPM) to partially offset the strike loss.

The committee supports the JROC determination to incorporate VPM into the Virginia-class submarine, but is concerned that the introduction period of VPM be based on a one per year build strategy during the 2020s. The committee notes that the tables accompanying the 30-year shipbuilding plan include a Virginia-class build rate that varies between one and two per year during the 2020s. The committee is perplexed by the Navy decision to not incorporate VPM into every Block V Virginia-class submarine and believes that this inconsistent build rate suboptimizes the overall development of this important capability.

The committee supports the expeditious development of this capability consistent with the delivery of every Block V Virginia-class submarine. (Page 32)

Senate

The Senate Armed Services Committee, in its report (S.Rept. 114-49 of May 19, 2015) on S. 1376, recommends approving the Navy's FY2016 request for procurement funding for the Virginia-class program (page 362, line 3), increasing the Navy's FY2016 request for advance procurement (AP) funding for the Virginia-class program by \$800 million, with the increase being for "Accelerate shipbuilding funding" (page 362, line 4), and approving the Navy's FY2016 request for research and development funding for the VPM (page 408, line 123).

S.Rept. 114-49 states:

Virginia-class submarines

The budget request included \$2.0 billion in advance procurement and \$3.3 billion in procurement in Shipbuilding and Conversion, Navy for Virginia-class submarines.

The committee notes that the Virginia-class submarine program has continued to perform well, delivering submarines early and within budget to combatant commanders. As Assistant Secretary of Navy for Research, Development, and Acquisition Sean Stackley testified on March 18, 2015, "Submarines' stealth and ability to conduct sustained forward-deployed operations in anti-access/aread denial environments serve as force multipliers by providing high-quality intelligence, surveillance, and reconnaissance as well as indication and warning of potential hostile action. In addition, attack submarines are effective in anti-surface warfare and undersea warfare in almost every environment, thus eliminating any safe-haven that an adversary might pursue with access-denial systems. As such, they represent a significant conventional deterrent."

Despite these important capabilities and the success of the Virginia-class submarine program, the committee notes that on March 18, 2015, Vice Admiral Joseph P. Mulloy testified that the Navy is only meeting approximately 54 percent of combatant commander requests for attack submarines.

The Navy has a validated requirement for 48 attack submarines, and currently has a fleet of 53 attack submarines. However, the committee notes that the Navy's attack submarine fleet will drop to 41 submarines in fiscal year 2029. This smaller attack submarine fleet, combined with an increasing demand for the unique capabilities they provide, could result in the Navy meeting an even smaller percentage of combatant commander requests for attack submarines. The committee believes it is important that the Navy procure two Virginia-class submarines per year in fiscal years 2016 to 2020.

The committee understands that the Virginia Payload Module (VPM) will help mitigate the nearly 60 percent decrease in undersea strike capacity associated with the declining number of attack submarines and retirement of the Navy's guided missile submarines (SSGNs) in the 2020s. The VPM will increase the capacity of Virginia-class submarines from 12 to 40 cruise missiles. The committee believes it is essential to accelerate as soon as practicable the inclusion of the VPM on Virginia-class submarines. Furthermore, once inclusion of the VPM is determined to be feasible, the committee supports inclusion of the VPM on every new construction Virginia-class submarine.

Therefore, the Secretary of the Navy is directed to submit a report to the committee no later than December 1, 2015 on the feasibility of accelerating the VPM introduction to Virginia-class submarines, as well as an assessment of the industrial base impact of building Ohio-class replacement submarines, Virginia-class submarines with the VPM, and Virginia-class submarines without the VPM, simultaneously.

Furthermore, in light of the importance of Virginia-class submarines and the VPM, the committee recommends an increase of \$800.0 million in advance procurement and the full requested amount in procurement for Virginia-class submarines. (Pages 23-24)

Conference (Version Vetoed)

The conference report (H.Rept. 114-270 of September 29, 2015) on H.R. 1735 (which was agreed to by the House and Senate on October 1 and 7, 2015, respectively, and vetoed by the president on October 22, 2015), recommends approving the Navy's FY2016 request for procurement and advance procurement (AP) funding for the Virginia-class program (page 911, lines 003 and 004), and the Navy's FY2016 request for research and development funding for the VPM (page 955, line 123).

FY2016 DOD Appropriations Act (H.R. 2685/S. 1558)

House

The House Appropriations Committee, in its report (H.Rept. 114-139 of June 5, 2015) on H.R. 2685, recommended reducing by \$21.9 million the Navy's FY2016 request for procurement funding for the Virginia-class program, with the reduction being for "Nuclear propulsion plant equipment cost growth" (page 161), and reducing by \$17.1 million the Navy's FY2016 request for research and development funding for the Virginia Payload Module (VPM), with the reduction being for "Program execution" (page 227, line 123).

Senate

The Senate Appropriations Committee, in its report (S.Rept. 114-63 of June 11, 2015) on S. 1558, recommended approving the Navy's FY2016 requests for procurement and advance procurement (AP) funding for the Virginia-class program (page 98, lines 3 and 4), and approving the Navy's FY2016 request for research and development funding for the Virginia Payload Module (VPM) (page 160, line 123).

S.Rept. 114-63 states:

Virginia Payload Module [VPM].—The fiscal year 2016 budget request includes \$167,719,000 to continue development of the Virginia Payload Module in support of production beginning in fiscal year 2019. According to the Navy, the VPM concept was proposed to compensate for the decline in strike capacity precipitated by the planned retirement of converted Ohio class guided missile submarines scheduled in the mid- to late- 2020s. The Committee recommends full funding of the Navy's request; however, the Committee remains concerned with the program's stability, cost and schedule pressures. Therefore, the Committee amends the reporting requirement previously included in Division C of the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014 (Public Law 113-76), to a quarterly submission, and directs the Secretary of Navy to include in this quarterly report planned and actual performance of program metrics identified in the March 2015 report provided to the congressional defense committees.

In addition, the fiscal year 2016 budget request includes \$12,900,000 in program element 0603502N and \$3,800,000 in program element 0603561N for the development and evaluation of non-strike payloads for possible insertion into VPM. The Committee finds this inconsistent with the VPM concept as proposed, and is concerned with the technical risk this adds to delivering the VPM on cost and schedule. Therefore, the Committee recommends no funding for these specific efforts. (Page 165)

Appendix A. Past SSN Force-Level Goals

This appendix summarizes attack submarine force-level goals since the Reagan Administration (1981-1989).

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.⁴² 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 2012.⁴³

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.⁴⁴ 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."⁴⁵ 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:

- "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

⁴² 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*, March 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.

⁴³ 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*, November 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*, March 15-21, 1993, p. 10; Barbara Nagy, "Size of Sub Force Next Policy Battle," *New London Day*, July 20, 1992, pp. A1, A8.

⁴⁴ Secretary of Defense Les Aspin, U.S. Department of Defense, *Report on the Bottom-Up Review*, October 1993, pp. 55-57.

⁴⁵ Secretary of Defense William S. Cohen, U.S. Department of Defense, *Report of the Quadrennial Defense Review*, May 1997, pp. 29, 30, 47.

- “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.”⁴⁶

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 Department of Defense (DOD) force-level goals.

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.”⁴⁷

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.⁴⁸

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-ship fleet including 37 SSNs and 4 SSGNs, and a 325-ship fleet including 41 SSNs and 4 SSGNs.⁴⁹

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.⁵⁰

In February 2006, the Navy proposed to maintain in coming years a fleet of 313 ships, including 48 SSNs. Some of the Navy’s ship force-level goals have changed since 2006, and the goals now add up to a desired fleet of 328 ships. The figure of 48 SSNs, however, remains unchanged from 2006.

⁴⁶ Department of Navy point paper dated February 7, 2000. Reprinted in *Inside the Navy*, February 14, 2000, p. 5.

⁴⁷ U.S. Department of Defense, *Quadrennial Defense Review*, September 2001, p. 23.

⁴⁸ 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.

⁴⁹ 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 March 23, 2005.

⁵⁰ 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.

Appendix B. Options for Funding SSNs

This appendix presents information on some alternatives for funding SSNs that was originally incorporated into this report during discussions in earlier years on potential options for Virginia-class procurement.

Alternative methods of funding the procurement of SSNs include but are not necessarily limited to the following:

- **two years of advance procurement funding followed by full funding**—the traditional approach, under which there are two years of advance procurement funding for the SSN’s long-leadtime components, followed by the remainder of the boat’s procurement funding in the year of procurement;
- **one year of advance procurement funding followed by full funding**—one year of advance procurement funding for the SSN’s long-leadtime components, followed by the remainder of the boat’s procurement funding in the year of procurement;
- **full funding with no advance procurement funding (single-year full funding)**—full funding of the SSN in the year of procurement, with no advance procurement funding in prior years;
- **incremental funding**—partial funding of the SSN in the year of procurement, followed by one or more years of additional funding increments needed to complete the procurement cost of the ship; and
- **advance appropriations**—a form of full funding that can be viewed as a legislatively locked in form of incremental funding.⁵¹

Navy testimony to Congress in early 2007, when Congress was considering the FY2008 budget, suggested that two years of advance procurement funding are required to fund the procurement of an SSN, and consequently that additional SSNs could not be procured until FY2010 at the earliest.⁵² This testimony understated Congress’s options regarding the procurement of additional SSNs in the near term. Although SSNs are normally procured with two years of advance procurement funding (which is used primarily for financing long-leadtime nuclear propulsion components), Congress can procure an SSN without prior-year advance procurement funding, or with only one year of advance procurement funding. Consequently, Congress at that time had option of procuring an additional SSN in FY2009 and/or FY2010.

Single-year full funding has been used in the past by Congress to procure nuclear-powered ships for which no prior-year advance procurement funding had been provided. Specifically, Congress used single-year full funding in FY1980 to procure the nuclear-powered aircraft carrier CVN-71, and again in FY1988 to procure the CVNs 74 and 75. In the case of the FY1988 procurement,

⁵¹ For additional discussion of these funding approaches, see CRS Report RL32776, *Navy Ship Procurement: Alternative Funding Approaches—Background and Options for Congress*, by Ronald O’Rourke.

⁵² For example, at a March 1, 2007, hearing before the House Armed Services Committee on the FY2008 Department of the Navy budget request, Representative Taylor asked which additional ships the Navy might want to procure in FY2008, should additional funding be made available for that purpose. In response, Secretary of the Navy Donald Winter stated in part: “The Virginia-class submarines require us to start with a two-year advanced procurement, to be able to provide for the nuclear power plant that supports them. So we would need to start two years in advance. What that says is, if we were able to start in ‘08 with advanced procurement, we could accelerate, potentially, the two a year to 2010.” (Source: Transcript of hearing.) Navy officials made similar statements before the same subcommittee on March 8, 2007, and before the Senate Armed Services Committee on March 29, 2007.

under the Administration's proposed FY1988 budget, CVNs 74 and 75 were to be procured in FY1990 and FY1993, respectively, and the FY1988 budget was to make the initial advance procurement payment for CVN-74. Congress, in acting on the FY1988 budget, decided to accelerate the procurement of both ships to FY1988, and fully funded the two ships that year at a combined cost of \$6.325 billion. The ships entered service in 1995 and 1998, respectively.⁵³

The existence in both FY1980 and FY1988 of a spare set of Nimitz-class reactor components was not what made it possible for Congress to fund CVNs 71, 74, and 75 with single-year full funding; it simply permitted the ships to be built more quickly. What made it possible for Congress to fund the carriers with single-year full funding was Congress's constitutional authority to appropriate funding for that purpose.

Procuring an SSN with one year of advance procurement funding or no advance procurement funding would not materially change the way the SSN would be built—the process would still encompass about two years of advance work on long-leadtime components, and an additional six years or so of construction work on the ship itself. The outlay rate for the SSN could be slower, as outlays for construction of the ship itself would begin one or two years later than normal.

Congress in the past has procured certain ships in the knowledge that those ships would not begin construction for some time and consequently would take longer to enter service than a ship of that kind would normally require. When Congress procured two nuclear-powered aircraft carriers (CVNs 72 and 73) in FY1983, and another two (CVNs 74 and 75) in FY1988, it did so in both cases in the knowledge that the second ship in each case would not begin construction until some time after the first.

⁵³ In both FY1988 and FY1980, the Navy had a spare set of Nimitz (CVN-68) class nuclear propulsion components in inventory. The existence of a spare set of components permitted the carriers to be built more quickly than would have otherwise been the case, but it is not what made the single-year full funding of these carriers possible. What made it possible was Congress's authority to appropriate funds for the purpose.

Appendix C. July 2014 Navy Report to Congress on Virginia Payload Module (VPM)

The joint explanatory statement for the FY2014 DOD Appropriations Act (Division C of H.R. 3547/P.L. 113-76 of January 17, 2014) requires the Navy to submit biannual reports to the congressional defense committees describing the actions the Navy is taking to minimize costs for the VPM.⁵⁴ This appendix reprints the first of these reports, which is dated July 2014.⁵⁵

⁵⁴ See PDF page 239 of 351 of the joint explanatory statement for Division C of H.R. 3547.

⁵⁵ The report was posted at *InsideDefense.com* (subscription required) on November 13, 2014.

REPORT TO CONGRESS

VIRGINIA (SSN774) ATTACK CLASS SUBMARINE

Cost Containment Strategy
for the
Block V VIRGINIA Payload Module (VPM) Design

July 2014



IN COMPLIANCE WITH THE JOINT EXPLANATORY STATEMENT ACCOMPANYING
THE
CONSOLIDATED APPROPRIATIONS ACT, 2014

PREPARED BY
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- 1.4 Block IV – Reduced Total Ownership Cost (RTOC) (SSNs 792–801)**

2.0 Block V Virginia Payload Module (VPM) Concept Origination

3.0 FY 2014 VPM Design Funding and Cost Control Management Requirements

4.0 Cost Containment Strategy for the Block V VPM Design

- 4.1 Implementation of IPPD in conjunction with execution of existing build plan**
- 4.2 Stable requirements**
- 4.3 Design completion**
- 4.4 Risk mitigation**
- 4.5 Cost reporting**

5.0 Conclusion

Reporting Requirement

Division C of the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014 (Public Law 113-76), directs the Secretary of the Navy to create a separate budget line item to enable additional congressional oversight and increase transparency into the costs of the VIRGINIA Payload Module (VPM). Furthermore, Congress directed the Secretary to submit a bi-annual report to the congressional defense committees describing the actions the Navy is taking to minimize costs. The agreement fences \$20 million until the first bi-annual report is provided to the congressional defense committees.

Executive Summary

In the mid-2020s, the Navy's four guided missile submarines (SSGNs) will begin to decommission. These SSGNs provide the Navy and the Nation with unmatched undersea conventional strike capability and capacity, with each SSGN carrying up to 154 Tomahawk land attack cruise missiles. The Navy's current fleet of attack submarines (SSNs) can carry 12 Tomahawks each. The loss of the SSGNs will result in an over 60 percent drop in undersea strike capacity.

The Department of Defense's Office of Cost and Program Evaluation (CAPE) conducted a review of the potential undersea strike alternatives to determine the optimal materiel solution to recapitalize the SSGNs' strike capacity. CAPE certified to the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) (AT&L) that the Navy studies in conjunction with CAPE's independent review and the Naval Sea Systems Command's (NAVSEA) Cost Engineering and Industrial Analysis's (O5C) cost estimate met the requirements of an Analysis of Alternatives (AoA), and CAPE did not recommend performing an AoA for undersea strike. The review determined that the VIRGINIA Payload Module (VPM), a hull insert with four large-diameter tubes inserted aft of the sail, each tube capable of carrying seven Tomahawks, represented the best materiel solution to mitigate the loss of undersea strike capacity given near-term budget constraints. To minimize cost, schedule, and technical risks, VPM will reuse operationally proven systems and will not require the development of any new technology. For example, the missile tubes that will be used in VPM are nearly identical to the multiple all-up-round canister (MAC) tubes that are currently deployed on the SSGNs.

In December 2013, the Joint Requirement Oversight Council (JROC) approved the Capability Development Document (CDD) establishing the requirements and Key Performance Parameters (KPPs) for VPM. The CDD set clear KPPs for cost, schedule, and strike capacity. By placing cost on equal footing as capability, the CDD ensures the Navy will leverage its best practices and lessons learned from previous submarine research and development, acquisition, and modernization efforts to deliver the required capability within the strict cost targets.

Alteration to the design of any weapon system in full rate production has the potential to introduce justifiable concern associated with the possible erosion of program cost performance and production. The Navy recognizes these risks as they apply to implementation of VPM during Block V construction and intends to employ a full range of management techniques to mitigate them, commencing early in the design phase. The Navy has a proven record of developing and executing similarly scaled efforts such as the Block III design for affordability effort including the redesigned bow. These techniques are well established and embedded in the current submarine acquisition community culture, developed during "NSSN" [the New Attack Submarine Program – the precursor to the VIRGINIA Class] program inception and evolved through the successful VIRGINIA Class Block IV construction contract award.

The Navy's disciplined engineering and acquisition management approach for VPM, in conjunction with treating cost and capability as equally important requirements, will minimize the potential for cost performance degradation and program disruption. The key actions the Navy is taking to minimize costs are: continue proven management techniques used from program inception through Block IV award; implementation of Integrated Product and Process Development (IPPD) in conjunction with execution of existing build plans; ensure stable requirements; high design completion at construction start; risk mitigation; and cost reporting.

1. Background

The VIRGINIA Class Submarine Program was the first major defense program to implement the tenets of the October 1994 Under Secretary of Defense for Acquisition and Technology memorandum, “Implementation of Integrated Product and Process Development (IPPD) in DoD Acquisition Programs.” The VIRGINIA Class program has continuously implemented the use of Commercial Off-the-Shelf (COTS) components, open systems standards, acquisition streamlining, total ownership cost (TOC) driven decision making, Lean 6 Sigma assessments of all processes, and recent should cost/will cost and Better Buying Power initiatives to improve the program as it has matured.

1.1 Block I – IPPD Design/Build Genesis (SSNs 774–777)

From inception, the VIRGINIA Class Submarine Program was strikingly different from past fast attack programs, in part due to advances in technology, but mostly due to revolutionary changes in the design/build, business, and acquisition processes. The Navy, General Dynamics Electric Boat (GDEB) and their major subcontractor, Huntington Ingalls Industries – Newport News Shipbuilding (HII-NNS), embraced the IPPD concept and established multi-disciplined teams to collaboratively design and build the submarine. Inherent in the definition of IPPD, both products and processes derived benefit from structured and hierarchical integration of the cross-functional teams. The IPPD approach holistically linked operational performance, construction techniques, test methods, and life-cycle supportability into an up-front “single-pass” design effort. IPPD enabled the shipbuilder to expand the use of modular construction and off-hull module assembly techniques beyond that of previous submarine programs and erect the entire submarine from 10 major sections. While the IPPD approach was exceedingly effective, the introduction of a new, sophisticated Computer Aided Three-dimensional Interactive Application (CATIA) also greatly enhanced the design/build process and programmatic business efficiency. The CATIA software design tool replaced traditional drawings and hand crafted wooden models with 3-D manipulative color graphics dispersed to Integrated Product Team members to facilitate timely and efficient, visual design collaboration. CATIA also established the single shipbuilding construction and procurement database, linking design with production and business operations. CATIA also provided a higher fidelity design release forecast which in turn supported the establishment of a more accurate budget baseline from which to conduct cost analysis.

1.2 Block II – Continuous Improvement via Capital Expenditure (SSNs 778–783)

As the program began construction on the Block II submarines, the Navy set about to improve construction efficiencies beginning with USS *New Hampshire* (SSN 778), the first submarine in the Block II contract. Recognizing construction span time reduction held the most immediate promise for lowering cost and accelerating delivery of the warships, focus was directed at determining what could be done to improve industrial efficiency without compromise to quality or performance. Teaming for success, the Navy and shipbuilders agreed that facility investment was needed, and a strategy to incorporate an innovative Capital Expenditure (CAPEX) incentive clause was devised and incorporated in the Block II contract. Of the 10 Block II CAPEX funded projects, the transportation system upgrades provided the most visible evidence of reduced span time by allowing a shift from the Block I 10 module build plan to a plan entailing only four “super” modules to undergo final assembly at the delivery shipyard. Block II CAPEX projects have produced a seven to one return on investment.

1.3 Block III – Design for Affordability (DFA) (SSNs 784–791)

The VIRGINIA Class cost reduction program began in earnest in late 2005, when the Chief of Naval Operations (CNO) issued a challenge to the VIRGINIA Class Program to reduce the acquisition cost of each submarine to \$2 billion (in FY 2005 dollars) by 2012 as a condition of increasing the procurement rate from one to two submarines per year. This challenge represented a 20 percent decrease in unit cost. The CNO issued the challenge to support the acquisition of VIRGINIA Class submarines within the Navy shipbuilding budget, and make the necessary increase in attack submarine production to support national force levels. At the time, cutting 20 percent of the unit cost of a submarine with a mature design in serial production, without removing capability, was an unprecedented task.

General Dynamics Electric Boat and the Navy developed an integrated cost reduction strategy focusing on three areas – Design for Affordability (DFA), construction performance, and acquisition/procurement strategy. Implementation of all three elements resulted in a savings of \$400 million per ship and a reduction in construction span by 30 percent (from 84 to 60 months). In recognition of these collaborative achievements, the VIRGINIA Class Program received the 2008 David Packard Excellence in Acquisition Award for “embracing the principles of acquisition reform since its initiation,” and for having significantly reduced total program costs.

1.4 Block IV – Reduced Total Ownership Cost (RTOC) (SSNs 792–801)

Having optimized the construction process via targeted capital investment and DFA, the program concentrated on creating more operational value from each submarine by increasing the time between major maintenance availabilities. The goal was to alter the established life cycle maintenance plan from 72-month operating cycles, with 14 deployments and four major depot availabilities, to 96-month operating cycles, with 15 deployments and only three major depot availabilities. The challenge once again was to identify which design changes offered the highest Reduction of Total Ownership Cost (RTOC) return on investment from a limited design budget – assessing maintenance drivers and factors that determine the aggregate operating cycle. By eliminating one depot availability per hull, the program will avoid approximately \$120 million (FY 2010 dollars) in Operating and Support costs per submarine. By enabling an additional deployment from each subsequent Block IV and beyond hull, an operational availability equivalent to one submarine will be realized following delivery of SSN 805.

2.0 Block V –VPM Concept Origination

The VPM concept was introduced to address the eventual loss of submarine guided missile (SSGN) strike capabilities in the mid-2020s when the Navy’s four SSGNs retire, reducing Navy-wide undersea strike volume by almost two-thirds. The SSGNs’ retirement also coincides with a historically low attack class submarine force structure.

In a 2013 review of undersea strike alternatives conducted by CAPE, VPM was identified to be the optimal materiel solution to recapitalize undersea strike without substantially changing a mature and stable submarine design. CAPE certified to AT&L that the review met the requirements of an AoA, and an AoA was not required. VIRGINIA Class submarines with VPM would retain all existing mission capability, while providing approximately 94 percent of the current undersea strike volume.

In December 2013, the JROC approved the CDD establishing the requirements and KPPs for VPM. The CDD sets clear KPPs for strike capacity, schedule, and cost. The strike KPP increases the missile capacity from 12 to 40. For schedule, the VPM's Initial Operating Capability (IOC) threshold and objective dates are no later than 2nd quarter FY 2028 and no later than 4th quarter FY 2026, respectively.

The cost KPP includes criteria for design, lead ship, and follow ship thresholds and objectives requiring a disciplined approach to balance capabilities within the established cost parameters. Based on the NAVSEA 05C current estimate, the VPM cost estimate is below the CDD's cost objectives.

Cost - CY10\$ (\$M)				Cost - TYS (\$M)			
	Threshold	Objective	Current Est.		Threshold	Objective	Current Est.
NRE:	800	750	744	NRE:	994	931	924
Lead Ship:	475	425	423	Lead Ship:	633	567	564
Follow on Ships	350	325	318	Follow on Ships	567	527	515

Note: CDD Cost values are for 20 VPM modules and start of construction in FY19

The Navy/Industry team is focused on controlling VPM program costs, while minimizing baseline ship impacts, and maintaining the established VIRGINIA Class build plan cadence. As a result of the VIRGINIA Class modular design, inherent design features make the insertion of a hull section less of an impact on the build plan. The VPM design is modeled after other successful VIRGINIA Class programs, which have lowered costs through a proven cost reduction framework.

3.0 FY 2014 VPM Design Funding and Cost Control Management Requirements

The Consolidated Appropriations Act, 2014 (Public Law 113-76) appropriated \$59.1 million for the development of VPM. Division C of the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014, directed the creation of a separate budget line item to enable additional congressional oversight and increase transparency into the costs of the VPM. The Navy established *Navy PE: 0604580N VIRGINIA Payload Module (VPM)* to fulfill this requirement. The Joint Explanatory Statement also stipulated the withholding of \$20 million in funding until the first submission of a bi-annual report to the congressional defense committees describing the actions the Navy plans to take to minimize costs. The following sections of this report are intended to fulfill this requirement.

4.0 Cost Containment Strategy for the Block V VPM Design

The strategy to design and seamlessly insert VPM into the construction sequence within the established budget is to employ the full spectrum of proven management techniques used from program inception through Block IV contract award. Specifically:

- Incorporate key tenets of the USD(AT&L) Better Buying Power 2.0 approach to defense acquisition such as affordability targets and innovative contract incentives.
- Apply overarching IPPD practices and implement design/build teams (Block I and III lessons learned).

- Identify capital investment opportunities with high return on investment potential (Block II and III lessons learned).
- Develop design focused on affordability (Block III lessons learned) and life cycle maintenance costs (Block IV lessons learned).
- Explore and establish ship and component level acquisition strategies to yield a higher confidence/lower cost construction cost (Block III and IV lessons learned).
- Utilize an incentive structure that specifically details required cost reductions in design, construction, and operations and support.

These techniques have guided the VIRGINIA Class Program and will be used throughout the VPM effort.

4.1 Implementation of IPPD in conjunction with execution of existing build plan

The IPPD approach that was utilized as part of the successful Block III bow redesign effort provided the program with the experience and the strategy that can be leveraged for VPM during ongoing production. This will ensure the VPM design is strategically coordinated with construction and will not disrupt the established four-module build plan or construction cadence. This, in turn, requires an increase in the Advance Procurement funding profile for Block V to enable the completion of VPM during the fabrication and assembly phase at the same time as the other module components. A detailed Integrated Master Schedule (IMS) and Module Build Plan will be completed in December 2014, providing the comprehensive IPPD roadmap to minimize baseline ship impacts and maintain the established VIRGINIA Class construction cadence. In addition, the design team will evaluate capital investment opportunities to lower construction costs.

4.2 Stable requirements

The CDD sets clear KPPs for cost, strike capacity, and schedule based on stable requirements. These KPPs promote stability in the Program, providing the Navy and Shipbuilders with fixed, tangible, and measurable objectives. By placing cost on equal footing as capability, the CDD ensures the Navy will leverage its best practices and lessons learned from previous submarine research and development, acquisition, and modernization efforts to deliver the required capability within the strict cost targets. The ship specification process will further define the requirements in strict accordance with the KPPs.

4.3 Design completion

The current VPM design concept does not require the development of any new technology to satisfy the CDD requirements. By relying on proven operational systems, the Navy avoids the unnecessary risk new technology poses. Similarly, “like” systems and components already utilized or proven elsewhere in the submarine enterprise will be leveraged, scaled, or reused to an extensive degree. The most obvious example of this strategy pertains to replication of the tubes and scaling of the launch control electronics from the bow of the Block III design. The collective sum of the re-use strategy tied to the VIRGINIA Payload Tubes (VPTs), Submarine Warfare Federated Tactical System (SWFTS) combat system, Ship Service Hydraulic Plant, Electronic Auxiliary Fresh Water Plant, and other Hull, Mechanical and Electrical subsystems results in a high Technology Readiness Level (TRL) for the VPM effort. This equates to an achievable goal of having the VPM design 80 percent complete prior to

construction start, adding confidence to completing the design within budget and minimizing construction costs.

4.4 Risk mitigation

The VPM cost reduction program will employ a low-risk technical approach, with a goal of having the VPM design 80 percent complete prior to construction start. This will ensure that design errors do not create issues during the construction phase, thereby avoiding unforeseen costs later in the program. With no new technology and significant design and component reuse, the VPM design has a high TRL, thus low risk to the shipbuilder. The program will continue to evaluate and mitigate construction and design risk. For example, the program will benefit when the land based VPT test site is completed at Naval Undersea Warfare Center (NUWC) Newport this fall. Manufactured at Quonset Point and installed by Electric Boat, this collaborative Navy/shipbuilder test facility will support early electronic testing to mitigate VPM risk, and lower shipbuilding construction risk.

The shipbuilding industrial base is well positioned to simultaneously design both VPM and OHIO Replacement as the completion of the VIRGINIA Block III and Moored Training Ship design efforts allow for sufficient General Dynamics Electric Boat (GDEB) resources to support both designs.

The VIRGINIA Program is collaborating with the OHIO Replacement Program to ensure commonality among select ship components and design features which will benefit the acquisition and life-cycle costs for both programs. Where possible, the programs will utilize common equipment designs such as Ship Control System hardware, and Command, Control, Communications, and Intelligence (C3I) systems. The two programs will utilize best manufacturing processes and practices to ensure cost savings across both classes.

4.5 Cost reporting

The VPM program will continue to use the established best practices that enabled previous cost reduction. The program has an effective and established metrics/performance measurement system to manage cost, schedule and risk. A key and essential factor governing effectiveness is the accuracy of the underlying work scope comprising the budget baseline being tracked. The CATIA design application has remained in use since Block I and provides this essential fidelity. Cost analysis data, combined shipbuilder and Navy estimates at completion (EACs), formal risk management program outputs, and quarterly design reviews will all be utilized to assess the VPM program health. To promote specific transparency into cost, as directed, a separate Research, Development, Test and Evaluation (RDT&E) Program Element (PE: 0604580N) was developed for VPM funding. This new PE is reflected in the 2015 budget submission to Congress and ensures VPM costs are separate and distinct from the program's overall RDT&E budget. Consistent with the program's history of monitoring cost, cost estimates for VPM design will be reviewed quarterly and refined by the VPM design team and the program has developed action plans (based on estimates of cost-at-completion) to track cost reporting.

5.0 Conclusion

This report provides a baseline understanding of VPM and the cost reduction and containment strategies employed by the Navy throughout the VIRGINIA Class Program to include the early efforts on VPM.

Subsequent bi-annual reports will provide additional specific metrics for VPM as its acquisition, design, and construction strategies are developed and refined. Products such as design curves, manning ramp-up plans, design drawings, and progress on ship specifications will be provided with future reports as they become available.

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