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Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress

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Specialist in Naval Affairs

March 8, 2016

Congressional Research Service

7-....

www.crs.gov

R41129

Summary

The Navy's proposed FY2017 budget requests \$773.1 million in advance procurement (AP) funding and \$1,091.1 million in research and development funding for the Ohio replacement program (ORP), a program to design and build a new class of 12 ballistic missile submarines (SSBNs) to replace the Navy's current force of 14 Ohio-class SSBNs. The Navy has identified the Ohio replacement program, also known as the SSBN(X) program, as the Navy's top priority program. The Navy wants to procure the first Ohio replacement boat in FY2021, and the \$773.1 million in AP funding requested for FY2017 represents the initial procurement funding for that boat.

A March 2015 GAO report assessing selected major DOD weapon acquisition programs states that the estimated total acquisition cost of the Ohio replacement program is about \$95.8 billion in constant FY2015 dollars, including about \$11.8 billion in research and development costs and about \$84.0 billion in procurement costs.

The Navy as of February 2015 estimated the procurement cost of the lead boat in the program at \$14.5 billion in then-year dollars, including \$5.7 billion in detailed design and nonrecurring engineering (DD/NRE) costs for the entire class, and \$8.8 billion in construction costs for the ship itself. (It is a traditional budgeting practice for Navy shipbuilding programs to attach the DD/NRE costs for a new class of ships to the procurement cost of the lead ship in the class.) In constant FY2010 dollars, these figures become \$10.4 billion, including \$4.2 billion in DD/NRE costs and \$6.2 billion in construction costs for the ship itself. The Navy in January 2015 estimated the average procurement cost of boats 2 through 12 in the Ohio replacement program at about \$5.2 billion each in FY2010 dollars, and is working to reduce that figure to a target of \$4.9 billion each in FY2010 dollars. Even with this cost-reduction effort, observers are concerned about the impact the Ohio replacement program will have on the Navy's ability to procure other types of ships at desired rates in the 2020s and early 2030s.

Potential issues for Congress for the Ohio replacement program include the following:

- whether to approve, reject, or modify the Navy's FY2017 funding request for the program;
- whether to authorize and appropriate FY2017 advance procurement (AP) funding for the program in the Navy's shipbuilding account or the National Sea-Based Deterrence Fund (NSBDF);
- whether to approve, reject, or modify the Navy's proposed strategy for building Ohio replacement boats at the country's two submarine-construction shipyards;
- the likelihood that the Navy will be able to reduce the estimated average procurement cost of boats 2 through 12 in the program to the target figure of \$4.9 billion each in FY2010 dollars;
- the accuracy of the Navy's estimate of the procurement cost of each SSBN(X); and
- the prospective affordability of the Ohio replacement program and its potential impact on funding available for other Navy shipbuilding programs.

This report focuses on the Ohio replacement program as a Navy shipbuilding program. CRS Report RL33640, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, by (name redacted) discusses the SSBN(X) as an element of future U.S. strategic nuclear forces in the context of strategic nuclear arms control agreements.

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Introduction

This report provides background information and potential oversight issues for Congress on the Ohio replacement program (ORP), a program to design and build a new class of 12 ballistic missile submarines (SSBNs) to replace the Navy's current force of 14 Ohio-class SSBNs. The Navy has identified the Ohio replacement program, also known as the SSBN(X) program, as the Navy's top priority program. The Navy wants to procure the first Ohio replacement boat in FY2021, with advance procurement (AP) funding for that boat starting in FY2017.

The Navy's proposed FY2017 budget requests \$773.1 million in advance procurement (AP) funding for the first boat in the class, and \$1,091.1 million in research and development funding for the Ohio replacement program. The program poses a number of funding and oversight issues for Congress. Decisions that Congress makes on the Ohio replacement program could substantially affect U.S. military capabilities and funding requirements, and the U.S. shipbuilding industrial base.

This report focuses on the Ohio replacement program as a Navy shipbuilding program. Another CRS report discusses the SSBN(X) as an element of future U.S. strategic nuclear forces in the context of strategic nuclear arms control agreements.¹

Background

Strategic and Budgetary Context

For an overview of the strategic and budgetary context in which the Ohio replacement program and other Navy shipbuilding programs may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by (name redacted) .

U.S. Navy SSBNs in General

Mission of SSBNs

The U.S. Navy operates three kinds of submarines—nuclear-powered attack submarines (SSNs), nuclear-powered cruise missile submarines (SSGNs), and nuclear-powered ballistic missile submarines (SSBNs).² The SSNs and SSGNs are multi-mission ships that perform a variety of peacetime and wartime missions.³ They do not carry nuclear weapons.⁴

¹ CRS Report RL33640, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, by (name redacted)

² In the designations SSN, SSGN, SSBN, and SSBN(X), the SS stands for submarine, N stands for nuclear-powered (meaning the ship is powered by a nuclear reactor), G stands for guided missile (such as a cruise missile), B stands for ballistic missile, and (X) means the design of the ship has not yet been determined.

As shown by the "Ns" in SSN, SSGN, and SSBN, all U.S. Navy submarines are nuclear-powered. Other navies operate non-nuclear powered submarines, which are powered by energy sources such as diesel engines. 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 These missions include 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 (SOF); covert strikes against land targets with the Tomahawk cruise missiles; covert offensive and defensive mine warfare; anti-submarine (continued...)

The SSBNs, in contrast, perform a specialized mission of strategic nuclear deterrence. To perform this mission, SSBNs are armed with submarine-launched ballistic missiles (SLBMs), which are large, long-range missiles armed with multiple nuclear warheads. SSBNs launch their SLBMs from large-diameter vertical launch tubes located in the middle section of the boat.⁵ The SSBNs' basic mission is to remain hidden at sea with their SLBMs, so as to deter a nuclear attack on the United States by another country by demonstrating to other countries that the United States has an assured second-strike capability, meaning a survivable system for carrying out a retaliatory nuclear attack.

Navy SSBNs, which are sometimes referred to informally as “boomers,”⁶ form one leg of the U.S. strategic nuclear deterrent force, or “triad,” which also includes land-based intercontinental ballistic missiles (ICBMs) and land-based long-range bombers. At any given moment, some of the Navy's SSBNs are conducting nuclear deterrent patrols. The Navy's report on its FY2011 30-year shipbuilding plan states: “These ships are the most survivable leg of the Nation's strategic arsenal and provide the Nation's only day-to-day assured nuclear response capability.”⁷ The Department of Defense's (DOD's) report on the 2010 Nuclear Posture Review (NPR), released on April 6, 2010, states that “strategic nuclear submarines (SSBNs) and the SLBMs they carry represent the most survivable leg of the U.S. nuclear Triad.”⁸

Current Ohio-Class SSBNs

The Navy currently operates 14 Ohio (SSBN-726) class SSBNs (see **Figure 1**). The boats are commonly called Trident SSBNs or simply Tridents because they carry Trident SLBMs.

(...continued)

warfare (ASW); and anti-surface ship warfare. The Navy's four SSGNs, which are converted former SSBNs, can carry larger numbers of Tomahawks and SOF personnel than can the SSNs. SSGN operations consequently may focus more strongly on Tomahawk and SOF missions than do SSN operations. For more on the Navy's SSNs and SSGNs, see CRS Report RL32418, *Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress*, by (name redacted) , and CRS Report RS21007, *Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress*, by (name redacted) .

⁴ The Navy's non-strategic nuclear weapons—meaning all of the service's nuclear weapons other than submarine-launched ballistic missiles (SLBMs)—were removed from Navy surface ships and submarines under a unilateral U.S. nuclear initiative announced by President George H. W. Bush in September 1991. The initiative reserved a right to rearm SSNs at some point in the future with nuclear-armed Tomahawk land attack missiles (TLAM-Ns) should conditions warrant. Navy TLAM-Ns were placed in storage to support this option. DOD's report on the 2010 Nuclear Posture Review (NPR), released on April 6, 2010, states that the United States will retire the TLAM-Ns. (Department of Defense, *Nuclear Posture Review Report*, April 2010, pp. xiii and 28.)

⁵ SSBNs, like other Navy submarines, are also equipped with horizontal torpedo tubes in the bow for firing torpedoes or other torpedo-sized weapons.

⁶ This informal name is a reference to the large boom that would be made by the detonation of an SLBM nuclear warhead.

⁷ U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, February 2010, p. 15.

⁸ Department of Defense, *Nuclear Posture Review Report*, April 2010, p. 22. The next sentence in the report states: “Today, there appears to be no viable near or mid-term threats to the survivability of U.S. SSBNs, but such threats—or other technical problems—cannot be ruled out over the long term.” The report similarly states on page 23: “Today, there appears to be no credible near or mid-term threats to the survivability of U.S. SSBNs. However, given the stakes involved, the Department of Defense will continue a robust SSBN Security Program that aims to anticipate potential threats and develop appropriate countermeasures to protect current and future SSBNs.”

Figure I. Ohio (SSBN-726) Class SSBN
With the hatches to some of its SLBM launch tubes open



Source: U.S. Navy file photo accessed by CRS on February 24, 2011, at <http://www.navy.mil/management/photodb/photos/101029-N-1325N-005.jpg>.

A total of 18 Ohio-class SSBNs were procured in FY1974-FY1991. The ships entered service in 1981-1997. The boats were designed and built by General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI. They were originally designed for 30-year service lives but were later certified for 42-year service lives, consisting of two approximately 19-year periods of operation separated by an approximately four-year mid-life nuclear refueling overhaul, called an engineered refueling overhaul (ERO). The nuclear refueling overhaul includes both a nuclear refueling and overhaul work on the ship that is not related to the nuclear refueling.

Ohio-class SSBNs are designed to each carry 24 SLBMs, although by 2018, four SLBM launch tubes on each boat are to be deactivated, and the number of SLBMs that can be carried by each boat consequently is to be reduced to 20, so that the number of operational launchers and warheads in the U.S. force will comply with strategic nuclear arms control limits.

The first 8 boats in the class were originally armed with Trident I C-4 SLBMs; the final 10 were armed with larger and more-capable Trident II D-5 SLBMs. 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 Ohio-class SSBNs, all armed with D-5s. This recommendation prompted interest in the idea of converting the first four Ohio-class boats (SSBNs 726-729) into SSGNs, so as to make good use of the 20 years of potential operational life remaining in these four boats, and to bolster the U.S. SSN fleet. The first four Ohio-class boats were converted into SSGNs in 2002-2008,⁹ and the next four (SSBNs 730-733) were backfitted with D-5 SLBMs in 2000-2005, producing the current force of 14 Ohio-class SSBNs, all of which are armed with D-5 SLBMs.

Eight of the 14 Ohio-class SSBNs are homeported at Bangor, WA, in Puget Sound; the other six are homeported at Kings Bay, GA, close to the Florida border.

⁹ For more on the SSGN conversion program, see CRS Report RS21007, *Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress*, by (name redacted) .

Unlike most Navy ships, which are operated by single crews, Navy SSBNs are operated by alternating crews (called the Blue and Gold crews) so as to maximize the percentage of time that they spend at sea in deployed status. The Navy consequently maintains 28 crews to operate its 14 Ohio-class SSBNs.

The first of the 14 Ohio-class SSBNs (SSBN-730) will reach the end of its 42-year service life in 2027. The remaining 13 will reach the ends of their service lives at a rate of roughly one ship per year thereafter, with the 14th reaching the end of its service life in 2040.

The Navy has initiated a program to refurbish and extend the service lives of D-5 SLBMs to 2042 “to match the OHIO Class submarine service life.”¹⁰

Including the Ohio class, the Navy has operated four classes of SSBNs since 1959. For a table summarizing these four classes, see **Appendix A**.

U.S.-UK Cooperation on SLBMs and the New UK SSBN

SSBNs are also operated by the United Kingdom, France, Russia, China, and India. The UK’s four Vanguard-class SSBNs, which entered service in 1993-1999, each carry 16 Trident II D-5 SLBMs. Previous classes of UK SSBNs similarly carried earlier-generation U.S. SLBMs.¹¹ The UK plans to replace the four Vanguard-class boats with three or four next-generation SSBNs called Successor-class SSBNs. Successor-class boats are to each carry eight D-5 SLBMs. The United States providing technical assistance to the United Kingdom for the Successor-class program; for additional discussion, see **Appendix B**.

Submarine Construction Industrial Base

U.S. Navy submarines are built at two shipyards—General Dynamics’ Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI, and Huntington Ingalls Industries’ Newport News Shipbuilding Shipbuilding (HII/NNS), of Newport News, VA. GD/EB and HII/NNS are the only two shipyards in the country capable of building nuclear-powered ships. GD/EB builds submarines only, while HII/NNS also builds nuclear-powered aircraft carriers and is capable of building other types of surface ships. The two yards currently are jointly building Virginia-class attack submarines.¹²

In addition to GD/EB and HII/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.¹³

¹⁰ Statement of Rear Admiral Stephen Johnson, USN, Director, Strategic Systems Programs, Before the Subcommittee on Strategic Forces of the Senate Armed Services Committee [on] FY2011 Strategic Systems, March 17, 2010, p. 4.

¹¹ Although the SLBMs on UK SSBNs are U.S.-made, the nuclear warheads on the missiles are of UK design and manufacture.

¹² For more on the arrangement for jointly building Virginia-class boats, see CRS Report RL32418, *Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress*, by (name redacted) .

¹³ For more on this program, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by (name redacted) . In terms of work provided to nuclear-propulsion component suppliers, 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 HII/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 Ohio replacement boats.

Ohio Replacement Program

Program Origin and Early Milestones

Although the eventual need to replace the Ohio-class SSBNs has been known for many years, the Ohio replacement program can be traced more specifically to an exchange of letters in December 2006 between President George W. Bush and UK Prime Minister Tony Blair concerning the UK's desire to participate in a program to extend the service life of the Trident II D-5 SLBM into the 2040s, and to have its next-generation SSBNs carry D-5s. For more on the Ohio replacement program's origin and early milestones, see **Appendix C**.

Planned Procurement Quantity and Schedule

Planned Procurement Quantity

Navy plans call for procuring 12 Ohio replacement boats to replace the current force of 14 Ohio-class SSBNs. In explaining the planned procurement quantity of 12 boats, the Navy states the following:

- Ten operational SSBNs—meaning boats not encumbered by lengthy maintenance actions—are needed to meet strategic nuclear deterrence requirements for having a certain number of SSBNs at sea at any given moment.
- Fourteen Ohio-class boats are needed to meet this requirement because, during the middle years of the Ohio class life cycle, three and sometimes four of the boats are non-operational at any given moment on account of being in the midst of lengthy mid-life nuclear refueling overhauls or other extended maintenance actions.
- Twelve (rather than 14) Ohio replacement boats will be needed to meet the requirement for 10 operational boats because the mid-life overhauls of Ohio replacement boats, which will not include a nuclear refueling, will require less time (about two years) than the mid-life refueling overhauls of Ohio-class boats (which require about four years from contract award to delivery),¹⁴ the result being that only two Ohio replacement boats (rather than three or sometimes four) will be in the midst of mid-life overhauls or other extended maintenance actions at any given moment during the middle years of the SSBN(X) class life cycle.¹⁵

¹⁴ Navy budget submissions show that Ohio-class mid-life nuclear refueling overhauls have contract-award-to-delivery periods generally ranging from 47 months to 50 months.

¹⁵ Source: Navy update briefing on Ohio replacement program to CRS and CBO, September 17, 2012. See also "Navy Responds to Debate Over the Size of the SSBN Force," Navy Live, May 16, 2013, accessed July 26, 2013, at <http://navylive.dodlive.mil/2013/05/16/navy-responds-to-debate-over-the-size-of-the-ssbn-force/>, and Richard Breckenridge, "SSBN Force Level Requirements: It's Simply a Matter of Geography," Navy Live, July 19, 2013, (continued...)

Planned Procurement Schedule

Table 1 shows the Navy’s proposed schedule for procuring 12 Ohio replacement boats, and for having Ohio replacement boats replace Ohio-class SSBNs. As shown in **Table 1**, under the Navy’s FY2012 budget, the first Ohio replacement boat was scheduled to be procured in FY2019, and Ohio replacement boats were to enter service on a schedule that would maintain the Navy’s SSBN force at 12 boats. As also shown in **Table 1**, the Navy’s FY2013 budget deferred the procurement of the first Ohio replacement boat by two years, to FY2021.

As a result of the deferment of the procurement of the lead boat from FY2019 to FY2021, the Navy’s SSBN force will drop to 11 or 10 boats for the period FY2029-FY2041. The Navy states that the reduction to 11 or 10 boats during this period is acceptable in terms of meeting strategic nuclear deterrence requirements, because during these years, all 11 or 10 of the SSBNs in service will be operational (i.e., none of them will be in the midst of a lengthy mid-life overhaul). The Navy acknowledges that there is some risk in having the SSBN force drop to 11 or 10 boats, because it provides little margin for absorbing an unforeseen event that might force an SSBN into an unscheduled and lengthy maintenance action.¹⁶ (See also “Planned Procurement Quantity” above.)

The minimum level of 10 boats shown in **Table 1** for the period FY2032-FY2040 can be increased to 11 boats (providing some margin for absorbing an unforeseen event that might force an SSBN into an unscheduled and lengthy maintenance action) by accelerating by about one year the planned procurement dates of boats 2 through 12 in the program. Under this option, the second boat in the program would be procured in FY2023 rather than FY2024, the third boat in the program would be procured in FY2025 rather than FY2026, and so on. Implementing this option could affect the Navy’s plan for funding the procurement of other Navy shipbuilding programs during the period FY2022-FY2025.

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accessed July 26, 2013, at <http://navylive.dodlive.mil/2013/07/19/ssbn-force-level-requirements-its-simply-a-matter-of-geography/>.

¹⁶ Source: Navy update briefing on Ohio replacement program to CRS and CBO, September 17, 2012. A September 28, 2012, press report similarly quotes Rear Admiral Barry Bruner, the Navy’s director of undersea warfare, as stating that “During this time frame, no major SSBN overhauls are planned, and a force of 10 SSBNs will support current at-sea presence requirements,” and that “This provides a low margin to compensate for unforeseen issues that may result in reduced SSBN availability. The reduced SSBN availability during this time frame reinforces the importance of remaining on schedule with the Ohio Replacement program to meet future strategic requirements. As the Ohio Replacement ships begin their mid-life overhauls in 2049, 12 SSBNs will be required to offset ships conducting planned maintenance.” (Michael Fabey, U.S. Navy Defends Boomer Submarine Replacement Plans,” *Aerospace Daily & Defense Report*, September 28, 2012: 3.)

Table I. Navy Schedule for Procuring Ohio Replacement Boats and Replacing Ohio-Class SSBNs

Fiscal Year	Schedule in FY2012 Budget				Schedule Under Subsequent Budgets			
	Number of SSBN(X)s procured each year	Cumulative number of SSBN(X)s in service	Ohio-class SSBNs in service	Combined number of Ohio-class SSBNs and SSBN(X)s in service	Number of SSBN(X)s procured each year	Cumulative number of SSBN(X)s in service	Ohio-class SSBNs in service	Combined number of Ohio-class SSBNs and SSBN(X)s in service
2019	1		14	14			14	14
2020			14	14			14	14
2021			14	14	1		14	14
2022	1		14	14			14	14
2023			14	14			14	14
2024	1		14	14	1		14	14
2025	1		14	14			14	14
2026	1		14	14	1		14	14
2027	1		13	13	1		13	13
2028	1		12	13	1		12	12
2029	1	1	11	12	1		11	11
2030	1	2	10	12	1	1	10	11
2031	1	3	9	12	1	2	9	11
2032	1	4	8	12	1	2	8	10
2033	1	5	7	12	1	3	7	10
2034		6	6	12	1	4	6	10
2035		7	5	12	1	5	5	10
2036		8	4	12		6	4	10
2037		9	3	12		7	3	10
2038		10	2	12		8	2	10
2039		11	1	12		9	1	10
2040		12		12		10	0	10
2041		12		12		11	0	11
2042		12		12		12	0	12

Source: Table prepared by CRS based on Navy FY2012-FY2017 budget submissions.

SSBN(X) Design

Some Key Design Features

The design of the SSBN(X), now being developed (see **Figure 2**), will reflect the following:

- The SSBN(X) is to be designed for a 42-year expected service life.¹⁷

¹⁷ Rear Admiral David Johnson, briefing to Naval Submarine League Annual Symposium [on] Expanding Undersea Dominance, October 23, 2014, briefing slide 19. See also William Baker et al., “Design for Sustainment: The Ohio Replacement Submarine,” *Naval Engineers Journal*, September 2015: 89-96.

- Unlike the Ohio-class design, which requires a mid-life nuclear refueling,¹⁸ the SSBN(X) is to be equipped with a life-of-the-ship nuclear fuel core (a nuclear fuel core that is sufficient to power the ship for its entire expected service life).¹⁹ Although the SSBN(X) will not need a mid-life nuclear refueling, it will still need a mid-life non-refueling overhaul (i.e., an overhaul that does not include a nuclear refueling) to operate over its full 42-year life.
- The SSBN(X) is to be equipped with an electric-drive propulsion train, as opposed to the mechanical-drive propulsion train used on other Navy submarines. The electric-drive system is expected to be quieter (i.e., stealthier) than a mechanical-drive system.²⁰
- The SSBN(X) is to have SLBM launch tubes that are the same size as those on the Ohio class (i.e., tubes with a diameter of 87 inches and a length sufficient to accommodate a D-5 SLBM).
- The SSBN(X) will have a beam (i.e., diameter)²¹ of 43 feet, compared to 42 feet on the Ohio-class design,²² and a length of 560 feet, the same as that of the Ohio-class design.²³
- Instead of 24 SLBM launch tubes, as on the Ohio-class design, the SSBN(X) is to have 16 SLBM launch tubes. (For further discussion of the decision to equip the boat with 16 tubes rather than 20, see **Appendix D**.)
- Although the SSBN(X) is to have fewer launch tubes than the Ohio-class SSBN, it is to be larger than the Ohio-class SSBN design, with a reported submerged displacement of 20,815 tons (as of August 2014), compared to 18,750 tons for the Ohio-class design.²⁴

¹⁸ As mentioned earlier (see “Current Ohio-Class SSBNs”), the Ohio-class boats receive a mid-life nuclear refueling overhaul, called an Engineered Refueling Overhaul (ERO), which includes both a nuclear refueling and overhaul work on the ship that is not related to the nuclear refueling.

¹⁹ U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, February 2010, p. 5. The two most recent classes of SSNs—the Seawolf (SSN-21) and Virginia (SSN-774) class boats—are built with cores that are expected to be sufficient for their entire 33-year expected service lives.

²⁰ Source: Rear Admiral David Johnson, briefing to Naval Submarine League Annual Symposium [on] Expanding Undersea Dominance, October 23, 2014, briefing slide 19. See also the spoken testimony of Admiral Kirkland Donald, Deputy Administrator for Naval Reactors, and Director, Naval Nuclear Propulsion, National Nuclear Security Administration, at a March 30, 2011, hearing before the Strategic Forces Subcommittee of the Senate Armed Services Committee, as shown in the transcript of the hearing, and Dave Bishop, “What Will Follow the Ohio Class?” *U.S. Naval Institute Proceedings*, June 2012: 31; and Sam LaGrone and Richard Scott, “Strategic Assets: Deterrent Plans Confront Cost Challenges,” *Jane’s Navy International*, December 2011: 16.

²¹ Beam is the maximum width of a ship. For Navy submarines, which have cylindrical hulls, beam is the diameter of the hull.

²² Dave Bishop, “What Will Follow the Ohio Class?” *U.S. Naval Institute Proceedings*, June 2012: 31. (Bishop was program manager for the Ohio replacement program.) See also Sam LaGrone and Richard Scott, “Strategic Assets: Deterrent Plans Confront Cost Challenges,” *Jane’s Navy International*, December 2011: 15 and 16.

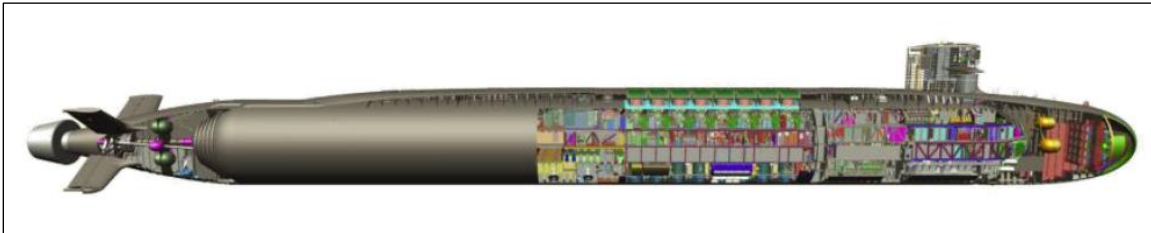
²³ Sydney J. Freedberg, “Navy Seeks Sub Replacement Savings: From NASA Rocket Boosters To Reused Access Doors,” *Breaking Defense* (<http://breakingdefense.com>), April 7, 2014.

²⁴ Navy information paper on Ohio replacement program dated August 11, 2014, provided to CBO and CRS on August 11, 2014.

- The Navy states that “owing to the unique demands of strategic relevance, [Ohio replacement boats] must be fitted with the most up-to-date capabilities and stealth to ensure they are survivable throughout their full 40-year life span.”²⁵

In an article published in June 2012, the program manager for the Ohio replacement program stated that “the current configuration of the Ohio replacement is an SSBN with 16 87-inch-diameter missile tubes, a 43-foot-diameter hull, electric-drive propulsion, [an] X-stern,²⁶ accommodations for 155 personnel, and a common submarine radio room²⁷ tailored to the SSBN mission.”²⁸

Figure 2. Ohio Replacement Boat
Notional cutaway illustration



Source: Detail of slide 2, entitled “OHIO Replacement Program System Description,” in Navy briefing on Ohio replacement program presented by Captain William J. Brougham, Program Manager of PMS 397 (i.e., Project Manager Shipbuilding, Office Code 397, the office for the Ohio replacement program), at the Sea, Air, and Space Symposium, April 8, 2014, posted at InsideDefense.com (subscription required), April 9, 2014.

For a June 26, 2013, Navy blog post discussing options that were examined for replacing the Ohio-class SSBNs, see **Appendix E**.

Common Missile Compartment (CMC)

Current U.S. and UK plans call for the SSBN(X) and the UK’s Successor-class SSBN to use a missile compartment—the middle section of the boat with the SLBM launch tubes—of the same general design.²⁹ As mentioned earlier, Successor-class SSBNs are to each be armed with eight D-5 SLBMs, or half the number to be carried by the SSBN(X). The modular design of the CMC will accommodate this difference.

²⁵ U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, February 2010, p. 24. See also Mike McCarthy, “Navy Striving To Reduce Detectability Of Next Boomers,” *Defense Daily*, February 6, 2015: 1.

²⁶ The term X-stern means that the steering and diving fins at the stern of the ship are, when viewed from the rear, in the diagonal pattern of the letter X, rather than the vertical-and horizontal pattern of a plus sign (which is referred to as a cruciform stern).

²⁷ The common submarine radio room is a standardized (i.e., common) suite of submarine radio room equipment that is being installed on other U.S. Navy submarines.

²⁸ Dave Bishop, “What Will Follow the Ohio Class?” *U.S. Naval Institute Proceedings*, June 2012: 31. See also Sam LaGrone and Richard Scott, “Strategic Assets: Deterrent Plans Confront Cost Challenges,” *Jane’s Navy International*, December 2011: 15 and 16. The X-stern is also shown in Rear Admiral David Johnson, briefing to Naval Submarine League Annual Symposium [on] Expanding Undersea Dominance, October 23, 2014, briefing slide 19.

²⁹ Statement of Rear Admiral Stephen Johnson, USN, Director, Strategic Systems Programs, Before the Subcommittee on Strategic Forces of the Senate Armed Services Committee [on] FY2011 Strategic Systems, March 17, 2010, p. 6, which states: “The OHIO Replacement programs includes the development of a common missile compartment that will support both the OHIO Class Replacement and the successor to the UK Vanguard Class.”

Since the UK's first Vanguard-class SSBN was originally projected to reach the end of its service life in 2024—three years before the first Ohio-class SSBN is projected to reach the end of its service life—design work on the CMC began about three years sooner than would have been required to support the Ohio replacement program alone. The UK has provided some of the funding for the design of the CMC, including a large portion of the initial funding.³⁰ Under the October 2010 UK defense and security review report (see **Appendix B**), the UK now plans to deliver its first Successor class SSBN in 2028, or about four years later than previously planned.

Program Cost

Acquisition Cost

A March 2015 GAO report assessing selected major DOD weapon acquisition programs states that the estimated total acquisition cost of the Ohio replacement program is \$95,775.7 million (about \$95.8 billion) in constant FY2015 dollars, including \$11,801 million (about \$11.8 billion) in research and development costs and \$83,974.7 million (about \$84.0 billion) in procurement costs.³¹

The Navy as of February 2015 estimated the procurement cost of the lead boat in the program at \$14.5 billion in then-year dollars, including \$5.7 billion in detailed design and nonrecurring engineering (DD/NRE) costs for the entire class, and \$8.8 billion in construction costs for the ship itself. (It is a traditional budgeting practice for Navy shipbuilding programs to attach the DD/NRE costs for a new class of ships to the procurement cost of the lead ship in the class.) In constant FY2010 dollars, these figures become \$10.4 billion, including \$4.2 billion in DD/NRE costs and \$6.2 billion in construction costs for the ship itself.³²

³⁰ A March 2010 Government Accountability office (GAO) report stated:

According to the Navy, in February 2008, the United States and United Kingdom began a joint effort to design a common missile compartment. This effort includes the participation of government officials from both countries, as well as industry officials from Electric Boat Corporation and BAE Systems. To date, the United Kingdom has provided a larger share of funding for this effort, totaling just over \$200 million in fiscal years 2008 and 2009.

(Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-10-388SP, March 2010, p. 152.)

A March 2011 GAO report stated:

The main focus of OR [Ohio Replacement program] research and development to date has been the CMC. The United Kingdom has provided \$329 million for this effort since fiscal year 2008. During fiscal years 2009 and 2010, the Navy had allocated about \$183 million for the design and prototyping of the missile compartment.

(Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-11-233SP, March 2011, p. 147.)

A May 2010 press report stated that “the UK has, to date, funded the vast majority of [the CMC’s] upfront engineering design activity and has established a significant presence in Electric Boat’s Shaw’s Cove CMC design office in New London, CT.” (Sam LaGrone and Richard Scott, “Deterrent Decisions: US and UK Wait on Next Steps for SSBN Replacements,” *Jane’s Navy International*, May 2010, pp. 10-11.)

³¹ Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapons Programs*, GAO-15-342SP, March 2015, p. 148.

³² Source: Navy information paper dated February 3, 2015, provided to CRS and CBO on February 24, 2015. See also Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition) and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources and Lieutenant General Kenneth J. Glueck, Jr., Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, Before the Subcommittee on Seapower and (continued...)

The Navy in February 2010 preliminarily estimated the procurement cost of each Ohio replacement boat at \$6 billion to \$7 billion in FY2010 dollars.³³ Following the Ohio replacement program's December 9, 2010, Milestone A acquisition review meeting (see **Appendix C**), DOD issued an Acquisition Decision Memorandum (ADM) that, among other things, established a target average unit procurement cost for boats 2 through 12 in the program of \$4.9 billion in constant FY2010 dollars.³⁴ The Navy is working to achieve this target cost. In January 2015, the Navy stated that its cost-reduction efforts had reduced the estimated average unit procurement cost of boats 2 through 12 to about \$5.2 billion each in constant FY2010 dollars.³⁵ The Navy continues examining potential further measures to bring the cost of boats 2 through 12 closer to the \$4.9 billion target cost.

The above cost figures do not include costs for refurbishing D-5 SLBMs so as to extend their service lives to 2042.

Operation and Support (O&S) Cost

The Navy is working to reduce the estimated operation and support (O&S) cost of each SSBN(X) from \$124 million per year to \$110 million per year in constant FY2010 dollars.³⁶

National Sea-Based Deterrence Fund (NSBDF)

Created by P.L. 113-291; Amended by P.L. 114-92

Section 1022 of the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015 (H.R. 3979/P.L. 113-291 of December 19, 2014) created the National Sea-Based Deterrence Fund (NSBDF), a fund in the DOD budget, codified at 10 U.S.C. 2218a, that is separate from the Navy's regular shipbuilding account (which is formally known as the Shipbuilding and Conversion, Navy, or SCN, appropriation account).

Section 1022 of the National Defense Authorization Act for Fiscal Year 2016 (S. 1356/P.L. 114-92 of November 25, 2015) amended 10 U.S.C. 2218a to provide additional authorities for the NSBDF.

The text of 10 U.S.C. 2218a, as amended by P.L. 114-92, is as follows:

§2218a. National Sea-Based Deterrence Fund

(...continued)

Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection Forces Capabilities, February 25, 2015, p. 7.

³³ U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, February 2010, p. 20.

³⁴ Christopher J. Castelli, "DOD: New Nuclear Subs Will Cost \$347 Billion To Acquire, Operate," *Inside the Navy*, February 21, 2011; Elaine M. Grossman, "Future U.S. Nuclear-Armed Vessel to Use Attack-Submarine Technology," *Global Security Newswire*, February 24, 2011; Jason Sherman, "Navy Working To Cut \$7.7 Billion From Ohio Replacement Program," *Inside the Navy*, February 28, 2011. See also Christopher J. Castelli, "DOD Puts 'Should-Cost' Pressure On Major Weapons Programs," *Inside the Navy*, May 2, 2011.

³⁵ Lee Hudson, "Navy Continues Working Toward SSBN(X) Cost Target, Slashes \$360M," *Inside the Navy*, January 26, 2015.

³⁶ Dave Bishop, "Two Years In And Ground Strong, The Ohio Replacement Program," *Undersea Warfare*, Spring 2012: 5; Megan Eckstein, "Ohio-Replacement Sub Technology To Drop O&S Costs To \$110M A Year," *Inside the Navy*, March 1, 2013.

(a) Establishment.-There is established in the Treasury of the United States a fund to be known as the "National Sea-Based Deterrence Fund".

(b) Administration of Fund.-The Secretary of Defense shall administer the Fund consistent with the provisions of this section.

(c) Fund Purposes.-

- (1) Funds in the Fund shall be available for obligation and expenditure only for construction (including design of vessels), purchase, alteration, and conversion of national sea-based deterrence vessels.

- (2) Funds in the Fund may not be used for a purpose or program unless the purpose or program is authorized by law.

(d) Deposits.-There shall be deposited in the Fund all funds appropriated to the Department of Defense for construction (including design of vessels), purchase, alteration, and conversion of national sea-based deterrence vessels.

(e) Expiration of Funds After 5 Years.-No part of an appropriation that is deposited in the Fund pursuant to subsection (d) shall remain available for obligation more than five years after the end of fiscal year for which appropriated except to the extent specifically provided by law.

(f) Authority to Enter Into Economic Order Quantity Contracts.-

- (1) The Secretary of the Navy may use funds deposited in the Fund to enter into contracts known as "economic order quantity contracts" with private shipyards and other commercial or government entities to achieve economic efficiencies based on production economies for major components or subsystems. The authority under this subsection extends to the procurement of parts, components, and systems (including weapon systems) common with and required for other nuclear powered vessels under joint economic order quantity contracts.

- (2) A contract entered into under paragraph (1) shall provide that any obligation of the United States to make a payment under the contract is subject to the availability of appropriations for that purpose, and that total liability to the Government for termination of any contract entered into shall be limited to the total amount of funding obligated at time of termination.

(g) Authority to Begin Manufacturing and Fabrication Efforts Prior to Ship Authorization.-

- (1) The Secretary of the Navy may use funds deposited into the Fund to enter into contracts for advance construction of national sea-based deterrence vessels to support achieving cost savings through workload management, manufacturing efficiencies, or workforce stability, or to phase fabrication activities within shipyard and manage sub-tier manufacturer capacity.

- (2) A contract entered into under paragraph (1) shall provide that any obligation of the United States to make a payment under the contract is subject to the availability of appropriations for that purpose, and that total liability to the Government for termination of any contract entered into shall be limited to the total amount of funding obligated at time of termination.

(h) Authority to Use Incremental Funding to Enter Into Contracts for Certain Items.-

- (1) The Secretary of the Navy may use funds deposited into the Fund to enter into incrementally funded contracts for advance procurement of high value, long lead time items for nuclear powered vessels to better support construction schedules and achieve cost savings through schedule reductions and properly phased installment payments.

- (2) A contract entered into under paragraph (1) shall provide that any obligation of the United States to make a payment under the contract is subject to the availability of appropriations for that purpose, and that total liability to the Government for termination

of any contract entered into shall be limited to the total amount of funding obligated at time of termination.

(i) Budget Requests.-Budget requests submitted to Congress for the Fund shall separately identify the amount requested for programs, projects, and activities for construction (including design of vessels), purchase, alteration, and conversion of national sea-based deterrence vessels.

(j) Definitions.-In this section:

(1) The term "Fund" means the National Sea-Based Deterrence Fund established by subsection (a).

(2) The term "national sea-based deterrence vessel" means any vessel owned, operated, or controlled by the Department of Defense that carries operational intercontinental ballistic missiles.

Precedents for Funding Navy Acquisition Programs Outside Navy Appropriation Accounts

Prior to the establishment of the NSBDF, some observers had suggested funding the procurement of Ohio replacement boats outside the Navy's shipbuilding budget, so as to preserve Navy shipbuilding funds for other Navy shipbuilding programs. There was some precedent for such an arrangement:

- Construction of certain DOD sealift ships and Navy auxiliary ships has been funded in past years in the National Defense Sealift Fund (NDSF), a part of DOD's budget that is outside the Shipbuilding and Conversion, Navy (SCN) appropriation account, and also outside the procurement title of the DOD appropriations act.
- Most spending for ballistic missile defense (BMD) programs (including procurement-like activities) is funded through the Defense-Wide research and development and procurement accounts rather than through the research and development and procurement accounts of the individual military services.

A rationale for funding DOD sealift ships in the NDSF has been that DOD sealift ships perform a transportation mission that primarily benefits services other than the Navy, and therefore should not be forced to compete for funding in a Navy budget account that funds the procurement of ships central to the Navy's own missions. A rationale for funding BMD programs together in the Defense-Wide research and development account is that this makes potential tradeoffs in spending among various BMD programs more visible and thereby helps to optimize the use of BMD funding.

In addition, it can be noted that as a reference tool for better understanding DOD spending, DOD includes in its annual budget submission a presentation of the DOD budget reorganized into 11 program areas, of which one is strategic forces. The FY2016 budget submission, for example, shows that about \$11.9 billion is requested for strategic forces for FY2016.³⁷

³⁷ Department of Defense, *National Defense Budget Estimates For FY 2016*, March 2015, Table 6-4, "Department of Defense TOA by Program," page 102. See also Table 6-5 on page 102, which presents the same data in constant FY2015 dollars. The other 10 program areas in addition to strategic forces are general purpose forces; C3, intelligence and space; mobility forces; guard and reserve forces; research and development; central supply and management; training, medical and other; administration and associated; support of other nations; and special operations forces. (A 12th category—other—shows relatively small amounts of funding.)

Potential Implications of NSBDF on Funding Available for Other Programs

The NSBDF has at least two potential implications for the impact that the Ohio replacement program may have on funding available in coming years for other DOD acquisition programs:

- A principal apparent intent in creating the NSBDF is to help preserve funding in coming years for other Navy programs, and particularly Navy shipbuilding programs other than the Ohio replacement program, by placing funding for the Ohio replacement program in a location within the DOD budget that is separate from the Navy's shipbuilding account and the Navy's budget in general. This separation, it might be argued, might encourage observers, in discussing defense budget issues, to consider funding for the Ohio replacement program separately from funding for other Navy shipbuilding programs, rather than add the two figures together to create a single sum representing funding for the procurement of all ships. In addition, referring to the fund as a national fund and locating it outside the Navy's budget might encourage a view (consistent with an argument made by supporters of the Ohio replacement program that the program is intended to meet a national military need rather than a Navy-specific need) that funding for the Ohio replacement program should be resourced from DOD's budget as a whole, rather than from the Navy's budget in particular.
- The authorities in subsections (f), (g), and (h) of 10 U.S.C. 2218a, which were added by P.L. 114-92, could marginally reduce the procurement costs of not only Ohio replacement boats, but also other nuclear-powered ships, such as Virginia-class attack submarines and Gerald R. Ford (CVN-78) class aircraft carriers, by increasing economies of scale in the production of ship components and better optimizing ship construction schedules.

Navy's Proposed Plan for Building the Boats at the Two Submarine-Construction Shipyards

The Navy is proposing to build Ohio replacement boats jointly at GD/EB and HII/NNS, with most of the working going to GD/EB. In connection with this plan, the Navy is also proposing to adjust the division of work on the Virginia-class attack submarine program, so that HII/NNS would receive a larger share of the work for that program than it has received in the past. The Navy states:

In 2014, the Navy led a comprehensive government-Industry assessment of shipbuilder construction capabilities and capacities at GDEB and HII-NNS to formulate the Submarine Unified Build Strategy (SUBS) for concurrent OR and Virginia class submarine production. This build strategy's guiding principles are: affordability, delivering OR on time and within budget, maintaining Virginia class performance with a continuous reduction in costs, and maintaining two shipbuilders capable of delivering nuclear-powered submarines. To execute this strategy, GDEB has been selected as the prime contractor for OR with the responsibilities to deliver the twelve OR [Ohio replacement] submarines [i.e., GD/EB will perform final assembly on all 12 boats in the program]. HII-NNS will design and construct major assemblies and OR modules leveraging their expertise with Virginia construction [i.e., HII/NNS will build parts of Ohio replacement boats that are similar to the parts it builds for Virginia-class boats]. Both shipbuilders will continue to deliver [i.e., perform final assembly of] Virginia class submarines throughout the period with GDEB continuing its prime contractor responsibility for the program. Given the priority of the OR Submarine Program, the

delivery [i.e., final assembly] of Virginia class submarines will be adjusted with HII-NNS performing additional deliveries. Both shipbuilders have agreed to this build strategy.³⁸

Program Funding

Table 2 shows funding for the Ohio replacement program. The table shows U.S. funding only; it does not include funding provided by the UK to help pay for the design of the CMC. As can be seen in the table, the Navy’s proposed FY2017 budget requests \$773.1 million in advance procurement (AP) funding and \$1,091.1 million in research and development funding for the program. The \$773.1 million in AP funding requested for FY2017 represents the initial procurement funding for the first boat in the class.

Table 2. Ohio Replacement Program Funding

(Millions of then-year dollars, rounded to nearest tenth; totals may not add due to rounding)

	FY16	FY17 (req.)	FY18 (proj.)	FY19 (proj.)	FY20 (proj.)	FY21 (proj.)
Research and development (R&D) funding						
PE0603570N/Project 3219	419.3	390.3	389.3	281.2	270.1	149.7
PE0603595N/Project 3220	971.4	700.8	757.7	476.1	199.0	330.5
Subtotal R&D funding	1,390.7	1,091.1	1,147.0	757.3	469.1	480.2
Procurement funding	0	773.1	787.1	2,767.0	1,311.5	3,611.2
TOTAL	1,390.7	1,864.2	1,934.1	3,524.3	1,780.6	4,091.4

Source: Navy FY2017 budget submission.

Notes: PE means Program Element, that is, a research and development line item. A Program Element may include several projects. **PE0603570N/Project 3219** is the SSBN(X) reactor plant project within the PE for Advanced Nuclear Power Systems. **PE0603561N/Project 3220** is the Sea-Based Strategic Deterrent (SBSD) Advanced Submarine System Development project within the PE for Ohio Replacement. **Procurement funding** shown in FY2017 through FY2020 is advance procurement (AP) funding for the first SSBN(X), which is scheduled to be procured in FY2021.

Issues for Congress

FY2017 Funding Request

One issue for Congress is whether to approve, reject, or modify the Navy’s FY2017 funding request for the program. In assessing this question, Congress may consider whether the Navy has accurately priced the work that is proposed to be done with FY2017 funding, as well as broader issues, including those discussed in some of the sections below.

³⁸ Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition), and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources, and Lieutenant General Robert S. Walsh, Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection Forces Capabilities, February 25, 2016, p. 12.

Providing FY2017 Advance Procurement Funding in Shipbuilding Account or National Sea-Based Deterrence Fund (NSBDF)

Another issue for Congress is whether to authorize and appropriate FY2017 advance procurement (AP) funding for the program in the Navy’s shipbuilding account—known formally as the Shipbuilding and Conversion, Navy (SCN) appropriation account—or in the National Sea-Based Deterrence Fund (NSBDF). As noted earlier (see “National Sea-Based Deterrence Fund (NSBDF)” in “Background”), Subsection (d) of 10 U.S.C. 2218a—the provision in the U.S. Code that establishes the NSBDF—states: “There shall be deposited in the Fund all funds appropriated to the Department of Defense for construction (including design of vessels), purchase, alteration, and conversion of national sea-based deterrence vessels.” If procurement or AP funds for the program were authorized and appropriated in the SCN account, a potential follow-on issue for Congress might be whether to approve a transfer of those funds to the NSBDF. The Navy’s proposed FY2017 budget requests AP funding for the program in the SCN account. The Navy states:

The Navy greatly appreciates Congressional support in overcoming the challenges posed by funding the OR Program. The procurement authorities such as Economic Order Quantity, Advance Construction, and Incremental Funding, provided [for the National Sea-Based Deterrence Fund] in the FY 2016 National Defense Authorization Act are not required in FY 2017. However, the Navy will work with Congress in 2016 to provide details regarding how these authorities contribute to achieving the overarching objectives of delivering the OR capability on schedule and in the most affordable manner. The 2017 President’s Budget continues to request funding for the OR Program via the SCN and Research, Development, Test and Evaluation, Navy (RDT&E,N) appropriations [accounts] to ensure the same level of transparency, accountability, and adherence to financial management principles and policies as all other shipbuilding programs.³⁹

Navy’s Proposed Plan for Building the Boats at the Two Submarine-Construction Shipyards

Another issue for Congress is whether to approve, reject, or modify the Navy’s proposed strategy for building Ohio replacement boats at GD/EB and HII/NNS, and for adjusting the division of work on the Virginia-class attack submarine program. In assessing this issue, Congress may consider various factors, including the overall cost effectiveness of the Navy’s proposed plan, the plan’s potential impact on workloads and employment levels at the two shipyards, and the views of the GD/EB and HII/NNS regarding the plan. As noted earlier (see “Navy’s Proposed Plan for Building the Boats at the Two Submarine-Construction Shipyards” in “Background”), the Navy states that “both shipbuilders have agreed to this build strategy.”

³⁹ Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition), and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources, and Lieutenant General Robert S. Walsh, Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection Forces Capabilities, February 25, 2016, p. 11.

Likelihood That Navy Will Reach \$4.9 Billion Target Cost

Another issue for Congress regarding the Ohio replacement program is the likelihood that the Navy will be able to achieve DOD's goal of reducing the estimated average unit procurement cost of boats 2 through 12 in the program to \$4.9 billion each in FY2010 dollars. As mentioned earlier, as of January 2015, the Navy estimated that its cost-reduction efforts had reduced the average unit procurement cost of boats 2 through 12 to about \$5.2 billion each in FY2010 dollars, leaving another \$300 million or so in cost reduction to reach the \$4.9 billion target cost.

A January 26, 2015, press report quoted Rear Admiral David Johnson, the program executive officer for submarines, as stating that in achieving the targeted reduction in per-boat procurement cost, "I'm confident we'll get to the \$4.9 billion number that we have [as a target], we just have to keep working at it and we'll need the help of Congress with multiyear authorities in how we'll actually fund the ships."⁴⁰

Accuracy of Navy's Estimated Unit Procurement Cost

Overview

Another potential issue for Congress concerns the accuracy of the Navy's estimated procurement cost for each Ohio replacement boat. The accuracy of the Navy's estimate is a key consideration in assessing the potential affordability of the Ohio replacement program, including its potential impact on the Navy's ability to procure other kinds of ships during the years of Ohio replacement procurement. Some of the Navy's ship designs in recent years, such as the Gerald R. Ford (CVN-78) class aircraft carrier,⁴¹ the San Antonio (LPD-17) class amphibious ship⁴² and the Littoral Combat Ship (LCS),⁴³ have proven to be substantially more expensive to build than the Navy originally estimated. An October 2015 Congressional Budget Office (CBO) report on the cost of the Navy's shipbuilding programs states that the Navy in recent years has underestimated the cost of lead ships in new classes by a weighted average of 27%.⁴⁴

The accuracy of the Navy's procurement cost estimate for the Ohio replacement program can be assessed in part by examining known procurement costs for other recent Navy submarines—including Virginia (SSN-774) class attack submarines (which are currently being procured), Seawolf (SSN-21) class attack submarines (which were procured prior to the Virginia class), and Ohio (SSBN-726) class ballistic missile submarines—and then adjusting these costs for the Ohio replacement program so as to account for factors such as differences in ship displacement and design features, changes over time in submarine technologies (which can either increase or reduce a ship's procurement cost, depending on the exact technologies in question), advances in design for producibility (i.e., design features that are intended to make ships easier to build), advances in

⁴⁰ Lee Hudson, "Navy Continues Working Toward SSBN(X) Cost Target, Slashes \$360M," *Inside the Navy*, January 26, 2015.

⁴¹ For more on the CVN-78 program, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by (name redacted) .

⁴² For more on the LPD-17 program, see CRS Report RL34476, *Navy LPD-17 Amphibious Ship Procurement: Background, Issues, and Options for Congress*, by (name redacted) .

⁴³ For more on the LCS program, see CRS Report RL33741, *Navy Littoral Combat Ship (LCS)/Frigate Program: Background and Issues for Congress*, by (name redacted) .

⁴⁴ Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2016 Shipbuilding Plan*, October 2015, p. 30 (Figure 10).

shipyard production processes (such as modular construction), and changes in submarine production economies of scale (i.e., changes in the total number of attack submarines and ballistic missile submarines under construction at any one time).

The Navy's estimated unit procurement cost for the program at any given point will reflect assumptions on, among other things, the division of work between GD/EB and HII/NNS in building the boats, and how much Virginia-class construction will be taking place in the years when Ohio replacement boats are being built. If shipbuilding affordability pressures result in Virginia-class boats being removed from the 30-year shipbuilding plan during the years of SSBN(X) procurement, the resulting reduction in submarine production economies of scale could make Ohio replacement boats more expensive to build than the Navy estimates.

October 2015 CBO Report

The October 2015 CBO report on the cost of the Navy's shipbuilding programs stated:

The design, cost, and capabilities of the 12 Ohio Replacement submarines in the 2016 shipbuilding plan are among the most significant uncertainties in the Navy's and CBO's analyses of the cost of future shipbuilding....

The Navy currently estimates the cost of the first Ohio Replacement submarine at \$12.1 billion in 2015 dollars, and it estimates an average cost for follow-on ships of \$5.7 billion (the Navy has stated an objective of reducing that cost to \$5.6 billion). The implied total cost for the 12 submarines is \$75 billion, or an average individual cost of \$6.2 billion....

The Navy's estimate represents a 12 percent reduction in the cost per thousand tons for the first Ohio Replacement submarine compared with the first Virginia class submarine—an improvement that would affect costs for the entire new class of ballistic missile submarines. The main reason for those purported improved costs by weight for the Ohio Replacement is that the Navy will recycle, to the extent possible, the design, technology, and components used for the Virginia class. Furthermore, because ballistic missile submarines (such as the Ohio Replacement) tend to be larger and less densely built ships than attack submarines (like the Virginia class), they will be easier to build and therefore less expensive per thousand tons, the Navy asserts.

However, the historical record for the lead ships of new classes of submarines in the 1970s and 1980s provides little evidence that ballistic missile submarines are cheaper by weight to build than attack submarines.... The first Ohio class submarine was more expensive than the lead ships of the two classes of attack submarines built during the same period—the Los Angeles and the Improved Los Angeles. (The design of the Improved Los Angeles included the addition of 12 vertical launch system cells.) In addition, the average cost by weight of the first 12 or 13 ships of the Ohio, Los Angeles, and Improved Los Angeles classes was virtually identical. By the 1990s, the cost of lead ships for submarines had grown substantially. The first Virginia class submarine, which was ordered in 1998, cost about the same per thousand tons as the first Seawolf submarine, even though the Seawolf is 20 percent larger and was built nine years earlier.

Using data from the Virginia class submarine program, CBO estimates that the first Ohio Replacement submarine will cost \$13.2 billion in 2015 dollars. Estimating the cost of the first submarine of a class with an entirely new design is particularly difficult because of uncertainty about how much the Navy will spend on nonrecurring engineering and detail design. All told, 12 Ohio Replacement submarines would cost \$88 billion, in CBO's estimation, or an average of \$7.3 billion each—\$1.1 billion more per submarine than the Navy's estimate. That average includes the \$13.2 billion estimated cost of the lead submarine and a \$6.8 billion average estimated cost for the 2nd through 12th submarines. Research and development would cost between \$10 billion and \$15 billion, for a total program cost of \$98 billion to \$103 billion, CBO estimates.

Overall, the Navy expects a 22 percent improvement in the cost-to-weight relationship of the Ohio Replacement class compared with the first 12 submarines in the Virginia class. Given the history of submarine construction, however, CBO is less optimistic that the Navy will realize as large an improvement in the cost-to-weight relationship of the Ohio Replacement class compared with the Virginia class. CBO estimates a 9 percent improvement, based in part on projected savings attributable to the concurrent production of the Ohio Replacement and Virginia class submarines.

As the Navy develops its acquisition strategy, costs for the Ohio Replacement could decline. For example, if lawmakers authorized and the Navy used a block-buy strategy to purchase a group of submarines over a specified period (effectively promising a steady stream of work for the shipyard to achieve better prices for those submarines, as it does for some other ship types)—and if that action also authorized the Navy to purchase submarines' components and materials in batches—the savings could be considerable. Similarly, if the Congress funded the purchase of the Ohio Replacement submarines through the National Sea-Based Deterrence Fund, which was established in the fiscal year 2015 National Defense Authorization Act, the Navy could potentially save several hundred million dollars per submarine by purchasing components and materials for several submarines at the same time. A disadvantage of that acquisition strategy is that if the Congress decided not to build all of the submarines for which the Navy purchased some materials, those materials might go unused.⁴⁵

Program Affordability and Impact on Other Navy Shipbuilding Programs

Overview

Another issue for Congress concerns the prospective affordability of the Ohio replacement program and its potential impact on funding available for other Navy shipbuilding programs. It has been known for some time that the Ohio replacement program, if funded through the Navy's shipbuilding account, could make it considerably more difficult for the Navy to procure other kinds of ships in desired numbers, unless the shipbuilding account were increased to accommodate the additional funding needs of the Ohio replacement program. On February 26, 2015, Admiral Jonathan Greenert, the Chief of Naval Operations, testified that

In the long term beyond 2020, I am increasingly concerned about our ability to fund the Ohio Replacement ballistic missile submarine (SSBN) program—our highest priority program—within our current and projected resources. The Navy cannot procure the Ohio Replacement in the 2020s within historical shipbuilding funding levels without severely impacting other Navy programs.⁴⁶

On February 25, 2015, Department of the Navy officials testified that

The Navy continues to need significant increases in our topline beyond the FYDP [Future Years Defense Plan], not unlike that during the period of [the original] Ohio [class] construction [effort], in order to afford the OR [Ohio replacement] SSBN procurement costs. Absent a significant increase to the SCN [Shipbuilding and Conversion, Navy] appropriation [i.e., the Navy's shipbuilding account], OR SSBN construction will

⁴⁵ Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2016 Shipbuilding Plan*, October 2015, pp. 23-25.

⁴⁶ Statement of Admiral Jonathan Greenert, U.S. Navy, Chief of Naval Operations, Before the House Subcommittee on Defense, Committee on Appropriations, on FY 2016 Department of the Navy Posture, February 26, 2015, p. 5.

seriously impair construction of virtually all other ships in the battle force: attack submarines, destroyers, and amphibious warfare ships. The shipbuilding industrial base will be commensurately impacted and shipbuilding costs would spiral unfavorably. The resulting battle force would fall markedly short of the FSA [Force Structure Assessment—the Navy’s force structure goal for the fleet as a whole], [and be] unable to meet fleet inventory requirements. The National Sea-Based Deterrence Fund [see discussion below] is a good first step in that it acknowledges the significant challenge of resourcing the OR SSBN, but the fund is unresourced [i.e., no funding has been placed into the account].⁴⁷

Ohio Replacement Program Is Navy’s Top Priority Program

On September 18, 2013, Admiral Jonathan Greenert, the Chief of Naval Operations, testified that the Ohio replacement program “is the top priority program for the Navy.”⁴⁸ Navy officials since then have reiterated this statement on numerous occasions.

The Navy’s decision to make the Ohio replacement program its top program priority means that the Ohio replacement program will be fully funded, and that any resulting pressures on the Navy’s shipbuilding account would be borne by other Navy programs, including shipbuilding programs. At a September 12, 2013, hearing before the Seapower and Projection Forces subcommittee of the House Armed Services Committee on undersea warfare, a Navy official stated:

The CNO has stated, his number one priority as the chief of Naval operations, is our—our strategic deterrent—our nuclear strategic deterrent. That will trump all other vitally important requirements within our Navy, but if there’s only one thing that we do with our ship building account, we—we are committed to sustaining a two ocean national strategic deterrent that protects our homeland from nuclear attack, from other major war aggression and also access and extended deterrent for our allies.⁴⁹

At this same hearing, Navy officials testified that the service is seeking about \$4 billion per year over 15 years in supplemental funding—a total of about \$60 billion—for the Ohio replacement program.⁵⁰ The 15 years in question, Navy officials suggested in their testimony, are the years in which the Ohio replacement boats are to be procured (FY2021-FY2035, as shown in **Table 1**).⁵¹ The \$60 billion in additional funding equates to an average of \$5 billion for each of the 12 boats, which is close to the Navy’s target of an average unit procurement cost of \$4.9 billion in constant FY2010 dollars for boats 2 through 12 in the program. The Navy stated at the hearing that the \$60 billion in supplemental funding that the Navy is seeking would equate to less than 1% of DOD’s budget over the 15-year period. The Navy also suggested that the 41 pre-Ohio class SSBNs that

⁴⁷ Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition) and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources and Lieutenant General Kenneth J. Glueck, Jr., Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, Before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection Forces Capabilities, February 25, 2015, p. 8.

⁴⁸ Statement of Admiral Jonathan Greenert, U.S. Navy, Chief of Naval Operations, Before the House Armed Services Committee on Planning for Sequestration in FY 2014 and Perspectives of the Military Services on the Strategic Choices and Management Review, September 18, 2013, p. 10.

⁴⁹ Transcript of hearing. (Spoken remarks of Rear Admiral Richard Breckenridge. The other witness at the hearing was Rear Admiral David Johnson).

⁵⁰ Transcript of hearing. (Spoken remarks of Rear Admiral Richard Breckenridge.)

⁵¹ Transcript of hearing. (Spoken remarks of Rear Admiral Richard Breckenridge.)

were procured in the 1950s and 1960s (see **Table A-1**) were partially financed with funding that was provided as a supplement to the Navy's budget.⁵²

The Navy officials stated at the September 12 hearing that if the Navy were to receive about \$30 billion in supplemental funding for the Ohio replacement program—about half the amount that the Navy is requesting—then the Navy would need to eliminate from its 30-year shipbuilding plan a notional total of 16 other ships, including, notionally, 4 Virginia-class attack submarines, 4 destroyers, and 8 other combatant ships (which might mean ships such as Littoral Combat Ships or amphibious ships). Navy officials stated, in response to a question, that if the Navy were to receive none of the supplemental funding that it is requesting, then these figures could be doubled—that is, that the Navy would need to eliminate from its 30-year shipbuilding plan a notional total of 32 other ships, including, notionally, 8 Virginia-class attack submarines, 8 destroyers, and 16 other combatant ships.⁵³

Some Options for Addressing the Issue

In addition to making further changes and refinements in the design of the SSBN(X), options for reducing the cost of the Ohio replacement program or for otherwise reducing the program's potential impact on funding available for other Navy programs (particularly shipbuilding programs) include the following:

- using block buy contracting (BBC) for procuring the first several Ohio replacement boats, and either BBC or multiyear-procurement (MYP) contracting for procuring later boats in the program;
- using authorities granted under the National Sea-Based Deterrence Fund (NSBDF);
- using a partial batch-building approach for building the Ohio replacement boats;
- altering the schedule for procuring the Ohio replacement boats so as to create additional opportunities for using incremental funding for procuring the ships; and
- reducing the planned number of Ohio replacement boats.

⁵² Transcript of hearing (Spoken remarks of Rear Admiral Richard Breckenridge.) Regarding supplemental funding for the 41 earlier SSBNs, Breckenridge stated:

The—just a little backstep and history to talk about the two other times that we've had to, as a nation, build the strategic deterrent. So in—in the '60s we built 41 SSBNs; they were called the 41 For Freedom. We did that in a seven-year period, which again is just an incredible—only in America could you go ahead and put out 41 ballistic missile submarines in a seven-year period.

There was an impact to other shipbuilding accounts at that time, but the priority was such for national survival that we had to go ahead and—and make that a—an imperative and a priority.

There was a supplement to the Navy's top line at that time when we—when we fielded the class, but it did leave—cast quite a shadow over the rest of the shipbuilding in the '60s.

We recapitalized those 41 For Freedom with 18 Ohio-class SSBNs in the '80s. It was the Reagan years. There was a major naval buildup. And underneath the umbrella of that buildup we were able to afford as a nation the recapitalization of building 18 SSBNs.

See also Joseph Tofalo, "The Value of Sea Based Strategic Deterrence," *Navy Live* (<http://navylive.dodlive.mil>), July 31, 2014; Eric J. Labs, "Finding Funding for the New Boomer," *U.S. Naval Institute Proceedings*, February 2015: 63-67.

⁵³ Transcript of hearing. (Spoken remarks of Rear Admiral Richard Breckenridge.) See also Christopher J. Castelli, "Admiral: DOD Likely To Support SSBN(X) Supplemental Funding," *Inside the Navy*, November 11, 2013.

Each of these options is discussed below.

Block Buy Contracting (BBC) and Multiyear Procurement (MYP) Contracting

To help reduce ship procurement costs, the Navy in recent years has made extensive use of MYP contracts and block buy contracting (BBC) in its shipbuilding programs. In light of this, the Navy may seek to use a block buy contract for procuring the first several Ohio replacement boats, and either BBC or an MYP contract for procuring later boats in the program. As discussed in other CRS reports and testimony, using BBC and MYP can reduce procurement costs in shipbuilding programs by roughly 10%, compared to costs under the standard or default DOD approach of annual contracting.⁵⁴

The Navy is also investigating the possibility of using a single, joint-class block buy contract that would cover both Ohio replacement boats and Virginia-class attack submarines. Such a contract, which could be viewed as precedent-setting in its scope, could offer savings beyond what would be possible using separate block buy or MYP contracts for the two submarine programs. A March 2014 GAO report stated that if the Navy decides to propose such a contract, it would develop a legislative proposal in 2017.⁵⁵ The Navy reportedly plans to finalize its acquisition strategy for the Ohio replacement program, including the issue of the contracting approach to be used, in the fall of 2016 as part of DOD's Milestone B decision for the program.⁵⁶

Authorities Granted Under NSBDF

As mentioned earlier (see “Potential Implications of NSBDF on Funding Available for Other Programs”), using the authorities in subsections (f), (g), and (h) of 10 U.S.C. 2218a (the location in the U.S. Code where the NSBDF is codified) could marginally reduce the procurement costs of not only Ohio replacement boats, but also other nuclear-powered ships, such as Virginia-class attack submarines and Gerald R. Ford (CVN-78) class aircraft carriers, by increasing economies of scale in the production of ship components and better optimizing ship construction schedules.

Partial Batch-Build Approach for Building Ohio Replacement Boats

As another possible means for further reducing the procurement cost of the Ohio replacement boats, the Navy is considering a partial batch-build approach for building the boats. Under this approach, instead of building the boats in serial fashion, portions of several boats would be built together, in batch form, so as to maximize economies of scale in the production of those portions. Under this approach, the boats would still be finished and enter service one at a time, under the schedule shown in **Table 1**, but aspects of their construction would be undertaken in batch fashion rather than serial fashion. One option for providing the authority to implement a partial batch-building approach would be to include it as part of a provision granting authority for using a block buy contract.

⁵⁴ For additional discussion, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by (name redacted) and (name redacted) , and CRS Testimony TE10001, *Acquisition Efficiency and the Future Navy Force*, by (name redacted) .

⁵⁵ Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapons Programs*, GAO-14-340SP, March 2014, p. 141.

⁵⁶ Lee Hudson, “Navy SSBN(X) Acquisition Strategy Will Not Be Finalized Until Fall 2016,” *Inside the Navy*, September 8, 2014.

Altering Procurement Schedule to Make More Use of Incremental Funding

Another option for managing the potential impact of the Ohio replacement program on other Navy shipbuilding programs would be to stretch out the schedule for procuring Ohio replacement boats and make greater use of split funding (i.e., two-year incremental funding) in procuring them.⁵⁷ This option would not reduce the total procurement cost of the Ohio replacement program—to the contrary, it might increase the program’s total procurement cost somewhat by reducing production learning curve benefits in the Ohio replacement program.⁵⁸ This option could, however, reduce the impact of the Ohio replacement program on the amount of funding available for the procurement of other Navy ships in certain individual years. This might reduce the amount of disruption that the Ohio replacement program causes to other shipbuilding programs in those years, which in turn might avoid certain disruption-induced cost increases for those other programs. The annual funding requirements for the Ohio replacement program might be further spread out by funding some of the Ohio replacement boats with three- or four-year incremental funding.⁵⁹

Table 3 shows the Navy’s currently planned schedule for procuring 12 Ohio replacement boats and a notional alternative schedule that would start two years earlier and end two years later than the Navy’s currently planned schedule.

⁵⁷ Under split funding, a boat’s procurement cost is divided into two parts, or increments. The first increment would be provided in the fiscal year that the boat is procured, and the second would be provided the following fiscal year.

⁵⁸ Procuring one SSBN(X) every two years rather than at the Navy’s planned rate of one per year could result in a loss of learning at the shipyard in moving from production of one SSBN to the next.

⁵⁹ The Navy, with congressional support, currently uses split funding to procure large-deck amphibious assault ships (i.e., LHAs). The Navy currently is permitted by Congress to use four-year incremental funding for procuring the first three Ford (CVN-78) class carriers (i.e., CVN-78, CVN-79, and CVN-80); the authority was granted in §121 of the FY2007 defense authorization act [H.R. 5122/P.L. 109-364 of October 17, 2006].

Table 3. Navy SSBN(X) Procurement Schedule and a Notional Alternative Schedule

Fiscal year	Navy's Schedule	Boat might be particularly suitable for 2-, 3-, or 4-year incremental funding	Notional alternative schedule	Boat might be particularly suitable for 2-, 3-, or 4-year incremental funding
2019				X
2020				
2021		X		X
2022				
2023				X
2024		X		
2025				X
2026				
2027				
2028				
2029				
2030				
2031				X
2032				
2033		X		X
2034		X		
2035		X		X
2036				
2037				X
Total	12		12	

Source: Navy's current plan is taken from the Navy's FY2015 budget submission. Potential alternative plan prepared by CRS.

Notes: Notional alternative schedule could depend on Navy's ability to carefully husband the use of the nuclear fuel cores on the last two Ohio-class SSBNs, so as to extend the service lives of these two ships by one or two years. Alternatively, Congress could grant the Navy the authority to begin construction on the 11th boat a year before its nominal year of procurement, and the 12th boat two years prior to its nominal year of procurement. Under Navy's schedule, the boat to be procured in FY2033 might be particularly suitable for 4-year incremental funding, and boat to be procured in FY2034 might be particularly suitable for 3- or 4-year incremental funding.

Although the initial ship in the alternative schedule would be procured in FY2019, it could be executed as if it were funded in FY2021. Subsequent ships in the alternative schedule that are funded earlier than they would be under the Navy's currently planned schedule could also be executed as if they were funded in the year called for under the Navy's schedule. Congress in the past has funded the procurement of ships whose construction was executed as if they had been procured in later fiscal years.⁶⁰ The ability to stretch the end of the procurement schedule by two years, to FY2035, could depend on the Navy's ability to carefully husband the use of the nuclear fuel cores on the last two Ohio-class SSBNs, so as to extend the service lives of these two ships by one or two years. Alternatively, Congress could grant the Navy the authority to begin construction on the 11th boat a year before its nominal year of procurement, and the 12th boat two years prior to its nominal year of procurement.

⁶⁰ Congress funded the procurement of two aircraft carriers (CVNs 72 and 73) in FY1983, and another two (CVNs 74 and 75) in FY1988. Although CVN-73 was funded in FY1983, it was built on a schedule consistent with a carrier funded in FY1985; although CVN-75 was funded in FY1988, it was built on a schedule consistent with a carrier funded in FY1990 or FY1991.

Reducing the Planned Number of Ohio Replacement Boats

Some observers over the years have advocated or presented options for an SSBN force of fewer than 12 SSBNs. A November 2013 CBO report on options for reducing the federal budget deficit, for example, presented an option for reducing the SSBN force to eight boats as a cost-reduction measure.⁶¹ Earlier CBO reports have presented options for reducing the SSBN force to 10 boats as a cost-reduction measure.⁶² CBO reports that present such options also provide notional arguments for and against the options. A June 2010 report by a group known as the Sustainable Defense Task Force recommends reducing the SSBN force to 7 boats,⁶³ a September 2010 report from the Cato Institute recommends reducing the SSBN force to 6 boats,⁶⁴ and a September 2013 report from a group organized by the Stimson Center recommends reducing the force to 10 boats.⁶⁵

Views on whether a force of fewer than 12 Ohio replacement boats would be adequate could depend on, among other things, assessments of strategic nuclear threats to the United States and the role of SSBNs in deterring such threats as a part of overall U.S. strategic nuclear forces, as influenced by the terms of strategic nuclear arms control agreements.⁶⁶ Reducing the number of SSBNs below 12 could also raise a question as to whether the force should continue to be homeported at both Bangor, WA, and Kings Bay, GA, or consolidated at a single location. The Navy's position (see "Planned Procurement Quantity") is that the current requirement for having a certain number of SSBNs on patrol translates into a need for a force of 14 Ohio-class boats, and that this requirement can be met in the future by a force of 12 Ohio replacement boats.

Legislative Activity for FY2017

Summary of Congressional Action on FY2017 Funding Request

Table 4 Error! Reference source not found.below summarizes congressional action on the Navy's FY2017 funding request for the Ohio replacement program.

⁶¹ Congressional Budget Office, *Options for Reducing the Deficit: 2014 to 2023*, November 2013, pp. 68-69.

⁶² See, for example, Congressional Budget Office, *Rethinking the Trident Force*, July 1993, 78 pp.; and Congressional Budget Office, *Budget Options*, March 2000, p. 62.

⁶³ *Debt, Deficits, and Defense, A Way Forward[:] Report of the Sustainable Defense Task Force*, June 11, 2010, pp. 19-20.

⁶⁴ Benjamin H. Friedman and Christopher Preble, *Budgetary Savings from Military Restraint*, Washington, Cato Institute, September 23, 2010 (Policy Analysis No. 667), p. 8.

⁶⁵ *Strategic Agility: Strong National Defense for Today's Global and Fiscal Realities*, Stimson, Washington, DC, 2013, p. 29. (Sponsored by the Peter G. Peterson Foundation, Prepared by Stimson, September 2013.)

⁶⁶ For further discussion, see CRS Report RL33640, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, by (name redacted)

Table 4. Congressional Action on FY2017 Funding Request
(Millions of then-year dollars, rounded to nearest tenth; totals may not add due to rounding)

	Request	Authorization			Appropriation		
		HASC	SASC	Conf.	HAC	SAC	Conf.
Research and development (R&D)							
PE0603570N/Project 3219	390.3						
PE0603595N/Project 3220	700.8						
Subtotal R&D	1,091.1						
Procurement	773.1						
TOTAL	1,864.2						

Source: Navy FY2017 budget submission.

Notes: **PE** means Program Element, that is, a research and development line item. A Program Element may include several projects. **PE0603570N/Project 3219** is the SSBN(X) reactor plant project within the PE for Advanced Nuclear Power Systems. **PE0603561N/Project 3220** is the Sea-Based Strategic Deterrent (SBSD) Advanced Submarine System Development project within the PE for Ohio Replacement. **HASC** is House Armed Services Committee; **SASC** is Senate Armed Services Committee; **HAC** is House Appropriations Committee; **SAC** is Senate Appropriations Committee; **Conf.** is conference agreement. The procurement funding requested for FY2017 is advance procurement (AP) funding.

Appendix A. Summary of U.S. SSBN Designs

This appendix provides background information on the four SSBN classes that the United States has operated since 1959. The four classes are summarized in **Table A-1**. As shown in the table, the size of U.S. SSBNs has grown over time, reflecting in part a growth in the size and number of SLBMs carried on each boat. The Ohio class carries an SLBM (the D-5) that is much larger than the SLBMs carried by earlier U.S. SSBNs, and it carries 24 SLBMs, compared to the 16 on earlier U.S. SSBNs.⁶⁷ In part for these reasons, the Ohio-class design, with a submerged displacement of 18,750 tons, is more than twice the size of earlier U.S. SSBNs.

Table A-1. U.S. SSBN Classes

	George Washington (SSBN-598) class	Ethan Allen (SSBN-608) class	Lafayette/Benjamin Franklin (SSBN-616/640) class	Ohio (SSBN-726) class
Number in class	5	5	31	18/14
Fiscal years procured	FY1958-FY1959	FY1959 and FY1961	FY1961-FY1964	FY1974/FY1977 - FY1991
Years in commission	1959-1985	1961-1992	1963-2002	1981/1984 - present
Length	381.7 feet	410.5 feet	425 feet	560 feet
Beam	33 feet	33 feet	33 feet	42 feet
Submerged displacement	6,700 tons	7,900 tons	8,250 tons	18,750 tons
Number of SLBM launch tubes	16	16	16	24 (to be reduced to 20 by 2018)
Final type(s) of SLBM carried	Polaris A-3	Polaris A-3	Poseidon C-3/ Trident I C-4	Trident II D-5
Diameter of those SLBMs	54 inches	54 inches	74 inches	83 inches
Length of those SLBMs	32.3 feet	32.3 feet	34 feet	44 feet
Weight of each SLBM (pounds)	36,000 pounds	36,000 pounds	65,000/73,000 pounds	~130,000 pounds
Range of SLBMs	~2,500 nm	~2,500 nm	~2,500 nm/~4,000 nm	~4,000 nm

Sources: Prepared by CRS based on data in Norman Polmar, *The Ships and Aircraft of the U.S. Fleet*, Annapolis, Naval Institute Press, various editions, and (for SSBN decommissioning dates) U.S. Naval Vessel Register.

Notes: Beam is the maximum width of a ship. For the submarines here, which have cylindrical hulls, beam is the diameter of the hull.

The range of an SLBM can vary, depending on the number and weight of nuclear warheads it carries; actual ranges can be lesser or greater than those shown.

The George Washington-class boats were procured as modifications of SSNs that were already under construction. Three of the boats were converted into SSNs toward the ends of their lives and were

⁶⁷ The larger size of the Ohio-class design also reflects a growth in size over time in U.S. submarine designs due to other reasons, such as providing increased interior volume for measures to quiet the submarine acoustically, so as to make it harder to detect.

decommissioned in 1983-1985. The two boats that remained SSBNs throughout their lives were decommissioned in 1981.

All five Ethan Allen-class boats were converted into SSNs toward the ends of their lives. The boats were decommissioned in 1983 (two boats), 1985, 1991, and 1992.

Two of the Lafayette/Benjamin Franklin-class boats were converted into SSNs toward the ends of their lives and were decommissioned in 1999 and 2002. The 29 that remained SSBNs throughout their lives were decommissioned in 1986-1995. For 19 of the boats, the Poseidon C-3 was the final type of SLBM carried; for the other 12, the Trident I C-4 SLBM was the final type of SLBM carried.

A total of 18 Ohio-class SSBNs were built. The first four, which entered service in 1981-1984, were converted into SSGNs in 2002-2008. The remaining 14 boats entered service in 1984-1997. Although Ohio-class SSBNs are designed to each carry 24 SLBMs, by 2018, four SLBM launch tubes on each boat are to be deactivated, and the number of SLBMs that can be carried by each boat consequently is to be reduced to 20, so that the number of operational launchers and warheads in the U.S. force will comply with strategic nuclear arms control limits.

Appendix B. U.S.-UK Cooperation on SLBMs and the New UK SSBN

This appendix provides background information on U.S.-UK cooperation on SLBMs and the UK's next-generation SSBN.

The UK's four Vanguard-class SSBNs, which entered service in 1993-1999, each carry 16 Trident II D-5 SLBMs. Previous classes of UK SSBNs similarly carried earlier-generation U.S. SLBMs.⁶⁸ The UK's use of U.S.-made SLBMs on its SSBNs is one element of a long-standing close cooperation between the two countries on nuclear-related issues that is carried out under the 1958 Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes (also known as the Mutual Defense Agreement). Within the framework established by the 1958 agreement, cooperation on SLBMs in particular is carried out under the 1963 Polaris Sales Agreement and a 1982 Exchange of Letters between the two governments.⁶⁹ The Navy testified in

⁶⁸ Although the SLBMs on UK SSBNs are U.S.-made, the nuclear warheads on the missiles are of UK design and manufacture.

⁶⁹ A March 18, 2010, report by the UK Parliament's House of Commons Foreign Affairs Committee stated:

During the Cold War, the UK's nuclear co-operation with the United States was considered to be at the heart of the [UK-U.S.] 'special relationship'. This included the 1958 Mutual Defence Agreement, the 1963 Polaris Sales Agreement (PSA) (subsequently amended for Trident), and the UK's use of the US nuclear test site in Nevada from 1962 to 1992. The co-operation also encompassed agreements for the United States to use bases in Britain, with the right to store nuclear weapons, and agreements for two bases in Yorkshire (Fylingdales and Menwith Hill) to be upgraded to support US missile defence plans.

In 1958, the UK and US signed the Mutual Defence Agreement (MDA). Although some of the appendices, amendments and Memoranda of Understanding remain classified, it is known that the agreement provides for extensive co-operation on nuclear warhead and reactor technologies, in particular the exchange of classified information concerning nuclear weapons to improve design, development and fabrication capability. The agreement also provides for the transfer of nuclear warhead-related materials. The agreement was renewed in 2004 for another ten years.

The other major UK-US agreement in this field is the 1963 Polaris Sales Agreement (PSA) which allows the UK to acquire, support and operate the US Trident missile system. Originally signed to allow the UK to acquire the Polaris Submarine Launched Ballistic Missile (SLBM) system in the 1960s, it was amended in 1980 to facilitate purchase of the Trident I (C4) missile and again in 1982 to authorise purchase of the more advanced Trident II (D5) in place of the C4. In return, the UK agreed to formally assign its nuclear forces to the defence of NATO, except in an extreme national emergency, under the terms of the 1962 Nassau Agreement reached between President John F. Kennedy and Prime Minister Harold Macmillan to facilitate negotiation of the PSA.

Current nuclear co-operation takes the form of leasing arrangements of around 60 Trident II D5 missiles from the US for the UK's independent deterrent, and long-standing collaboration on the design of the W76 nuclear warhead carried on UK missiles. In 2006 it was revealed that the US and the UK had been working jointly on a new 'Reliable Replacement Warhead' (RRW) that would modernise existing W76-style designs. In 2009 it emerged that simulation testing at Aldermaston on dual axis hydrodynamics experiments had provided the US with scientific data it did not otherwise possess on this RRW programme.

The level of co-operation between the two countries on highly sensitive military technology is, according to the written submission from Ian Kearns, "well above the norm, even for a close alliance relationship". He quoted Admiral William Crowe, the former US Ambassador to London, who likened the UK-US nuclear relationship to that of an iceberg, "with a small tip of it sticking out, but beneath the water there is quite a bit of everyday business that goes on between our two governments in a fashion that's unprecedented in the world." Dr Kearns also commented that the personal bonds between the US/UK scientific and technical establishments were deeply rooted.

(continued...)

March 2010 that “the United States and the United Kingdom have maintained a shared commitment to nuclear deterrence through the Polaris Sales Agreement since April 1963. The U.S. will continue to maintain its strong strategic relationship with the UK for our respective follow-on platforms, based upon the Polaris Sales Agreement.”⁷⁰

The first Vanguard-class SSBN was originally projected to reach the end of its service life in 2024, but an October 2010 UK defense and security review report states that the lives of the Vanguard class ships will now be extended by a few years, so that the four boats will remain in service into the late 2020s and early 2030s.⁷¹

The UK plans to replace the four Vanguard-class boats with three or four next-generation SSBNs called Successor class SSBNs. The October 2010 UK defense and security review report states that each new Successor class SSBN is to be equipped with 8 D-5 SLBMs, rather than 12 as previously planned. The report states that “‘Main Gate’—the decision to start building the submarines—is required around 2016.”⁷² The first new boat is to be delivered by 2028, or about four years later than previously planned.⁷³

The United States is assisting the UK with certain aspects of the Successor SSBN program. In addition to the modular Common Missile Compartment (CMC), the United States is assisting the UK with the new PWR-3 reactor plant⁷⁴ to be used by the Successor SSBN. A December 2011 press report states that “there has been strong [UK] collaboration with the US [on the Successor program], particularly with regard to the CMC, the PWR, and other propulsion technology,” and that the design concept selected for the Successor class employs “a new propulsion plant based on a US design, but using next-generation UK reactor technology (PWR-3) and modern secondary propulsion systems.”⁷⁵ The U.S. Navy states that

Naval Reactors, a joint Department of Energy/Department of Navy organization responsible for all aspects of naval nuclear propulsion, has an ongoing technical exchange with the UK Ministry of Defence under the US/UK 1958 Mutual Defence

(...continued)

(House of Commons, Foreign Affairs Committee, *Sixth Report Global Security: UK-US Relations*, March 18, 2010, paragraphs 131-135; <http://www.publications.parliament.uk/pa/cm200910/cmselect/cmaff/114/11402.htm>; paragraphs 131-135 are included in the section of the report available at <http://www.publications.parliament.uk/pa/cm200910/cmselect/cmaff/114/11406.htm>.)

See also “U.K. Stays Silent on Nuclear-Arms Pact Extension with United States,” *Global Security Newswire* (www.nti.org/gsn), July 30, 2014.

⁷⁰ Statement of Rear Admiral Stephen Johnson, USN, Director, Strategic Systems Programs, Before the Subcommittee on Strategic Forces of the Senate Armed Services Committee [on] FY2011 Strategic Systems, March 17, 2010, p. 6.

⁷¹ *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, Presented to Parliament by the Prime Minister by Command of Her Majesty, October 2010, p. 39.

⁷² *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, Presented to Parliament by the Prime Minister by Command of Her Majesty, October 2010, pp. 5, 38-39. For more on the UK’s Successor SSBN program as it existed prior to the October 2010 UK defense and security review report, see Richard Scott, “Deterrence At A Discount?” *Jane’s Defence Weekly*, December 23, 2009: 26-31.

⁷³ *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*, Presented to Parliament by the Prime Minister by Command of Her Majesty, October 2010, p. 39.

⁷⁴ PWR3 means pressurized water reactor, design number 3. U.S. and UK nuclear-powered submarines employ pressurized water reactors. Earlier UK nuclear-powered submarines are powered by reactor designs that the UK designated PWR-2 and PWR-1. For an article discussing the PWR3 plant, see Richard Scott, “Critical Mass: Re-Energising the UK’s Naval Nuclear Programme,” *Jane’s International Defence Review*, July 2014: 42-45, 47.

⁷⁵ Sam LaGrone and Richard Scott, “Strategic Assets: Deterrent Plans Confront Cost Challenges,” *Jane’s Navy International*, December 2011: 17 and 18.

Agreement. The US/UK 1958 Mutual Defence Agreement is a Government to Government Atomic Energy Act agreement that allows the exchange of naval nuclear propulsion technology between the US and UK.

Under this agreement, Naval Reactors is providing the UK Ministry of Defence with US naval nuclear propulsion technology to facilitate development of the naval nuclear propulsion plant for the UK's next generation SUCCESSOR ballistic missile submarine. The technology exchange is managed and led by the US and UK Governments, with participation from Naval Reactors prime contractors, private nuclear capable shipbuilders, and several suppliers. A UK based office comprised of about 40 US personnel provide full-time engineering support for the exchange, with additional support from key US suppliers and other US based program personnel as needed.

The relationship between the US and UK under the 1958 mutual defence agreement is an ongoing relationship and the level of support varies depending on the nature of the support being provided. Naval Reactors work supporting the SUCCESSOR submarine is reimbursed by the UK Ministry of Defence.⁷⁶

U.S. assistance to the UK on naval nuclear propulsion technology first occurred many years ago: To help jumpstart the UK's nuclear-powered submarine program, the United States transferred to the UK a complete nuclear propulsion plant (plus technical data, spares, and training) of the kind installed on the U.S. Navy's six Skipjack (SSN-585) class nuclear-powered attack submarines (SSNs), which entered service between 1959 and 1961. The plant was installed on the UK Navy's first nuclear-powered ship, the attack submarine *Dreadnought*, which entered service in 1963.

The December 2011 press report states that "the UK is also looking at other areas of cooperation between Successor and the Ohio Replacement Programme. For example, a collaboration agreement has been signed off regarding the platform integration of sonar arrays with the respective combat systems."⁷⁷

⁷⁶ Source: Email to CRS from Navy Office of Legislative Affairs, June 25, 2012. See also Jon Rosamond, "Next Generation U.K. Boomers Benefit from U.S. Relationship," *USNI News* (<http://news.usni.org>), December 17, 2014.

⁷⁷ Sam LaGrone and Richard Scott, "Strategic Assets: Deterrent Plans Confront Cost Challenges," *Jane's Navy International*, December 2011: 19. See also Jake Wallis Simons, "Brits Keep Mum on US Involvement in Trident Nuclear Program," *Politico*, April 30, 2015.

Appendix C. Ohio Replacement Program Origin and Early Milestones

This appendix provides background information on the Ohio replacement program's origin and early milestones.

Although the eventual need to replace the Ohio-class SSBNs has been known for many years, the Ohio replacement program can be traced more specifically to an exchange of letters in December 2006 between President George W. Bush and UK Prime Minister Tony Blair concerning the UK's desire to participate in a program to extend the service life of the Trident II D-5 SLBM into the 2040s, and to have its next-generation SSBNs carry D-5s. Following this exchange of letters, and with an awareness of the projected retirement dates of the Ohio-class SSBNs and the time that would likely be needed to develop and field a replacement for them, DOD in 2007 began studies on a next-generation sea-based strategic deterrent (SBSD).⁷⁸ The studies used the term sea-based strategic deterrent (SBSD) to signal the possibility that the new system would not necessarily be a submarine.

An Initial Capabilities Document (ICD) for a new SBSDB was developed in early 2008⁷⁹ and approved by DOD's Joint Requirements Oversight Committee (JROC) on June 20, 2008.⁸⁰ In July 2008, DOD issued a Concept Decision providing guidance for an analysis of alternatives (AOA) for the program; an acquisition decision memorandum from John Young, DOD's acquisition executive, stated the new system would, barring some discovery, be a submarine.⁸¹ The Navy established an Ohio replacement program office at about this same time.⁸²

The AOA reportedly began in the summer or fall of 2008.⁸³ The AOA was completed, with final brief to the Office of the Secretary of Defense (OSD), on May 20, 2009. The final AOA report was completed in September 2009. An AOA Sufficiency Review Letter was signed by OSD's Director, Cost Assessment & Program Evaluation (CAPE) on December 8, 2009.⁸⁴ The AOA concluded that a new-design SSBN was the best option for replacing the Ohio-class SSBNs. (For a June 26, 2013, Navy blog post discussing options that were examined for replacing the Ohio-class SSBNs, see **Appendix E.**)

⁷⁸ In February 2007, the commander of U.S. Strategic Command (STRATCOM) commissioned a task force to support an anticipated Underwater Launched Missile Study (ULMS). On June 8, 2007, the Secretary of the Navy initiated the ULMS. Six days later, the commander of STRATCOM directed that a Sea Based Strategic Deterrent (SBSD) capability-based assessment (CBA) be performed. In July 2007, the task force established by the commander of STRATCOM provided its recommendations regarding capabilities and characteristics for a new SBSDB. (Source: Navy list of key events relating to the ULMS and SBSDB provided to CRS and the Congressional Budget Office (CBO) on July 7, 2008.)

⁷⁹ On February 14, 2008, the SBSDB ICD was approved for joint staffing by the Navy's Resources and Requirements Review Board (R3B). On April 29, 2008, the SBSDB was approved by DOD's Functional Capabilities Board (FCB) to proceed to DOD's Joint Capabilities Board (JCB). (Source: Navy list of key events relating to the ULMS and SBSDB provided to CRS and CBO on July 7, 2008.)

⁸⁰ Navy briefing to CRS and CBO on the SBSDB program, July 6, 2009.

⁸¹ Navy briefing to CRS and CBO on the SBSDB program, July 6, 2009.

⁸² An August 2008 press report states that the program office, called PMS-397, "was established within the last two months." (Dan Taylor, "Navy Stands Up Program Office To Manage Next-Generation SSBN," *Inside the Navy*, August 17, 2008.)

⁸³ "Going Ballistic," *Defense Daily*, September 22, 2008, p. 1.

⁸⁴ *Department of Defense Fiscal Year (FY) 2012 Budget Estimates, Navy, Justification Book Volume 2, Research, Development, Test & Evaluation, Navy Budget Activity 4*, entry for PE0603561N, Project 3220 (PDF page 345 of 888).

The program's Milestone A review meeting was held on December 9, 2010. On February 3, 2011, the Navy provided the following statement to CRS concerning the outcome of the December 9 meeting:

The OHIO Replacement Program achieved Milestone A and has been approved to enter the Technology Development Phase of the Dept. of Defense Life Cycle Management System as of Jan. 10, 2011.

This milestone comes following the endorsement of the Defense Acquisition Board (DAB), chaired by Dr. Carter (USD for Acquisition, Technology, and Logistics) who has signed the program's Milestone A Acquisition Decision Memorandum (ADM).

The DAB endorsed replacing the current 14 Ohio-class Ballistic Missile Submarines (SSBNs) as they reach the end of their service life with 12 Ohio Replacement Submarines, each comprising 16, 87-inch diameter missile tubes utilizing TRIDENT II D5 Life Extended missiles (initial loadout). The decision came after the program was presented to the Defense Acquisition Board (DAB) on Dec. 9, 2010.

The ADM validates the program's Technology Development Strategy and allows entry into the Technology Development Phase during which warfighting requirements will be refined to meet operational and affordability goals. Design, prototyping, and technology development efforts will continue to ensure sufficient technological maturity for lead ship procurement in 2019.⁸⁵

⁸⁵ Source: Email from Navy Office of Legislative Affairs to CRS, February 3, 2011.

Appendix D. Earlier Oversight Issue: A Design with 16 vs. 20 SLBM Tubes

This appendix provides background information on an earlier oversight issues regarding the Ohio replacement program—the question of whether Ohio replacement boats should be equipped with 16 or 20 SLBM launch tubes.

Overview

The Navy’s decision to design Ohio replacement boats with 16 SLBM tubes rather than 20 was one of several decisions the Navy made to reduce the estimated average procurement cost of boats 2 through 12 in the program to toward the Navy’s target cost of \$4.9 billion in FY2010 dollars.⁸⁶ Some observers were concerned that designing the SSBN(X) with 16 tubes rather than 20 would create a risk that U.S. strategic nuclear forces might not have enough capability in the 2030s and beyond to fully perform their deterrent role. These observers noted that to comply with the New Start Treaty limiting strategic nuclear weapons, DOD plans to operate in coming years a force of 14 Trident SSBNs, each with 20 operable SLBM tubes (4 of the 24 tubes on each boat are to be rendered inoperable), for a total of 240 tubes, whereas the Navy in the Ohio replacement program is planning a force of 12 SSBNs each with 16 tubes, for a total of 192 tubes, or 20% less than 240. These observers also cited the uncertainties associated with projecting needs for strategic deterrent forces out to the year 2080, when the final SSBN(X) is scheduled to leave service. These observers asked whether the plan to design the SSBN(X) with 16 tubes rather than 20 was fully supported within all parts of DOD, including U.S. Strategic Command (STRATCOM).

In response, Navy and other DOD officials stated that the decision to design the SSBN(X) with 16 tubes rather than 20 was carefully considered within DOD, and that they believe a boat with

⁸⁶ At a March 30, 2011, hearing before the Strategic Forces subcommittee of the Senate Armed Services Committee, Admiral Kirkland Donald, Deputy Administrator for Naval Reactors and Director, Naval Nuclear Propulsion, National Nuclear Security Administration, when asked for examples cost efficiencies that are being pursued in his programs, stated:

The—the Ohio replacement [program] has been one that we’ve obviously been focused on here for—for several years now. But in the name of the efficiencies, and one of the issues as we work through the Defense Department’s acquisition process, we were the first program through that new process that Dr. [Aston] Carter [the DOD acquisition executive] headed up.

But we were challenged to—to drive the cost of that ship down, and as far as our part was concerned, one of the key decisions that was made that—that helped us in that regard was a decision to go from 20 missile tubes to 16 missile tubes, because what that allowed us to do was to down rate the—the propulsion power that was needed, so obviously, it’s a – it’s a small[er] the reactor that you would need.

But what it also allowed us to do was to go back [to the use of existing components]. The size [of the ship] fell into the envelope where we could go back and use components that we had already designed for the Virginia class [attack submarines] and bring those into this design, not have to do it over again, but several of the mechanical components, to use those over again.

And it enabled us to drive the cost of that propulsion plant down and rely on proven technology that’s—pumps and valves and things like that don’t change like electronics do.

So we’re pretty comfortable putting that in ship that’ll be around ‘til 2080. But we were allowed to do that.

(Source: Transcript of hearing.)

16 tubes will give U.S. strategic nuclear forces enough capability to fully perform their deterrent role in the 2030s and beyond.

Testimony in 2011

At a March 1, 2011, hearing before the House Armed Services Committee, Admiral Gary Roughead, then-Chief of Naval Operations, stated:

I'm very comfortable with where we're going with SSBN-X. The decision and the recommendation that I made with regard to the number of tubes—launch tubes are consistent with the new START treaty. They're consistent with the missions that I see that ship having to perform. And even though it may be characterized as a cost cutting measure, I believe it sizes the ship for the missions it will perform.⁸⁷

At a March 2, 2011, hearing before the Strategic Forces subcommittee of the House Armed Services Committee, the following exchange occurred:

REPRESENTATIVE TURNER:

General Kehler, thank you so much for your continued thoughts and of course your leadership. One item that we had a discussion on was the triad, of looking to—of the Navy and the tube reductions of 20 to 16, as contained in other hearings on the Hill today. I would like your thoughts on the reduction of the tubes and what you see driving that, how you see it affecting our strategic posture and any other thoughts you have on that?

AIR FORCE GENERAL C. ROBERT KEHLER, COMMANDER, U.S. STRATEGIC COMMAND

Thank you, Mr. Chairman. Well, first of all, sir, let me say that the—in my mind anyway, the discussion of Trident and Ohio-class replacement is really a discussion in the context of the need to modernize the entire triad. And so, first of all, I think that it's important for us to recognize that that is one piece, an important piece, but a piece of the decision process that we need to go through.

Second, the issue of the number of tubes is not a simple black-and-white answer. So let me just comment here for a minute.

First of all, the issue in my mind is the overall number of tubes we wind up with at the end, not so much as the number of tubes per submarine.

Second, the issue is, of course, we have flexibility and options with how many warheads per missile per tube, so that's another consideration that enters into this mixture.

Another consideration that is important to me is the overall number of boats and the operational flexibility that we have with the overall number of boats, given that some number will need to be in maintenance, some number will need to be in training, et cetera.

And so those and many other factors—to include a little bit of foresight here, in looking ahead to 20 years from now in antisubmarine warfare environment that the Navy will have to operate in, all of those bear on the ultimate sideways shape configuration of a follow-on to the Ohio.

At this point, Mr. Chairman, I am not overly troubled by going to 16 tubes. As I look at this, given that we have that kind of flexibility that I just laid out; given that this is an

⁸⁷ Source: Transcript of hearing.

element of the triad and given that we have some decision space here as we go forward to decide on the ultimate number of submarines, nothing troubles me operationally here to the extent that I would oppose a submarine with 16 tubes.

I understand the reasons for wanting to have 20. I understand the arguments that were made ahead of me. But as I sit here today, given the totality of the discussion, I am—as I said, I am not overly troubled by 16. Now, I don't know that the gavel has been pounded on the other side of the river yet with a final decision, but at this point, I am not overly troubled by 16.⁸⁸

At an April 5, 2011, hearing before the Strategic Forces subcommittee of the House Armed Services Committee, the following exchange occurred:

REPRESENTATIVE LARSEN:

General Benedict, we have had this discussion, not you and I, I am sorry. But the subcommittee has had a discussion in the past with regards to the Ohio-class replacement program.

The new START, though, when it was negotiated, assumed a reduction from 24 missile tubes per hole to, I think, a maximum a maximum of 20.

The current configuration [for the SSBN(X)], as I understand it, would move from 24 to 16.

Can you discuss, for the subcommittee here, the Navy's rationale for that? For moving from 24 to 16 as opposed to the max of 20?

NAVY REAR ADMIRAL TERRY BENEDICT, DIRECTOR, STRATEGIC SYSTEMS PROGRAMS (SSP):

Sir, as part—excuse me, as part of the work-up for the milestone A [review for the Ohio replacement program] with Dr. Carter in OSD, SSP supported the extensive analysis at both the OSD level as well as STRATCOM's analysis.

Throughout that process, we provided, from the SWS [strategic weapon system] capability, our perspective. Ultimately that was rolled up into both STRATCOM and OSD and senior Navy leadership and in previous testimony, the secretary of the Navy, the CNO, and General Chilton have all expressed their confidence that the mission of the future, given their perspectives, is they see the environment today can be met with 16.

And so, as the acquisition and the SWS provider, we are prepared to support that decision by leadership, sir.

REPRESENTATIVE LARSEN:

Yes.

And your analysis supports—did your analysis that fed into this, did you look at specific numbers then?

REAR ADMIRAL BENEDICT:

Sir, we looked at the ability of the system, again, SSP does not look at specific targets with...

REPRESENTATIVE LARSEN:

Right. Yes, yes, yes.

⁸⁸ Source: Transcript of hearing.

REAR ADMIRAL BENEDICT:

Our input was the capability of the missile, the number of re-entry bodies and the throw weight that we can provide against those targets and based on that analysis, the leadership decision was 16, sir.⁸⁹

At an April 6, 2011, hearing before the Strategic Forces subcommittee of the Senate Armed Services Committee, the following exchange occurred:

SENATOR SESSIONS:

Admiral Benedict, according to recent press reports, the Navy rejected the recommendations of Strategic Command to design the next generation of ballistic missile submarines with 20 missile tubes instead of opting for only 16 per boat.

What is the basis for the Navy's decision of 16? And I'm sure cost is a factor. In what ways will that decision impact the overall nuclear force structure associated with the command?

NAVY REAR ADMIRAL TERRY BENEDICT, DIRECTOR, STRATEGIC SYSTEMS PROGRAMS (SSP):

Yes, sir. SSP supported the Navy analysis, STRATCOM's analysis, as well as the OSD analysis, as we proceeded forward and towards the Milestone A decision [on the Ohio replacement program] that Dr. Carter conducted.

Based on our input, which was the technical input as the—as the director of SSP, other factors were considered, as you stated. Cost was one of them. But as the secretary, as the CNO, and I think as General Kehler submitted in their testimony, that given the threats that we see today, given the mission that we see today, given the upload capability of the D-5, and given the environment as they saw today, all three of those leaders were comfortable with the decision to proceed forward with 16 tubes, sir.

SENATOR SESSIONS:

And is that represent your judgment? To what extent were you involved—were you involved in that?

REAR ADMIRAL BENEDICT:

Sir, we were involved from technical aspects in terms of the capability of the missile itself, what we can throw, our range, our capability. And based on what we understand the capability of the D-5 today, which will be the baseline missile for the Ohio Replacement Program, as the director of SSP I'm comfortable with that decision.⁹⁰

Section 242 Report

Section 242 of the FY2012 National Defense Authorization Act (H.R. 1540/P.L. 112-81 of December 31, 2011) required DOD to submit a report on the Ohio replacement program that includes, among other things, an assessment of various combinations of boat quantities and numbers of SLBM launch tubes per boat. The text of the section is as follows:

SEC. 242. REPORT AND COST ASSESSMENT OF OPTIONS FOR OHIO-CLASS REPLACEMENT BALLISTIC MISSILE SUBMARINE.

⁸⁹ Source: Transcript of hearing.

⁹⁰ Source: Transcript of hearing.

(a) Report Required- Not later than 180 days after the date of the enactment of this Act, the Secretary of the Navy and the Commander of the United States Strategic Command shall jointly submit to the congressional defense committees a report on each of the options described in subsection (b) to replace the Ohio-class ballistic submarine program. The report shall include the following:

(1) An assessment of the procurement cost and total life-cycle costs associated with each option.

(2) An assessment of the ability for each option to meet—

(A) the at-sea requirements of the Commander that are in place as of the date of the enactment of this Act; and

(B) any expected changes in such requirements.

(3) An assessment of the ability for each option to meet—

(A) the nuclear employment and planning guidance in place as of the date of the enactment of this Act; and

(B) any expected changes in such guidance.

(4) A description of the postulated threat and strategic environment used to inform the selection of a final option and how each option provides flexibility for responding to changes in the threat and strategic environment.

(b) Options Considered- The options described in this subsection to replace the Ohio-class ballistic submarine program are as follows:

(1) A fleet of 12 submarines with 16 missile tubes each.

(2) A fleet of 10 submarines with 20 missile tubes each.

(3) A fleet of 10 submarines with 16 missile tubes each.

(4) A fleet of eight submarines with 20 missile tubes each.

(5) Any other options the Secretary and the Commander consider appropriate.

(c) Form- The report required under subsection (a) shall be submitted in unclassified form, but may include a classified annex.

Subsection (c) above states the report “shall be submitted in unclassified form, but may include a classified annex.”

The report as submitted was primarily the classified annex, with a one-page unclassified summary, the text of which is as follows (underlining as in the original):

The National Defense Authorization Act (NDAA) for Fiscal Year 2012 (FY12) directed the Secretary of the Navy and the Commander of U.S. Strategic Command (USSTRATCOM) to jointly submit a report to the congressional defense committees comparing four different options for the OHIO Replacement (OR) fleet ballistic missile submarine (SSBN) program. Our assessment considered the current operational requirements and guidance. The four SSBN options analyzed were:

1. 12 SSBNs with 16 missile tubes each

2. 10 SSBNs with 20 missile tubes each

3. 10 SSBNs with 16 missile tubes each

4. 8 SSBNs with 20 missile tubes each

The SSBN force continues to be an integral part of our nuclear Triad and contributes to deterrence through an assured second strike capability that is survivable, reliable, and

credible. The number of SSBNs and their combined missile tube capacity are important factors in our flexibility to respond to changes in the threat and uncertainty in the strategic environment.

We assessed each option against the ability to meet nuclear employment and planning guidance, ability to satisfy at-sea requirements, flexibility to respond to future changes in the postulated threat and strategic environment, and cost. In general, options with more SSBNs can be adjusted downward in response to a diminished threat; however, options with less SSBNs are more difficult to adjust upward in response to a growing threat.

Clearly, a smaller SSBN force would be less expensive than a larger force, but for the reduced force options we assessed, they fail to meet current at-sea and nuclear employment requirements, increase risk in force survivability, and limit flexibility in response to an uncertain strategic future. Our assessment is the program of record, 12 SSBNs with 16 missile tubes each, provides the best balance of performance, flexibility, and cost meeting commander's requirements while supporting the Nation's strategic deterrence mission goals and objectives.

The classified annex contains detailed analysis that is not releasable to the public.⁹¹

⁹¹ Report and Cost Assessment of Options for OHIO-Class Replacement Ballistic Missile Submarine, Unclassified Summary, received from Navy Legislative Affairs Office, August 24, 2012. See also Christopher J. Castelli, "Classified Navy Assessment On SSBN(X) Endorses Program Of Record," *Inside the Navy*, September 10, 2012.

Appendix E. June 2013 Navy Blog Post Regarding Ohio Replacement Options

This appendix presents the text of a June 26, 2013, blog post by Rear Admiral Richard Breckenridge, the Navy's Director for Undersea Warfare (N97), discussing options that were examined for replacing the Ohio-class SSBNs. The text is as follows:

Over the last five years, the Navy – working with U.S. Strategic Command, the Joint Staff and the Office of the Secretary of Defense – has formally examined various options to replace the Ohio ballistic missile submarines as they retire beginning in 2027. This analysis included a variety of replacement platform options, including designs based on the highly successful Virginia-class attack submarine program and the current Ohio-class ballistic missile submarine. In the end, the Navy elected to pursue a new design that leverages the lessons from the Ohio, the Virginia advances in shipbuilding and improvements in cost-efficiency.

Recently, a variety of writers have speculated that the required survivable deterrence could be achieved more cost effectively with the Virginia-based option or by restarting the Ohio-class SSBN production line. Both of these ideas make sense at face value – which is why they were included among the alternatives assessed – but the devil is in the details. When we examined the particulars, each of these options came up short in both military effectiveness and cost efficiency.

Virginia-based SSBN design with a Trident II D5 missile. An SSBN design based on a Virginia-class attack submarine with a large-diameter missile compartment was rejected due to a wide range of shortfalls. It would:

- Not meet survivability (stealth) requirements due to poor hull streamlining and lack of a drive train able to quietly propel a much larger ship
- Not meet at-sea availability requirements due to longer refit times (since equipment is packed more tightly within the hull, it requires more time to replace, repair and retest)
- Not meet availability requirements due to a longer mid-life overhaul (refueling needed)
- Require a larger number of submarines to meet the same operational requirement
- Reduce the deterrent value needed to protect the country (fewer missiles, warheads at-sea)
- Be more expensive than other alternatives due to extensive redesign of Virginia systems to work with the large missile compartment (for example, a taller sail, larger control surfaces and more robust support systems)

We would be spending more money (on more ships) to deliver less deterrence (reduced at-sea warhead presence) with less survivability (platforms that are less stealthy).

Virginia-based SSBN design with a smaller missile. Some have encouraged the development of a new, smaller missile to go with a Virginia-based SSBN. This would carry forward many of the shortfalls of a Virginia-based SSBN we just discussed, and add to it a long list of new issues. Developing a new nuclear missile from scratch with an industrial base that last produced a new design more than 20 years ago would be challenging, costly and require extensive testing. We deliberately decided to extend the life of the current missile to decouple and de-risk the complex (and costly) missile development program from the new replacement submarine program. Additionally, a smaller missile means a shorter employment range requiring longer SSBN patrol transits. This would compromise survivability, require more submarines at sea and ultimately

weaken our deterrence effectiveness. With significant cost, technical and schedule risks, there is little about this option that is attractive.

Ohio-based SSBN design. Some have argued that we should re-open the Ohio production line and resume building the Ohio design SSBNs. This simply cannot be done because there is no Ohio production line. It has long since been re-tooled and modernized to build state-of-the-art Virginia-class SSNs using computerized designs and modular, automated construction techniques. Is it desirable to redesign the Ohio so that a ship with its legacy performance could be built using the new production facilities? No, since an Ohio-based SSBN would:

- Not provide the required quieting due to Ohio design constraints and use of a propeller instead of a propulsor (which is the standard for virtually all new submarines)
- Require 14 instead of 12 SSBNs by reverting to Ohio class operational availability standards (incidentally creating other issues with the New START treaty limits)
- Suffer from reduced reliability and costs associated with the obsolescence of legacy Ohio system components

Once again, the end result would necessitate procuring more submarines (14) to provide the required at-sea presence and each of them would be less stealthy and less survivable against foreseeable 21st century threats.

The Right Answer: A new design SSBN that improves on Ohio: What has emerged from the Navy's exhaustive analysis is an Ohio replacement submarine that starts with the foundation of the proven performance of the Ohio SSBN, its Trident II D5 strategic weapons system and its operating cycle. To this it adds:

- Enhanced stealth as necessary to pace emerging threats expected over its service life
- Systems commonality with Virginia (pumps, valves, sonars, etc.) wherever possible, enabling cost savings in design, procurement, maintenance and logistics

Modular construction and use of COTS equipment consistent with those used in today's submarines to reduce the cost of fabrication, maintenance and modernization. Total ownership cost reduction (for example, investing in a life-of-the-ship reactor core enables providing the same at-sea presence with fewer platforms). Although the Ohio replacement is a "new design," it is in effect an SSBN that takes the best lessons from 50 years of undersea deterrence, from the Ohio, from the Virginia, from advances in shipbuilding efficiency and maintenance, and from the stern realities of needing to provide survivable nuclear deterrence. The result is a low-risk, cost-effective platform capable of smoothly transitioning from the Ohio and delivering effective 21st century undersea strategic deterrence.⁹²

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⁹² "Facts We Can Agree Upon About Design of Ohio Replacement SSBN," Navy Live, accessed July 3, 2013, at <http://navylive.dodlive.mil/2013/06/26/facts-we-can-agree-upon-about-design-of-ohio-replacement-ssbn/>.

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