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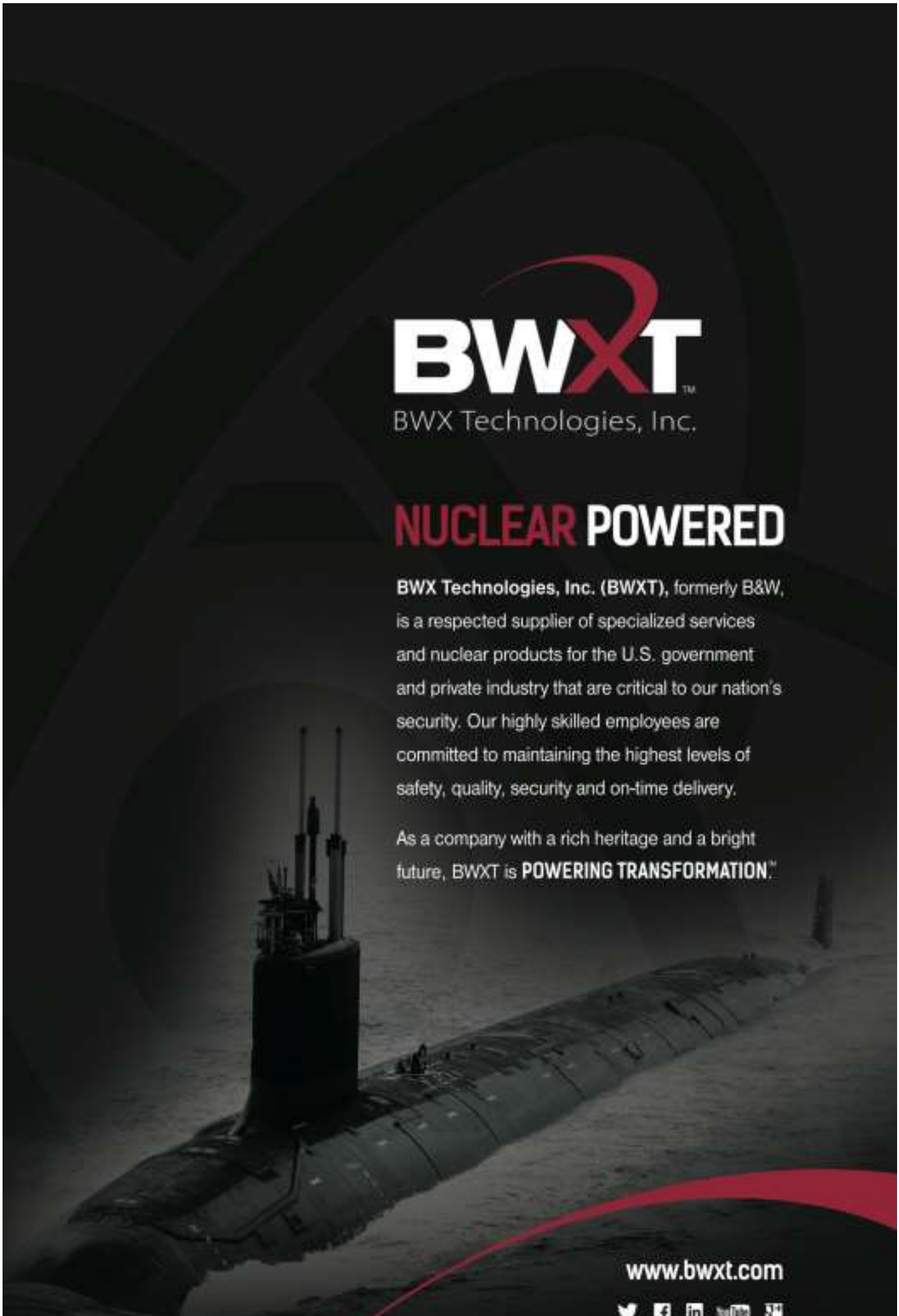
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EDITOR'S COMMENTS

It is not a usual practice to have an obvious *theme* treated across several articles in one issue, but if any issue of this magazine can be said to have a *theme,* the OHIO Replacement Program is certainly the issue addressed here. Excerpts from two current reports to Congress from the Congressional Research Service provide an objective overall summary from both shipbuilding and weaponeering aspects. Funding options for the OHIO Replacement Program are discussed in the shipbuilding report but there is not yet a final decision.

The general subject of U.S. Naval Force Structure is becoming a matter of concern as the cost of the OHIO Replacement Program, and its high priority, would seem to some as claiming an outsize share of the Shipbuilding budget. Accordingly, two of the lead Features address that *general purpose* naval force structure and its importance. One, Game Changers, outlines all which can be done with a *general purpose* Undersea Warfare force. The other addresses the question of overall size for the U.S. Navy. A third lead Feature, by Mr. Joe Buff, summarizes the current state of world unrest as a *cold war-like* set of threats to U.S. national security.

That's the *theme*, ORP with Nuclear Deterrence along with the place of the Navy in our near-future world. All taken from current writings and observations.

To keynote that *theme* we start this issue with two addresses given at the Submarine Forces Change of Command in September at Norfolk. Admiral Cecil Haney, Commander of U.S. Strategic Command spoke in celebration of Vice Admiral Mike Connor's "spectacular career" and welcomed Vice Admiral Joe Tofalo to the U.S. Strategic Command. In doing so he noted "…the importance and the significance of submarine operations around the globe…".

Vice Admiral Tofalo graciously thanked his seniors and mentors, and stated that his Commander's Intent will preserve the fundamental direction from previous guidance. He noted that

"This consistency and continuity should make it clear that we as a Force are on the right track…" He then went on to particularize the primary lines of effort to carry out that guidance. He closed his remarks with the direct statement of intent: "In short we must continue to own the undersea domain."

The two reports from the Congressional Research Service to Congress are excerpted here to provide the basic background, history and current status on the programs being reported. The reports themselves are a good bit longer and contain many more details, including references. It is recommended those who work on, or intend to comment on, these submarine programs keep the entire reports close as a desk reference. They are available for downloading on the Congressional Research Service web page.

Even as excerpts these two reports read together implicitly tell the story of national need for this weapons system for the uncertain future. That need is not explicitly articulated in these two reports but it can be inferred here that there is no obvious credible alternative. The ball is in our submarine community court.

Jim Hay
Editor

FROM THE PRESIDENT

Approaching the end of what has been a dynamic and, from time to time, tumultuous year, there is room for optimism, but also caution, as we venture into 2016.

The Department of Defense, the Navy, and, in particular, the Submarine Force, have met the myriad challenges that have arisen with focus of purpose, competence in execution, high standards of performance and absolute professionalism. They have excelled responding to complex and varying demands supporting United States Combatant Commanders around the world. This superior performance reflects a military that is well led, well trained, well maintained and able to respond to Overseas Contingencies as they arise.

The US Submarine Force has been particularly effective in meeting these diverse and demanding contingencies, ensuring undersea dominance in every maritime theater and providing continuous strategic deterrence, the cornerstone of our nation's defense.

Our Submarine Force leadership has maintained a steady focus on time honored standards of operational and technical excellence, providing "set and drift" adjustments to sustain well defined goals and priorities in the execution of Submarine Force responsibilities. In December 2015, VADM Tofalo, RADM Roegge, and RADM Richard promulgated the "Commander's Intent for the United States Submarine Force and Supporting Organizations" which reinforced and crystalized earlier guidance regarding the way ahead for our submariners. This document clearly states the mission, purpose, concept of operations and lines of effort necessary for the Submarine Force to respond successfully to the challenges that await. And they will. The guidance is clear, the standards are clear, and the expectations are clear. The Submarine Force will respond as they have in the past, and they will excel.

Attack and Strategic submarines operate around the world, executing diverse and demanding missions with operational skill and tactical innovation. Within a challenging fiscal environment,

they provide exceptional value to the nation's defense while demonstrating the importance of a continued investment in high quality maintenance and modernization, rigorous training, and tactical innovation. The Submarine Force modernization investment strategy maintains operational parity throughout the Force and the performance of our submarines and their crews has been uniformly superior.

Looking to the future, the OHIO Replacement Program is the Navy's top priority acquisition program, executing its engineering and design schedule to support the retirement of the OHIO Class submarines, sustaining United States strategic supremacy into the late 21st Century.

The VIRGINIA Class Submarine Program remains the standard within the Department of Defense for efficient program execution, with the construction shipyards delivering two ships per year, under cost and ahead of schedule. USS JOHN WARNER (SSN 785) was commissioned in August 2015, with Senator Warner overseeing the event, and USS ILLINOIS (SSN 786) was christened by First Lady Michelle Obama in October 2015.

The VIRGINIA Class Submarine Program keeps our construction shipyards fully engaged and optimally employed, while the design efforts supporting the OHIO Replacement and VIRGINIA Payload Module Programs energize and inform our submarine design, submarine construction, and submarine industrial base initiatives.

Looking ahead, the challenges are great and opportunities abound. As a result of demonstrated superior performance, the Submarine Force enjoys strong Congressional support and is valued within the Department of Defense and by our Combatant Commanders. The Submarine Force leadership is focused and fully engaged to ensure that Undersea Dominance remains a Submarine Force core value as we support our allies and engage our adversaries around the world.

The Submarine Force leadership will join us throughout 2016 to share their insight and provide their perspective during the meeting of Corporate Members in March, during the Submarine Technology Symposium in May, and during the Annual

Symposium in October. I look forward to seeing you there. Please check the NSL website for specific information.

Your Naval Submarine League works hard to provide value to our membership and we encourage constructive feedback to ensure the website and other services provided meet your needs.

I am privileged to work with the dedicated professionals who support the Naval Submarine League and I encourage you to recommend membership to your shipmates and friends.

Finally, as always, please keep our nation's service members in your prayers as they defend our freedom and I wish you all a Happy New Year.

John B. Padgett III
President

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COMMANDER, SUBMARINE FORCES CHANGE OF COMMAND

COMSUBFOR CHANGE OF COMMAND
ADMIRAL CECIL D. HANEY
NORFOLK, VIRGINIA
9/11/2015

Distinguished guests, fellow flag and general officers, ladies and gentlemen, family and friends, men and women of the Submarine Force—Good morning.

It's truly an honor to be back here on the Norfolk waterfront celebrating with Vice Admiral Mike and Kate Connor as they end a spectacular career, spanning 36 years of dedicated and faithful service to our nation; and also welcoming Vice Admiral Joe and Suzanne Tofalo to the U.S. Strategic Command family.

This extraordinarily large crowd is a powerful statement, not only about our Sailors we are honoring today, but also about the importance and the significance of submarine operations around the globe, as part of our nation's strategic deterrence forces, in support of our National Security and National Military Strategies.

So it's great to see you all here, particularly the family members, also those who have journeyed from many parts of our country as well as from other parts of the world; and the number of active duty and retired flag officers and general officers here is truly impressive. I won't list all the names, but to know that there is like, active and retired, six four-star admirals here and just the number of three stars, etc.; pretty impressive all-star line-up.

I also want to salute our submarine veterans that are out there, and all that you do and the legacy we ride upon. And for all the Sailors and our civilian workforce who operate, maintain, and provide security for our submarines, that are represented so vividly here by this great vessel, the USS NEWPORT NEWS.

Well, today is an important day for many reasons. We will observe the change of command from one exceptional leader to another. We will recognize Mike's accomplishments, honor a

lifetime of service, and express our heartfelt appreciation to the Connor family for their many contributions to our joint military force.

Our nation is blessed to have leaders like Mike and Joe here leading our Navy.

To the Tofalo family – Suzanne, and daughters Nicole and Maria – welcome to the U.S. Strategic Command family, and I want to thank you for the continued support of your dad and husband's career including this very demanding job he is about to undertake.

Joe…you are joining the team at a critical time, but given your credentials and your deep understanding of the challenges and opportunities we face, I can't think of a better leader postured to lead the submarine force and TF 144.

Given your most impressive resume, I look forward to your strategic thinking and critical thought; especially important given this uncertain and dynamically changing world we live in.

So I am especially challenged today to attempt to pay appropriate respect to Mike in the short timeframe provided. So, let me start with his undergraduate days at Bowdoin College, located in Maine, which Mike describes as a liberal arts school.

You see, during his interview for the nuclear propulsion program, Admiral Hyman G. Rickover questioned Mike's choice of a liberal arts college.

Now Mike had to spend some quality time in his interview there in what we called *the closet*, to think about his answer. But Mike came out of that closet swinging and told the great Admiral Hyman G. Rickover that he would do just fine if accepted into the program; being that he was, of course, a Physics major.

So Bowdoin College not only provided Mike that great education and foundation, but more importantly, Mike met his lovely bride, Kate, in an electronics-engineering lab there, I'm told. Sounds to me like there were some special sparks going on in that lab or what we like to term, in nuclear reactor physics, as *binding energy*, for they've now been married for some 34 years.

I think all who serve would agree that we could not do our mission without the constant and reassuring support from our

loved ones.

Kate – Bonny often reminds me about the sacrifices endured by our military families, and I can assure you I don't take that for granted.

Not only did you juggle your career as a Physician's Assistant and Medical School Professor, you also raised three wonderful and intelligent daughters—it's evident from your award that you were also involved in and around our military communities, especially in support of our Sailors and their families.

I can't thank you enough for what you have done, for your continued support of Mike, and your family, as well as your extended Navy family.

Elizabeth, Christina, and Marie—while I am sure you have fond memories from your Navy experiences, it is not lost on me that it's not easy growing up as a military family—leaving behind the familiar for the unknown, and knowing that as important as it was, your dad's service and the deployments meant that he could not always be with you.

I know your dad is extremely proud of each of you, University of Virginia graduates, and how you adapted and always found opportunities to excel:

• Marie—an aspiring chef – maybe I will get to sample some of your lovely cuisine my next time in New York City.

• Christina—working for Google in Manhattan; perhaps I will be asking you for a job when I retire.

• And Elizabeth—in residency to become an OB-GYN/Oncologist while also a mom to six-month-old Sloan, as was mentioned; Mike and Kate's granddaughter. Now as a second-time grandfather, I'm happy to share a few stories there too.

Similarly, I know you, too, are proud of your dad; who answered our nation's call, juggling a demanding career, and made our country safer – not only for you, but for generations to come.

Mike, as I look back I am reminded of how different the strategic landscape was when you graduated from college to what we see today—just a few, short decades later.

In the early 80's, what did we have? The Soviets had invaded Afghanistan; our nation was dealing with the failed Iranian

hostage crisis; we had the '83 Beirut bombings; we responded to turmoil in Grenada with Operation Urgent Fury; and a Korean Airliner was shot down by the Soviets.

Mike, this was just within your first three years of service.

Along with these crises, the Cold War persisted, putting the world on edge as many wondered what the Soviet Union would do next.

While the sense of crisis eased a bit after the Berlin Wall came down in 1989, our submarine strategic forces continued to *silently* maintain their important role of deterring adversaries and assuring Allies, as they had for almost 30 years, as the new security environment evolved.

Fast forward here—then came 9/11—the day that will forever change how we view peace and freedom, and the democratic values we hold so dear.

While our national attention was rightly focused on these emerging and asymmetric terrorist threats, Mike not only worked to address those threats, but at the same time, he did not lose sight of the strategic environment and remained acutely aware of the seriousness that other nation states, such as Russia, China and North Korea posed, as they began modernizing their nuclear weapons capability, developing and demonstrating mobile strategic platforms, and investing in counter-space and cyber-space technologies.

As a submarine Prospective Commanding Officer Instructor (during) 9/11, Mike taught future Commanding Officer's about the criticality of our undersea domain and our strategic deterrent force—and many also went on to commands that contributed to our counter-terrorism campaigns.

Clearly, Mike has seen a tectonic shift in the landscape in the course of his 36 years.

He has dedicated his career not only to leading the men and women of our all-volunteer force, especially the all-volunteer submarine force, but to also improving our submarine capabilities that allow us to respond to these hotspots of activity and uncertainty around the globe.

Under his astute leadership, the Submarine Force as a whole

has undergone enormous change and improvement:

- He sustained operational excellence with an unparalleled emphasis on safe operations;
- He modernized the force through the installation of the common submarine radio room and universal tactical fire control system; and
- He increased the ballistic missile submarine operational availability – an important endeavor, given that our Ohio-class SSBN submarines will be operating for an unprecedented 42 years – six years longer than the USS KAMEHAMEHA – previously our longest operating submarine.

You know, I saw KAMEHAMEHA before she was decommissioned, and I can tell you, she required a lot of care and attention in those final days—further highlighting the importance of maintaining 14 Ohio-class SSBNs to continue meeting my strategic requirements; for which Mike has been a staunch advocate.

As the Ohio-class submarines continue to mature, we must be mindful that they will be harder to maintain, and increasingly will require more heroic efforts from our Sailors, and our maintenance personnel, and the industrial base that supports them to keep them operating.

There is no margin left to delay replacing the Ohio-class submarines. Even in this fiscally constrained environment, our nation must invest in its replacement.

Our nuclear deterrent capabilities, including the survivable at-sea leg—the SSBN—is needed to ensure that any nation that thinks they can escalate their way out of a failed conflict, understands that restraint is a better option.

I commend the work not just of Mike and Joe, but that of the community at large, what they've done to get the Ohio Replacement Program on track.

Beyond the hardware, Mike's thoughtful leadership approach has been essential to spearheading the Nuclear Enterprise

improvement programs by sharing best practices, lessons learned, and working behind the scenes with other key leaders, especially my Air Force nuclear task force commanders.

While Mike has served on five submarines as a crewmember including his favorite tour as Commanding Officer of USS SEAWOLF, I believe his legacy will continue in the people he has trained, the forward leaning technology and solutions he's worked on, and his stalwart advocacy for our submarine programs.

I am certain that he will be remembered also, as a TV celebrity. Perhaps some of you saw him in his starring role in the recent PBS documentary, entitled "How many ballistic missile submarines does the U.S. Navy really need." If you didn't see it, I'm told you can see it on YouTube, so Google it, and I hope you'll watch it.

I am extremely proud of how he represented U.S. Strategic Command's deterrence and assurance mission, making it clear, in that presentation, that we use our nuclear weapons every day to deter major power war—something we have done successfully over the last 70 years.

Kate, Elizabeth, Christina, and Marie, I hope that Admiral Davidson's and my words, and from the award citation you will hear momentarily—that you understand that your husband and your dad has made a mark on history.

I realize we use a lot of *military speak*, but I'm mindful that it isn't always as meaningful for those of you who don't live with those terms every day.

So simply put, he made a difference. He made a difference not only in the operations and management of our Submarine Forces, but in our most important and vital resource—our people.

His down-to-earth leadership style, his always professional manner, his ability to mentor, made a lasting impression on everyone he met.

Mike—if I could sum up your career using an analogy from a sports team I know you admire, I would put it like this:

Your career can be modeled after *Big Papi* from the Boston Red Sox—a man who conquered the Green Wall repeatedly, hitting some 498 home runs and counting.

Your career, Mike, has been homerun after home run, and has been inspirational to all of us in the submarine community.

I am confident that Admiral Hyman G. Rickover would be proud he selected you for the Naval Nuclear Propulsion Program.

No matter your assignment—whether commanding the submarine USS SEAWOLF, or commanding Submarine Group 7, or Director for Submarine Warfare, or in your current role—you made analytical and tangible changes to improve every aspect of our force, from our crews to the hardware; and I couldn't agree more with CNO Greenert's assessment that you are leaving the Submarine Force in a much better condition than you found it.

Your legacy as a brilliant strategist, an operator and a mentor will guide those left behind who now have the watch.

Congratulations on a remarkable career—and thank you for your more than 36 years of loyal service to our country, conducted with honor, courage and commitment.

While you will be sorely missed, I am certain, though, that you will find ways to continue serving our country.

In the meantime, given your roots in the New England area and the *other love* in your life, your fishing boat——*The Katie J*— it is no surprise that you are heading for Mystic, Connecticut, for some well-deserved rest.

I hope you get to do more of the things you and Kate enjoy, including spending some time with your daughters and grandbaby, and I look forward to hearing some updates about your future endeavors.

I would like to leave you with a quote—by Bill Belichick, the New England Patriots coach, with whom I am sure many in the audience are familiar. It's very fitting for this family, given our passion for New England sports. And the results of last night's football game. The quote goes like this:

"There is an old saying about the strength of the wolf is the pack…On a football team, it's not the strength of the individual players, but it's the strength of the unit and how they all function together."

Just like the Connor family has shown us. As a family, you are representative of the sacrifices and demands of our joint

military families, and what it takes to allow our service members not only to serve, but to excel.

How about a round of applause for this special family, and their service and support to our nation.

As much as I would like to stay longer on this beautiful water-front, it's time for me to get off this stage. So I want to thank you all for being here this morning.

Mike, I wish you and Kate fair winds and following seas.

May God continue to bless these leaders, our Navy, and a grateful nation, the United States of America.

COMSUBFOR CHANGE OF COMMAND
VADM JOSEPH TOFALO, USN
NORFOLK, VA
9/11/15

Good morning! What a thrill for Suzanne and I to be back here in Norfolk. I can't believe it's been over 20 years since we first reported here as XO of USS MONTPELIER. With seven tours in the Norfolk area since then, it's so great to be back here again and see many old friends, both from Norfolk and numerous other duty stations over the years. For Admirals Greenert, Richardson, Connor and Hill, my four closest mentors, I recognize full well that this day would not be possible for me without your support. Thank you for leadership over the years, and for allowing Suzanne and me this tremendous opportunity to continue to serve—we are humbled…and we're ready to hit the decks running. Admiral Haney and Admiral Caldwell, thank you for your presence here today, and for your guidance to me over the years as well. Both of you epitomize both selfless silent service, and steadfast leadership of the Silent Service.

Admiral Davidson, thank you for your very kind words. Admiral Davidson and I first met in 1979 as Naval Academy 6th Company mates, and next-door neighbors in Bancroft Hall for two years. We've both come a long way boss, and I look forward to working for you and being neighbors again.

Admiral Connor, please accept my most heartfelt thanks to both you and Kate. Not only for your hospitality these past two weeks and for a fantastic turnover, but more importantly for your unequalled leadership and tireless service over your 36 year career. From your visionary Undersea Dominance Campaign Plan, to your forceful leadership of the Undersea Rapid Capability Initiatives, to the continued successful integration of women in submarines, and the overall outstanding performance of the greatest Submarine Force on the planet, all of us owe both of you a tremendous debt of gratitude. It has been an absolute honor to

work for you, and I will endeavor to build upon your outstanding legacy here.

Admiral Roegge, Admiral Richard, and myself, will be issuing a joint Commander's Intent document. It will integrate and update several previous Force guidance documents but you will find that the fundamental direction from that previous guidance is preserved. This consistency and continuity should make it clear that we as a Force are on the right track—our foundation is solid, our traditions reinforce the right attributes, and we have much to be proud of. This is less of a *course change*, but rather some *small rudder* to keep us in the middle of the channel as we face changes in set and drift.

The situation we face presents us with challenges in at least three world regions, each of which places substantially different operational demands on the Force. The future will also have increased emphasis on competitions short of war, requiring non-traditional special capabilities that are non-kinetic and non-lethal. The situation we face does not require these special capabilities instead of our traditional warfighting skills—it requires them in addition to our traditional warfighting skills. Consistent with our history as a maritime nation, the responsibility to prevent challengers from using the sea to threaten their regions will fall predominantly on the United States Navy. As anti-access/area denial systems proliferate, the share of the Navy's responsibility that falls on U.S. submarine and undersea forces will only grow.

To address this situation, our primary lines-of-efforts remain:

Provide Ready Forces, Employ the Force effectively, and Develop Future Capabilities, with all three of these built upon the Foundation of our Strength—our undersea warriors, confident experts of the highest character, and their families.

Some of the issues and initiatives, associated with the situation we face and these lines-of-effort, that will have my utmost attention include:

- The changing landscape and emerging challenges in Europe, the Pacific, and the Middle East, go directly to how we prepare our forces to be ready, and abso-

lutely requires their efficient employment. This must be built upon a foundation of operational safety and our continued pursuit of Force Improvement.

- We must continue to maximize SSBN operational availability as we execute the Nuclear Deterrence Enterprise Review's initiative to restore and maintain acceptable margin. With the extension of the OHIO Class submarines to 42 years, we've got to ensure that the only survivable leg of the nation's nuclear triad stays on patrol until the OHIO Replacement comes on line in 2031.
- We must smoothly standup and mature the Undersea Warfighting Development Center, which opened its doors just last week—there is much to do to ensure we get this right,
- The continued successful integration of women in submarines, including the introduction of enlisted women who just started their training pipeline this past month.
- From a *Future Capabilities* standpoint, the 25,000 men and women of the Submarine Force should recognize this as an incredibly exciting time to be a part of this fantastic team.
- OHIO Replacement, which will carry 70% of our nation's accountable nuclear warheads and be on patrol through the 2080s, is on track, and just had its requirements package approved by the Joint Staff.
- VIRGINIA Class two-per-year construction rate is in full swing, with both NORTH DAKOTA and JOHN WARNER commissioned in the last 11 months, both ahead of schedule, under budget, and with constantly improving quality.
- Both OHIO Replacement and VIRGINIA are centerpieces of our desired end state to *own the best*.
- The VIRGINIA Payload Module has been pulled to a 2019 start, and it is literally the doorway to an exciting

future of new kinetic and nonkinetic payloads that will ensure we *grow longer arms*, *beat the adversary's system*, and both *defend our strategic assets…and threaten theirs*.

- The Submarine Force is setting the standard for working to *get faster*, and is leading the charge in innovation with things like the Undersea Rapid Capabilities Initiatives and the Theater ASW Offset Strategy initiatives, which must successfully standup starting in 2016.
- We're forging new ground in the area of acoustic superiority with new sensors, coatings, and quieting techniques.
- And in the area of Heavyweight Torpedoes, in addition to the restart initiative that is now tangibly getting traction, it's been decades since there has been as much activity on the future of the Heavyweight Torpedo as there is today.

Again, all extremely exciting, and words cannot describe the pride and energy I get from being a part of it. Having been in on the ground floor in the development of the Undersea Dominance Campaign Plan and the Undersea Rapid Capability Initiatives, I assure you I remain firmly committed to their core initiatives.

In short we must continue to own the undersea domain. Undersea forces operate far forward, are persistent and covert. Our non-provocative influence can deter and de-escalate potential conflicts by providing cross-domain intelligence, real-time warning to U.S. leadership, and rapid transition from peacetime if required. We are the anti-A2AD force, operating inside adversary defenses, using our access to set the table for the joint force, exercising stealth and surprise at the time and place of choosing. I am deeply committed to this vision, and I am deeply committed to the tireless pursuit of undersea superiority.

Thank you.

REPORTS TO CONGRESS REGARDING OHIO REPLACEMENT

NAVY OHIO REPLACEMENT (SSBN[X]) BALLISTIC MISSILE SUBMARINE PROGRAM: BACKGROUND AND ISSUES FOR CONGRESS (Excerpts)

By Ronald O'Rourke
Specialist in Naval Affairs
Congressional Research Service
November 9, 2015

Summary

The Navy's proposed FY2016 budget requests $1,390.7 million for continued research and development work 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 Ohio Replacement Program is also known as the SSBN(X) program. The Navy wants to procure the first Ohio Replacement Boat in FY2021, with advance procurement (AP) funding starting in FY2017. The Navy has identified the Ohio replacement program as its top priority program.

A March 2015 GAO report assessing selected major DOD weapon acquisition programs states that the estimated total acquisition cost of the SSBN(X) 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 estimates 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 oversight issues for Congress for the Ohio replacement program include the following:

- the likelihood that the Navy will be able to reduce the 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);
- the prospective affordability of the Ohio replacement program and its potential impact on funding available for other Navy shipbuilding programs; and
- the question of which shipyard or shipyards will build SSBN(X)s.

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 Amy F. Woolf, discusses the SSBN(X) as an element of future U.S. strategic nuclear forces in the context of strategic nuclear arms control agreements.

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). The SSNs and SSGNs are multi-mission ships that perform a variety of peacetime and wartime missions. They do not carry nuclear weapons.

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. 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*, 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." 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."

Current Ohio-Class SSBNs

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

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 eight 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, 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.

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."

Summary of U.S. SSBN Designs

The Navy has operated four classes of SSBNs since 1959. Table 1 compares the current Ohio- class SSBN design to the three earlier U.S. SSBN designs. 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. 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 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	18/41
Fiscal years procured	FY 1958-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

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. 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. The Navy testified in 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."

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.

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 "'Initial Gate'—a decision to move ahead with early stages of the work involved—will be approved and the next phase of the project will start by the end of [2010]. 'Main Gate'—the decision to start building the submarines—is required around 2016." The first new boat is to be delivered by 2028, or about four years later than previously planned.

The UK has wanted the Successor SSBNs to carry D-5 SLBMs, and for any successor to the D-5 SLBM to be compatible with, or be capable of being made compatible with, the D-5 launch system. President George W. Bush, in a December 2006 letter to UK Prime Minister Tony Blair, invited the UK to participate in any program to replace the D-5 SLBMs, and stated that any successor to the D-5 system should be compatible with, or be capable of being made compatible with, the launch system for the D-5 SLBM.

The United States is assisting the UK with certain aspects of the Successor SSBN program. In addition to the modular Common Missile Compartment (CMC) discussed below (see "Common Missile Compartment (CMC)" in the following section on the Ohio replacement program), the United States is assisting the UK with the new PWR-3 reactor plant 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." 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 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.

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."

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. 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). 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 SBSD was developed in early 2008 and approved by DOD's Joint Requirements Oversight Committee (JROC) on June 20, 2008. 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. The Navy established an Ohio Replacement Program office at about this same time.

The AOA reportedly began in the summer or fall of 2008. 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. The AOA concluded that a new-design SSBN was the best option for replacing the Ohio-class SSBNs. 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.

Planned Procurement Quantity: 12 SSBN(X)s to Replace 14 Ohio-Class Boats

Navy plans call for procuring 12 SSBN(X)s to replace the current force of 14 Ohio-class SSBNs. In explaining the planned procurement quantity of 12 boats, the Navy states that 10 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. The Navy states that a force of 14 Ohio-class boats was 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. The Navy states that 12 rather than 14 SSBN(X)s will be needed to meet the requirement for 10 operational boats because the mid-life

overhauls of SSBN(X)s, 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), the result being that only two SSBN(X)s (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.

Procurement and Replacement Schedule

Table 2 shows the Navy's proposed schedule for procuring 12 SSBN(X)s, and for having SSBN(X)s replace Ohio-class SSBNs. As shown in **Table 2**, 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 2**, 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. (See also the discussion above in "Planned Procurement Quantity: 12 SSBN(X)s to Replace 14 Ohio-Class Boats.")

The minimum level of 10 boats shown in **Table 2** 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 Virginia-class attack submarines during the period FY2022-FY2025.

Table 2. Navy Schedule for Procuring SSBN(X)s and Replacing Ohio-Class SSBNs

Schedule in FY2012 Budget					Schedule Under Subsequent Budgets			
Fiscal Year	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: Navy FY2012-FY2015 budget submissions.

SSBN(X) Design Features

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

- The SSBN(X) is to be designed for a 42-year expected service life.
- Unlike the Ohio-class design, which requires a mid-life nuclear refueling, 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). 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 40-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.
- 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) of 43 feet, compared to 42 feet on the Ohio-class design, and a length of 560 feet, the same as that of the Ohio- class design.
- Instead of 24 SLBM launch tubes, as on the Ohio-class design, the SSBN(X) is to have 16 SLBM launch tubes.
- 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.
- The Navy states that "owing to the unique demands of strategic relevance, [SSBN(X)s] must be fitted with the most up-to-date capabilities and stealth to ensure they are survivable throughout their full 40-year life span."

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-diamater hull, electric-drive propulsion, [an] X-stern, accommodations for 155 personnel, and a common submarine radio room tailored to the SSBN mission."

Acquisition Cost

A March 2015 GAO report assessing selected major DOD weapon acquisition programs states that the estimated total acquisition cost of the SSBN(X) 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.

The Navy as of February 2015 estimates 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 February 2010 preliminarily estimated the procurement cost of each Ohio replacement boat at $6 billion to $7 billion in FY2010 dollars. Following the Ohio replacement program's December 9, 2010, Milestone A acquisition review meeting (see "Program Origin and Early Milestones"), 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. 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. 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.

Common Missile Compartment (CMC)

Current U.S. and UK plans call for the SSBN(X) and the UK's Successor SSBN to use a missile compartment—the middle section of the boat with the SLBM launch tubes—of the same general design. As mentioned earlier (see "U.S.-UK Cooperation on SLBMs"), the UK's SSBN is to be armed with eight SLBMs, or half the number to be carried by the SSBN(X). The modular design of the CMC will accommodate this difference. 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. This is the principal reason why the FY2010 budget included a substantial amount of research and development funding for the CMC. The UK is providing some of the funding for the design of the CMC, including a large portion of the initial funding.

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 Corpora-

tion 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.

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.

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."

Under the October 2010 UK defense and security review report (see "U.S.-UK Cooperation on SLBMs"), the UK now plans to deliver its first Successor class SSBN in 2028, or about four years later than previously planned.

Program Funding

Table 3 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 FY2016 budget requests $1,390.7 million for continued research and development work on the program.

Table 3. Ohio Replacement Program Funding
(Millions of then-year dollars, rounded to nearest tenth; totals may not add due to rounding)

	FY 15	FY 16 (req.)	FY17 (proj.)	FY 18 (proj.)	FY19 (proj.)	FY20 (proj.)
Research and development (R&D) funding						
PEO603570N/Project 3219	370.0	419.3	408.1	398.7	289.0	276.7
PEO603595N/Project 3220	816.8	971.4	712.4	766.5	484.9	206.0
PEO603595N/Project 3237	36.5	0	0	0	0	0
Subtotal R&D funding	1,223.3	1,390.7	1,120.5	1,165.2	773.9	482.7
Military Construction (MilCon) funding	24.3	0	0	0	0	0
Procurement funding	0	0	777.8	791.8	2,771.3	1,316.3
TOTAL	1,247.6	1,390.7	1,898.3	1,957.0	1,547.8	965.4

Source: Navy FY2016 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 SSBN(X) reactor plant project within the PE for Advanced Nuclear Power Systems. PE0603561N/Project 3220 is Sea-Based Strategic Deterrent (SBSD) Advanced Submarine System Development project within the PE for Ohio Replacement. PE0603595N/Project 3237 is Launch Test Facility project within the PE for Ohio Replacement. Military Construction (MilCon) funding for FY2015 is for an Ohio replacement program launch test facility (MilCon/0805376N) ($23.985 million) and Ohio Replacement Power and Propulsion Facility (MilCon/0901211N, design funds) ($0.364 million). Procurement funding shown in FY2017 through FY2020 is advance procurement funding for first SSBN(X), which is scheduled to be procured in FY2021.

Issues for Congress

Likelihood That Navy Will Reach $4.9 Billion Target Cost

One potential oversight 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 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."

Potential oversight questions include the following:

- How did DOD settle on the figure of $4.9 billion in FY2010 dollars as the target average unit procurement cost for boats 2 through 12 in the program? On what analysis was the selection of this figure based?
- How difficult will it be for the Navy to reach this target cost? What options is the Navy examining to achieve the additional $300 million or so in unit procurement cost savings needed to reach it?
- Would a boat costing $4.9 billion have sufficient capability to perform its intended missions?
- What, if anything, does DOD plan to do if the Navy is unable to achieve the $4.9 billion target cost figure? If $4.9 billion is the target figure, is there a corresponding "ceiling" figure higher than $4.9 billion, above which DOD would not permit the Ohio replacement program to proceed? If no such figure exists, should DOD establish one?

Accuracy of Navy's Estimated Unit Procurement Cost
Overview

Another potential oversight issue for Congress concerns the accuracy of the Navy's estimate of the procurement cost of each SSBN(X). 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 SSBN(X) procurement. Some of the Navy's ship designs in recent years, such as the GERALD R. FORD (CVN-78) class aircraft carrier, the SAN ANTONIO (LPD-17) class amphibious ship and the Littoral Combat Ship (LCS), have proven to be substantially more expensive to build than the Navy originally estimated.

The accuracy of the Navy's estimate 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 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, which shipyard or shipyards will build the boats, and how much Virginia-class construction will be taking place in the years when SSBN(X)s are being built. Changing the Navy's assumption about which shipyard or shipyards will build SSBN(X)s could reduce or

increase the Navy's estimated unit procurement cost for the boats. 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 SSBN(X)s more expensive to build than the Navy estimates.

October 2015 CBO Report

An October 2015 Congressional Budget Office (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 pro-

vides 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.

Program Affordability and Impact on Other Navy Shipbuilding Programs

Overview

Another oversight 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.

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 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].

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." Navy officials since then have reiterated this statement.

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.

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

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.

National Sea-Based Deterrence Fund

Fund Created by Section 1022 of P.L. 113-291

Congress, as part of its markup of the Navy's proposed FY2015 budget, created the National Sea- Based Deterrence Fund (NDBDF), a fund in the DOD budget that will be separate from the Navy's regular shipbuilding account (which is formally known as the Shipbuilding and Conversion, Navy, or SCN, appropriation account). The NSBDF was created by 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), which states:

A. SEC. 1022. NATIONAL SEA-BASED
B. DETERRENCE FUND. (a) Establishment of Fund.—
(1) In general.—Chapter 131 of title 10, United States Code, is amended by inserting after section 2218 the following new section:
C. "Sec. 2218a. National Sea-Based Deterrence Fund
D. "(a) Establishment.—There is established in the Treasury of the United States a fund to be known as the 'National Sea-Based Deterrence Fund'.
E. "(b) Administration of Fund.—The Secretary of Defense shall administer the Fund consistent with the provisions of this section.
F. "(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.
G. "(2) Funds in the Fund may not be used for a purpose or program unless the purpose or program is authorized by law.
H. "(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.
I. "(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.
J. "(f) 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.

K. "(g) 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."

(2) Clerical amendment.—The table of sections at the beginning of chapter 131 of such title is amended by inserting after the item relating to section 2218 the following new item:

"2218a. National Sea-Based Deterrence Fund."

(b) Transfer Authority.—

(1) In general.—Subject to paragraph (2), and to the extent provided in appropriations Acts, the Secretary of Defense may transfer to the National Sea-Based Deterrence Fund established by section 2218a of title 10, United States Code, as added by subsection (a)(1), amounts not to exceed $3,500,000,000 from unobligated funds authorized to be appropriated for fiscal years 2014, 2015, or 2016 for the Navy for the Ohio Replacement Program. The transfer authority provided under this paragraph is in addition to any other transfer authority provided to the Secretary of Defense by law.

(2) Availability.—Funds transferred to the National Sea-Based Deterrence Fund pursuant to paragraph (1) shall remain available for the same period for which the transferred funds were originally appropriated.

Precedents for Funding Navy Acquisition Programs Outside Navy Appropriation Accounts

Prior to the above legislation, some observers had suggested funding the procurement of SSBN(X)s 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 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) ap-

propriation 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.

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.

The first potential implication concerns the impact the Ohio replacement program may have on funding available in coming years for other Navy programs, and particularly other Navy shipbuilding programs. A principal apparent intent in creating the NSBDF was 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 separate 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.

A second potential implication of the NSBDF for funding available in coming years for other DOD programs concerns how DOD might be able to use funds appropriated for the procurement of Ohio replacement boats and the effect this use of funds might have in marginally reducing the procurement cost of those boats.

As discussed in the CRS report on the Navy's TAO(X) oiler program, the National Defense Sealift Fund is located in a part of the DOD budget that is outside the procurement title of the annual DOD appropriations act. Consequently, ships whose construction is funded through the NDSF are not subject to the DOD full funding policy in the same way as are ships and other DOD procurement programs that are funded through the procurement title of the annual DOD appropriations act.

For NDSF-funded ships, what this has meant is that although Congress in a given year would nominally fund the construction of an individual ship of a certain class, the Navy in practice could allocate that amount across multiple ships in that class. This is what happened with both the NDSF-funded Lewis and Clark (TAKE-1) class dry cargo ships and, before that, an NDSF-funded class of DOD sealift ships called Large, Medium-Speed Roll-on/Roll-off (LMSR) ships. In both cases, the result was that

although ships in these two programs were each nominally fully funded in a single year, they in fact had their construction financed with funds from amounts that were nominally appropriated in other fiscal years for other ships in the class.

The Navy's ability to use NDSF funds in this manner has permitted the Navy to, among other things, marginally reduce the procurement cost of ships funded through the NDSF by batch-ordering certain components of multiple ships in a shipbuilding program before some of the ships in question were fully funded—something that the Navy cannot do with a shipbuilding program funded through the Navy's shipbuilding account unless the Navy receives approval from Congress to execute the program through a multiyear procurement (MYP) contract.

If the National Sea-Based Deterrence Fund is located outside the procurement title of the annual DOD appropriations act, the Navy might be able to do something somewhat similar in using funds appropriated for the procurement of Ohio replacement boats. If so, this might facilitate the partial batch-build construction strategy that the Navy may wish to employ as a cost-reducing measure for building the Ohio replacement boats (see discussion in next section), which in turn could marginally reduce the cost of the Ohio replacement boats, and thereby marginally increase the amount of funding that would remain available within a DOD budget of a certain size for other DOD programs.

Some Options for Further Addressing the Issue

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

- using a partial batch-building approach for building the Ohio replacement boats;
- using a joint block buy contract that would cover both the Ohio replacement program and the Virginia-class attack submarine program;

- altering the schedule for procuring the SSBN(X)s so as to create additional opportunities for using incremental funding for procuring the ships; and
- reducing the planned number of SSBN(X)s.

Each of these options is discussed below.

Partial Batch-Build Approach for Building Ohio Replacement Boats

As one means of 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 2**, but aspects of their construction would be undertaken in batch fashion rather than serial fashion. Implementing a partial batch-building approach for building the boats might be facilitated by

- using a multiyear procurement (MYP) contract whose built-in Economic Order Quantity (EOQ) authority might be expanded to cover not just batch-ordering of selected long leadtime components, but also batch-building of sections of the ships; or
- using a block buy contract that included an added EOQ authority of similar scope; or
- locating the National Sea-Based Deterrence Fund outside the procurement title of the DOD appropriations act and using funds in that account for the construction of Ohio replacement boats in a manner somewhat similar to how the Navy has used funds in the National Defense Sealift Fund to batch-order components for ships acquired through the NDSF (see discussion in previous section).

Joint Block Buy Contract Covering Both Ohio Replacement and Virginia-Class Programs

To help reduce ship procurement costs, the Navy in recent years has made extensive use of multiyear procurement (MYP) contracts and block buy contracts in its shipbuilding programs, including the Virginia class attack submarine program. In light of this, the Navy will likely seek to use block buy and/or MYP contracting in the Ohio replacement program. Beyond that, the Navy is investigating the possibility of using a single, joint-class block buy contract that would cover both Ohio replacement boats and Virginia class boats. Such a contract, which could be viewed as precedent-setting in its scope, could offer savings beyond what would be possible using separate MYP or block buy 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. 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.

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 SSBN(X)s and make greater use of split funding (i.e., two-year incremental funding) in procuring them. 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. 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 SSBN(X)s with three- or four-year incremental funding.

Table 4 shows the Navy's currently planned schedule for procuring 12 SSBN(X)s and a notional alternative schedule that would start two years earlier and end two years later than the Navy's currently planned schedule. Although the initial ship in the alternative schedule would be procured in FY2019, it could be executed as it if 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. 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.

Table 4. 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			1	X
2020				
2021	I	X	I	X
2022				
2023			I	X
2024	I	X		
2025			I	X
2026	1			
2027	I		I	
2028	I		I	
2029	I		I	
2030	I		I	
2031	I		I	X
2032	I			
2033	I	X	I	X
2034	I	X		
2035	I	X	I	X
2036				
2037			I	X
TOTAL	**12**		**12**	

Source: Navy's current plan is taken from the Navy's FY 2015 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.

A December 19, 2011, press report states:

> The Office of Management and Budget's Nov. 29[, 2011,] passback memorandum to the Defense Department [regarding the FY2013 DOD budget] warns that the effort to build replacements for aging Ohio-class submarines is not exempt from rules requiring each new vessel to be fully funded in a single year....
>
> Spreading the cost of a big-ticket ship over more than one year—an approach referred to as "incremental funding"—is only allowed when a program meets three criteria, OMB writes....
>
> "OMB does not anticipate that the OHIO Replacement program will meet these criteria," the passback memo states.

Reducing the Planned Number of SSBN(X)s

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. Earlier CBO reports have presented options for reducing the SSBN force to 10 boats as a cost-reduction measure. 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; a September 2010 report from the Cato Institute recommends reducing the SSBN force to 6 boats, and a September 2013 report from a group organized by the Stimson Center recommends reducing the force to 10 boats.

Views on whether a force of fewer than 12 SSBN(X)s 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. 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.

U.S. strategic nuclear deterrence plans require a certain number of strategic nuclear warheads to be available for use on a day-to-day basis. After taking into account warheads on the other two legs of the strategic nuclear triad, the number of warheads on an SSBN's SLBMs, and factors independent of the number of warheads on the SLBMs, this translates into a requirement for a certain number of SSBNs to be on station (i.e., within range of expected targets) in Pacific and Atlantic waters at any given moment. The SSBN force is sized to support this requirement. Given the time needed for at-sea training operations, restocking SSBNs with food and other consumables, performing maintenance and repair work on the SSBNs, and transiting to and from deterrent patrol areas, only a fraction of the SSBN force can be on patrol at any given moment. The Navy's position (see "Planned Procurement Quantity: 12 SSBN(X)s to Replace 14 Ohio- Class Boats" in "Background") is that the requirement for having a certain number of SSBNs on patrol at any given moment 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 SSBN(X)s.

Construction Shipyard(s)

Another potential issue for Congress regarding the Ohio replacement program is which shipyard or shipyards would build SSBN(X)s. Two U.S. shipyards are capable of building nuclear-powered submarines—General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI, and Newport News

Shipbuilding (NNS), of Newport News, VA, which forms part of Huntington Ingalls Industries (HII). GD/EB's primary business is building nuclear-powered submarines; it can also perform submarine overhaul work. NNS's primary lines of business are building nuclear-powered aircraft carriers, building nuclear-powered submarines, and performing overhaul work on nuclear-powered aircraft carriers. The Navy reportedly plans to finalize its acquisition strategy for the Ohio replacement program,

including the issue of which shipyard or shipyards will build the boats, in the fall of 2016 as part of DOD's Milestone B decision for the program.

Table 5 shows the numbers of SSBNs built over time by GD/EB, NNS, and two government- operated naval shipyards (NSYs)—Mare Island NSY, located in the San Francisco Bay area, and Portsmouth NSY of Portsmouth, NH, and Kittery, ME. Mare Island NSY is no longer in operation. NSYs have not built new Navy ships since the early 1970s; since that time, they have focused solely on overhauling and repairing Navy ships.

Table 5. Construction Shipyards of U.S. SSBNs

	George Washington (SSBN-598) class	Ethan Allen (SSBN-608) class	Lafayette/Benjamin Franklin (SSBN-616/640) class	Ohio (SSBN-726) class
Fiscal years procured	FY58-FY59	FY59 and FY61	FY61-FY64	FY77-FY91
Number built by GD/EB	2	2	13	18
Number built by NNS	1	3	10	
Number built by Mare Island NSY	1		6	
Number built by Portsmouth NSY	1		2	
Total number in class	**5**	**5**	**31**	**18**

Source: Prepared by CRS based on data in Norman Polmar, The Ships and Aircraft of the U.S. Fleet, Annapolis, Naval Institute Press, various editions. NSY means naval shipyard.

Notes: GD/EB was the builder of the first boat in all four SSBN classes. The George Washington-class boats were procured as modifications of SSNs that were already under construction. A total of 18 Ohio-class SSBNs were built; the first four were converted into SSGNs in 2002-2008, leaving 14 in service as SSBNs.

As can be seen in the table, the Ohio-class boats were all built by GD/EB, and the three previous SSBN classes were built partly by GD/EB, and partly by NNS. GD/EB was the builder of the first boat in all four SSBN classes. The most recent SSBNs built by NNS were the George C. Marshall (SSBN-654) and George Washington Carver (SSBN-656), which were Lafayette/Benjamin Franklin-class boats that were procured in FY1964 and entered service in 1966.

There are at least five basic possibilities for building SSBN(X)s:

- **build all SSBN(X)s at GD/EB**—the approach that was used for building the Ohio-class SSBNs;
- **build all SSBN(X)s at NNS**;
- **build some SSBN(X)s GD/EB and some at NNS**—the approach that was used for building the George Washington-, Ethan Allen-, and Lafayette/Benjamin Franklin-class SSBNs;
- **build each SSBN(X) jointly at GD/EB and NNS**, **with final assembly of the boats alternating between the yards**—the approach currently being used for building Virginia-class SSNs; and
- **build each SSBN(X) jointly at GD/EB and NNS, with one yard—either GD/EB or NNS—performing final assembly on every boat.**

In assessing these five approaches, policymakers may consider a number of factors, including their potential costs, their potential impacts on employment levels at GD/EB and NNS, and the relative value of preserving SSBN-unique construction skills (such as those relating to the construction and installation of SLBM compartments) at one shipyard or two. The relative costs of these five approaches could depend on a number of factors, including the following:

- each yard's share of SSBN(X) production work (if both yards are involved);

- the number of SSNs procured during the years of SSBN(X) procurement (which
- can affect economies of scale in submarine production);
- whether the current joint-production arrangement for the Virginia class remains in effect during those years; and
- the volume of non-submarine-construction work performed at the two shipyards during these years, which would include in particular aircraft carrier construction and overhaul work at NNS.

At a July 30, 2015, hearing before the Senate Armed Services Committee on the nomination of Admiral John Richardson for the position of Chief of Naval Operations (CNO), Richardson stated, "We're conducting a study right now to both mature the design and mature the build plan [for the Ohio replacement program]. We should get that completed by the fall timeframe, and I look forward to collaborating when we have that more mature." (Richardson was confirmed by the Senate on August 5, 2015, and became the CNO on September 18, 2015.)

An October 5, 2015, press report states that

The Navy has yet to announce or sign off on its ORP acquisition strategy, and the shipyard that is expected to lead the effort, General Dynamics' Electric Boat, would like some decisions soon. Among the leading reasons, said the company's top shipbuilder, is the need to determine the right work

"We're within a year or so of needing to start, aside from what we already have started," said John Casey, GD's executive vice president for marine systems, which includes Electric Boat, the shipyard in Connecticut and Rhode Island that is expected to lead the ORP effort.

GD expects to spend more than $2 billion to ready its facilities to build the submarines, Casey said....

The shipbuilders can't move ahead, Casey said, until the Navy approves the work-sharing plan submitted in March by Electric Boat and Newport News.

"We do not have a commitment," Casey said. "Until we have the details of an estimate of what it takes to build a particular building or the equipment that goes in it," the work can't begin.

The Navy has said ORP will not replicate the 50-50 teaming arrangement used to build Virginia-class attack submarines....

With cost a major driving factor in the ORP production arrangement... it's expected that Electric Boat will oversee the design and assemble and complete all 12 ORP submarines. But Newport News will make a major contribution to the new submarines and, at the Navy's direction, the two shipyards got together last winter to hash out the details. Negotiations were tough, Casey said, but agreement was reached and the yards submitted their plan in March for approval.

But they're still waiting for the Navy's response....

Driving the sense of urgency, he said, is the need to have decisions in place before the middle of 2016, when a Milestone B decision on the program is due—a Pentagon review that decides if a program is ready to move into the engineering and manufacturing development phase.

"If the answer comes back, 'We do not like your recommendation. We want you to do something different,' then we have to start all over again," Casey said. "We have to evaluate what is most important to us. Newport News has to evaluate what is most important to them. We have to re-estimate the cost of the ship. We have to re-define what we think the schedules of the ship are.

"There is a lot of work to be done if the path we are on is disrupted. Frankly, we do not need any disruption. There is not any spare time in this program. We started a little late with the design as a result of the initial construction start being moved

about two years to the right. There is no room to be messing with this thing anymore in terms of schedule."

Discussions with the Navy continued throughout this summer, Casey said.
"There have been a number of meetings with the Navy. I am not sure we have answered all of their questions satisfactorily, frankly — they have not put them in a position of telling us what their position is," he said. "It is kind of tough to know for sure what concerns they specifically have.

"When there is a concern on an issue, I think it is important to understand what the source of that is, he said "We have seen nothing that I am aware of that would demonstrate that the recommendation we made is not the best recommendation available."...

The agreement hashed out between the companies, Casey said, provides for EB to undertake the larger share of the work, but also leaves a hefty portion for Newport News. Based on modular construction work, and not counting the hours needed to deliver, assemble and deliver each submarine, the work split is roughly 60 percent to 40 percent, he said.

"The estimates are not refined," Casey said, and "assume we do what that proposal says."

And, unlike the Virginia teaming arrangement, where illustrations and charts point to certain sections of each submarine denoting who builds what, the companies have decided not to talk about how the work is divided.

"We do have this agreement in place," Casey said. "We are not going to talk details of what this agreement says. But it plays out in pretty clear detail how the pieces and parts of the ship go together."

Experience from the Virginia program flowed into the proposed ORP build plan. "We tried to pick areas of the ship that were similar to areas that each person was already building for the most part," Casey said.

Casey pointed out that it's not just the two shipyards that need agreement on the ORP work plan. Britain has a significant interest, with a common Trident missile compartment designed for the SSBN(X) and the UK's Successor submarine program.

"I think of the 5,000 suppliers, along with the U.K. suppliers, that are necessary to execute a successful global strategic deterrent," Casey said. "I think the sooner we have alignment between the industrial base in the Navy, the better off we all will be."

A Capitol Hill source familiar with the issue agreed with much of what Casey had to say.

"The Navy agrees with 90 to 95 percent of this thing," the source said. "Issues have been raised about fees—prime versus subcontractor. The Navy is doing deep dives on what elements of the work split they can agree with, and which have questions."

In the absence of any public discussion of the submarine building plan, GD has been on the Hill in recent weeks briefing congressional delegations and staffers, the source said. According to the source, Newport News has not taken part in that process.

U.S. STRATEGIC NUCLEAR FORCES: BACKGROUND, DEVELOPMENTS, AND ISSUES (Excerpts)

By Amy F. Woolf
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Summary

Even though the United States plans to reduce the number of warheads deployed on its long range missiles and bombers, consistent with the terms of the New START Treaty, it also plans to develop new delivery systems for deployment over the next 20-30 years. The 114th Congress will continue to review these programs, and the funding requested for them, during the annual authorization and appropriations process.

During the Cold War, the U.S. nuclear arsenal contained many types of delivery vehicles for nuclear weapons. The longer-range systems, which included long-range missiles based on U.S. territory, long-range missiles based on submarines, and heavy bombers that could threaten Soviet targets from their bases in the United States, are known as strategic nuclear delivery vehicles. At the end of the Cold War, in 1991, the United States deployed more than 10,000 warheads on these delivery vehicles. That number has declined to less than 1,600 warheads today, and is slated to decline to 1,550 warheads by 2018, after the New START Treaty completes implementation.

At the present time, the U.S. land-based ballistic missile force (ICBMs) consists of 450 Minuteman III ICBMs, each deployed with one warhead. The fleet will decline to 400 deployed missiles, while retaining all 450 launchers, to meet the terms of the New START Treaty. The Air Force is also modernizing the Minuteman missiles, replacing and upgrading their rocket motors, guidance systems, and other components, so that they can remain in the force through 2030. It plans to replace the missiles with a new Ground-based Strategic Deterrent around 2030.

The U.S. ballistic missile submarine fleet currently consists of 14 Trident submarines; each carries 24 Trident II (D-5) missiles. The Navy converted 4 of the original 18 Trident submarines to carry non-nuclear cruise missiles. The remaining carry around 1,000 warheads in total; that number will decline as the United States implements the New START Treaty. The Navy has shifted the basing of the submarines, so that nine are deployed in the Pacific Ocean and five are in the Atlantic, to better cover targets in and around Asia. It also has undertaken efforts to extend the life of the missiles and warheads so that they and the submarines can remain in the fleet past 2020. It is designing a new submarine and will replace the existing fleet beginning in 2031.

The U.S. fleet of heavy bombers includes 20 B-2 bombers and 76 B-52 bombers. The B-1 bomber is no longer equipped for nuclear missions. The fleet will decline to around 60 aircraft in coming years, as the United States implements New START. The Air Force has also begun to retire the nuclear-armed cruise missiles carried by B-52 bombers, leaving only about half the B52 fleet equipped to carry nuclear weapons. The Air Force plans to procure both a new long-range bomber and a new cruise missile during the 2020s. DOE is also modifying and extending the life of the B61 bomb carried on B-2 bombers and fighter aircraft.

The Obama Administration completed a review of the size and structure of the U.S. nuclear force, and a review of U.S. nuclear employment policy, in June 2013. This review has advised the force structure that the United States will deploy under the New START Treaty. It is currently implementing the New START Treaty, with the reductions due to be completed by 2018. Congress will review the Administration's plans for U.S. strategic nuclear forces during the annual authorization and appropriations process, and as it assesses U.S. plans under New START and the costs of these plans in the current fiscal environment. This report will be updated as needed.

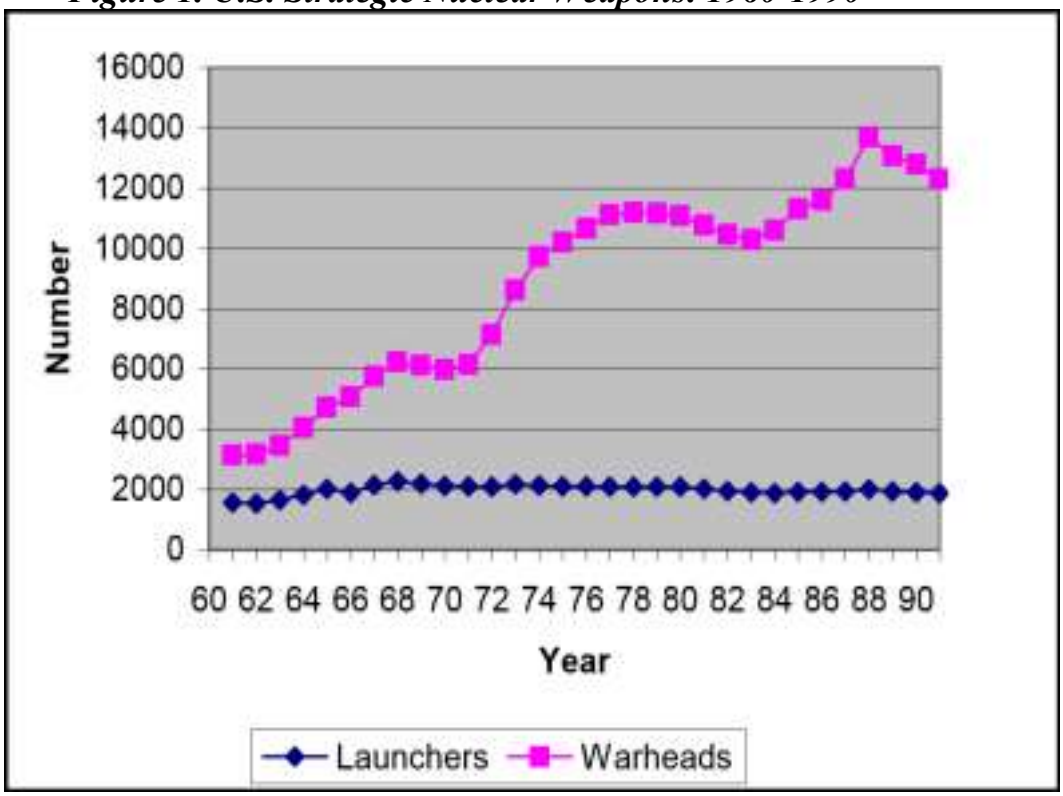
Background: The Strategic Triad

Force Structure and Size During the Cold War

Since the early 1960s the United States has maintained a *triad* of strategic nuclear delivery vehicles. The United States first developed these three types of nuclear delivery vehicles, in large part, because each of the military services wanted to play a role in the U.S. nuclear arsenal. However, during the 1960s and 1970s, analysts developed a more reasoned rationale for the nuclear *triad*. They argued that these different basing modes had complementary strengths and weaknesses. They would enhance deterrence and discourage a Soviet first strike because they complicated Soviet attack planning and ensured the survivability of a significant portion of the U.S. force in the event of a Soviet first strike. The different characteristics might also strengthen the credibility of U.S. targeting strategy. For example, ICBMs eventually had the accuracy and prompt responsiveness needed to attack hardened targets such as Soviet command posts and ICBM silos, SLBMs had the survivability needed to complicate Soviet efforts to launch a disarming first strike and to retaliate if such an attack were attempted, and heavy bombers could be dispersed quickly and launched to enhance their survivability, and they could be recalled to their bases if a crisis did not escalate into conflict.

According to unclassified estimates, the number of delivery vehicles (ICBMs, SLBMs, and nuclear-capable bombers) in the U.S. force structure grew steadily through the mid-1960s, with the greatest number of delivery vehicles, 2,268, deployed in 1967. The number then held relatively steady through 1990, at between 1,875 and 2,200 ICBMs, SLBMs, and heavy bombers. The number of warheads carried on these delivery vehicles increased sharply through 1975, then, after a brief pause, again rose sharply in the early 1980s, peaking at around 13,600 warheads in 1987. **Figure 1** displays the increases in delivery vehicles and warheads between 1960, when the United States first began to deploy ICBMs, and 1990, the year before the United States and Soviet Union signed the first Strategic Arms Reduction Treaty (START).

Figure 1. U.S. Strategic Nuclear Weapons: 1960-1990



Source: *Natural Resources Defense Council, Archive of Nuclear Data.*

The sharp increase in warheads in the early 1970s reflects the deployment of ICBMs and SLBMs with multiple warheads, known as MIRVs (multiple independent reentry vehicles). In particular, the United States began to deploy the Minuteman III ICBM, with 3 warheads on each missile, in 1970, and the Poseidon SLBM, which could carry 10 warheads on each missile, in 1971. The increase in warheads in the mid-1980s reflects the deployment of the Peacekeeper (MX) ICBM, which carried 10 warheads on each missile.

In 1990, before it concluded the START Treaty with the Soviet Union, the United States deployed a total of around 12,304 warheads on its ICBMs, SLBMs, and heavy bombers. The ICBM force consisted of single-warhead Minuteman II missiles, 3-warhead Minuteman III missiles, and 10-warhead Peacekeeper (MX) missiles, for a total force of 2,450 warheads on 1,000 missiles. The Submarine Force included Poseidon submarines with Poseidon C-3 and Trident I (C-4) missiles, and the Ohio-class

Trident submarines with Trident I, and some Trident II (D-5) missiles. The total force consisted of 5,216 warheads on around 600 missiles. The bomber force centered on 94 B-52H bombers and 96 B-1 bombers, along with many of the older B-52G bombers and 2 of the new (at the time) B-2 bombers. This force of 260 bombers could carry over 4,648 weapons.

Force Structure and Size After the Cold War

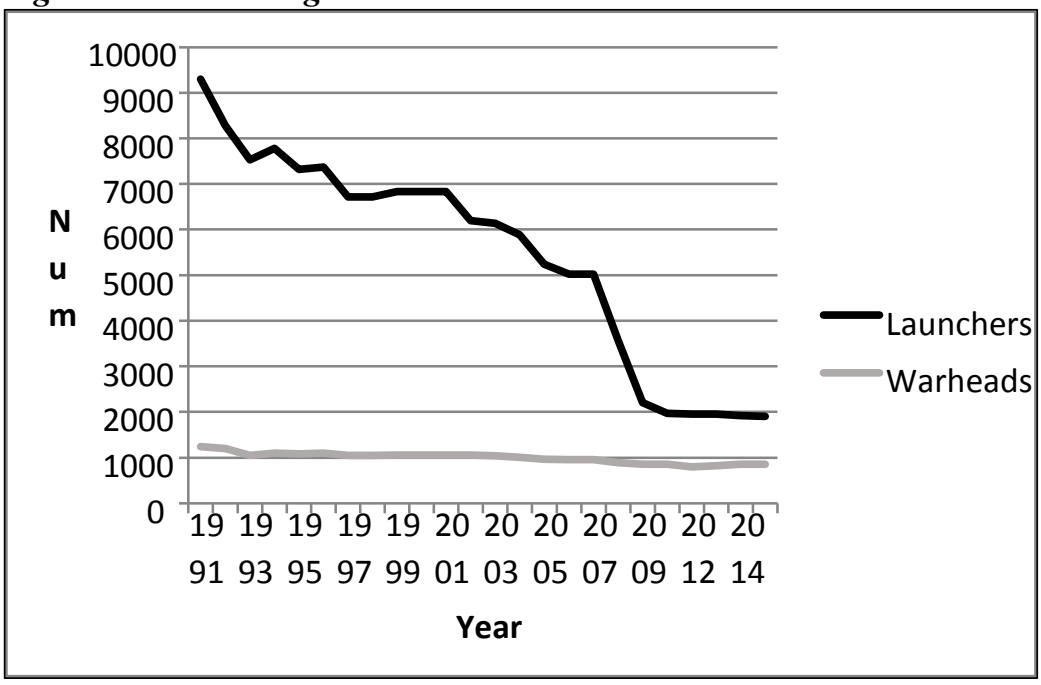
During the 1990s, the United States reduced the numbers and types of weapons in its strategic nuclear arsenal, both as a part of its modernization process and in response to the limits in the 1991 START Treaty. The United States continued to maintain a triad of strategic nuclear forces, however, with warheads deployed on ICBMs, SLBMs, and bombers. According to the Department of Defense, this mix of forces not only offered the United States a range of capabilities and flexibility in nuclear planning and complicated an adversary's attack planning, but also hedged against unexpected problems in any single delivery system. This latter issue became more of a concern in this time period, as the United States retired many of the different types of warheads and missiles that it had deployed over the years, reducing the redundancy in its force.

The 1991 START Treaty limited the United States to a maximum of 6,000 total warheads, and 4,900 warheads on ballistic missiles, deployed on up to 1,600 strategic offensive delivery vehicles. However, the treaty did not count the actual number of warheads deployed on each type of ballistic missile or bomber. Instead, it used *counting rules* to determine how many warheads would count against the treaty's limits. For ICBMs and SLBMs, this number usually equaled the actual number of warheads deployed on the missile. Bombers, however, used a different system. Bombers that were not equipped to carry air-launched cruise missiles (the B-1 and B-2 bombers) counted as one warhead; bombers equipped to carry air-launched cruise missiles (B-52 bombers) could carry 20 missiles, but would only count as 10 warheads against the treaty limits. These rules have led to differing estimates of the numbers of warheads on U.S. strategic

nuclear forces during the 1990s; some estimates count only those warheads that count against the treaty while others count all the warheads that could be carried by the deployed delivery systems.

According to the data from the Natural Resources Defense Council, the United States reduced its nuclear weapons from 9,300 warheads on 1,239 delivery vehicles in 1991 to 6,196 warheads on 1,064 delivery vehicles when it completed the implementation of START in 2001. By 2009, the United States had reduced its forces to approximately 2,200 warheads on around 850 delivery vehicles. According to the State Department, as of December 2009, the United States had 1,968 operationally deployed warheads on its strategic offensive nuclear forces. NRDC estimated that these numbers held steady in 2010, prior to New START's entry into force, then began to decline again, falling to around 1,900 warheads on around 850 delivery vehicles by early 2015, as the United States began to implement New START (this total includes weapons that the State Department does not count in the New START force). These numbers appear in **Figure 2**.

Figure 2. U.S. Strategic Nuclear Forces: 1991-2015



Source: *Natural Resources Defense Council, Archive of Nuclear Data, Bulletin of Atomic Scientists, Nuclear Notebook.*

During the 1990s, the United States continued to add to its Trident fleet, reaching a total of 18 submarines. It retired all of its remaining Poseidon submarines and all of the single-warhead Minuteman II missiles. It continued to deploy B-2 bombers, reaching a total of 21, and removed some of the older B-52G bombers from the nuclear fleet. Consequently, in 2001, its warheads were deployed on 18 Trident submarines with 24 missiles on each submarine and 6 or 8 warheads on each missile; 500 Minuteman III ICBMs, with up to 3 warheads on each missile; 50 Peacekeeper (MX) missiles, with 10 warheads on each missile; 94 B-52H bombers, with up to 20 cruise missiles on each bomber; and 21 B-2 bombers with up to 16 bombs on each aircraft.

The United States and Russia signed a second START Treaty in early 1993. Under this treaty, the United States would have had to reduce its strategic offensive nuclear weapons to between 3,000 and 3,500 accountable warheads. In 1994, the Department of Defense decided that, to meet this limit, it would deploy a force of 500 Minuteman III ICBMs with 1 warhead on each missile, 14 Trident submarines with 24 missiles on each submarine and 5 warheads on each missile, 76 B-52 bombers, and 21 B-2 bombers. The Air Force was to eliminate 50 Peacekeeper ICBMs and reorient the B-1 bombers to non-nuclear missions; the Navy would retire 4 Trident submarines (it later decided to convert these submarines to carry conventional weapons).

The START II Treaty never entered into force, and Congress prevented the Clinton Administration from reducing U.S. forces unilaterally to START II limits. Nevertheless, the Navy and Air Force continued to plan for the forces described above, and eventually implemented those changes. **Table 1** displays the forces the United States had deployed in 2001, after completing the START I reductions. It also includes those that it would have deployed under START II, in accordance with the 1994 decisions.

Table 1. U.S. Strategic Nuclear Forces Under START I and START II

	Deployed under START I (2001)		Planned for START II	
System	**Launchers**	**Accountable Warheads[a]**	**Launchers**	**Accountable Warheads**
Minuteman III ICBMs	500	1,200	500	500
Peacekeeper ICBMs	50	500	0	0
Trident I Missiles	168	1,008	0	0
Trident II Missiles	264	2,112	336	1,680
B-52 H Bombers (ALCM)	97	970	76	940
B-52 H Bombers (nonALCM)	47	47	0	0
B-1 Bombers[b]	90	90	0	0
B-2 Bombers	20	20	21	336
Total	**1,237**	**5,948**	**933**	**3,456**

Source: *U.S. State Department and CRS estimates.*

a. Under START I, bombers that are not equipped to carry ALCMs count as one warhead, even if they can carry up 16 nuclear bombs; bombers that are equipped to carry ALCMs count as 10 warheads, even if they can carry up to 20 ALCMs.

b. Although they still counted under START I, B-1 bombers are no longer equipped for nuclear missions.

The George W. Bush Administration stated in late 2001 that the United States would reduce its strategic nuclear forces to 1,700-2,200 *operationally deployed warheads* over the next decade. This goal was codified in the 2002 Moscow Treaty. According to the Bush Administration, operationally deployed warheads were those deployed on missiles and stored near bombers on a day-to-day basis. They are the warheads that would be available immediately, or in a matter of days, to meet *immediate and unexpected contingencies*. The Administration also indicated that the United States would retain a triad of ICBMs,

SLBMs, and heavy bombers for the foreseeable future. It did not, however, offer a rationale for this traditional "triad," although the points raised in the past about the differing and complementary capabilities of the systems probably still pertain. Admiral James Ellis, the former Commander of the U.S. Strategic Command (STRATCOM), highlighted this when he noted in a 2005 interview that the ICBM force provides responsiveness, the SLBM force provides survivability, and bombers provide flexibility and recall capability.

The Bush Administration did not specify how it would reduce the U.S. arsenal from around 6,000 warheads to the lower level of 2,200 operationally deployed warheads, although it did identify some force structure changes that would account for part of the reductions. Specifically, after Congress removed its restrictions, the United States eliminated the 50 Peacekeeper ICBMs, reducing by 500 the total number of operationally deployed ICBM warheads. It also continued with plans to remove four Trident submarines from service, and converted those ships to carry non-nuclear guided missiles. These submarines would have counted as 476 warheads under the START Treaty's rules. These changes reduced U.S. forces to around 5,000 warheads on 950 delivery vehicles in 2006; this reduction appears in **Figure 2**. The Bush Administration also noted that two of the Trident submarines remaining in the fleet would be in overhaul at any given time. The warheads that could be carried on those submarines would not count against the Moscow Treaty limits because they would not be *operationally deployed*. This would further reduce the U.S. deployed force by 200 to 400 warheads.

The Bush Administration, through the 2005 Strategic Capabilities Assessment and 2006 Quadrennial Defense Review, announced additional changes in U.S. ICBMs, SLBMs, and bomber forces; these included the elimination of 50 Minuteman III missiles and several hundred air-launched cruise missiles. (These are discussed in more detail below.) These changes appeared to be sufficient to reduce the number of operationally deployed warheads enough to meet the treaty limit of 2,200 warheads, as the United States announced, in mid-2009, that it had met this limit.

Reaching this level, however, also depends on the number of warheads carried by each of the remaining Trident and Minuteman missiles.

Current and Future Force Structure and Size

The Obama Administration indicated in the 2010 NPR that the United States will retain a triad of ICBMs, SLBMs, and heavy bombers as the United States reduces its forces to the limits in the 2010 New START Treaty. The NPR indicated that the unique characteristics of each leg of the triad were important to the goal of maintaining strategic stability at reduced numbers of warheads:

> Each leg of the Triad has advantages that warrant retaining all three legs at this stage of reductions. Strategic nuclear submarines (SSBNs) and the SLBMs they carry represent the most survivable leg of the U.S. nuclear Triad…. Single-warhead ICBMs contribute to stability, and like SLBMs are not vulnerable to air defenses. Unlike ICBMs and SLBMs, bombers can be visibly deployed forward, as a signal in crisis to strengthen deterrence of potential adversaries and assurance of allies and partners.

Moreover, the NPR noted that "retaining sufficient force structure in each leg to allow the ability to hedge effectively by shifting weight from one Triad leg to another if necessary due to unexpected technological problems or operational vulnerabilities."

The Administration continues to support the triad, even as reduces U.S. nuclear forces under New START and considers whether to reduce U.S. nuclear forces further in the coming years. In April 2013, Madelyn Creedon, then the Assistant Secretary of Defense for Global Security Affairs, stated, "The 2010 nuclear posture review concluded that the United States will maintain a triad of ICBMs, SLBMs, and nuclear capable heavy bombers. And the president's F.Y. '14 budget request supports modernization of these nuclear forces." Further, in its report on the Nuclear Employment Strategy of the United States, released in June 2013, DOD states that the United States will maintain a nuclear triad,

because this is the best way to "maintain strategic stability at reasonable cost, while hedging against potential technical problems or vulnerabilities."

On April 8, 2014, the Obama Administration released a report detailing the force structure that the United States would deploy under New START. It indicated that, although the reductions would be complete by the treaty deadline of February 5, 2018, most of the reductions would come late in the treaty implementation period so that the plans could change, if necessary. **Table 2** displays this force structure and compares it with estimates of U.S. operational strategic nuclear forces in 2010. This force structure is consistent with the statements and adjustments the Administration has made about deploying all Minuteman III missiles with a single warhead, retaining Trident submarines deployed in two oceans, and converting some number of heavy bombers to conventional-only missions.

Table 2. U.S. Strategic Nuclear Forces under New START
(Estimated Current Forces and Potential New START Forces)

Estimated Forces, 2010			**Planned forces Under new START, 2018[a]**		
	Launchers	**Warheads**	**Total Launchers**	**Deployed Launchers**	**Warheads**
Minuteman III	450	500	454	400	400
Trident	336	1,152	280	240	1,090
B-52	76	300	46	42	42
B-2	18	200	20	18	18
Total	**880**	**2,152**	**800**	**700**	**1,550**

Source: *U.S. Department of Defense, Report on Plan to Implement the Nuclear Force Reductions, Limitations, and Verification, Washington, DC, April 8, 2014.*

a. Under this force the United States will retain 14 Trident submarines with 2 in overhaul. In accordance with the terms of New START, the United States will eliminate 4 launchers on each submarine, so that each counts as only 20 launchers. The United States will also retain all 450 Minuteman III launchers, although only 400 would hold deployed missiles.

Submarine Launched Ballistic Missiles

The U.S. fleet of ballistic missile submarines consists of 14 Trident (Ohio-class) submarines, each equipped to carry 24 Trident missiles. With 2 submarines in overhaul, the operational fleet of 12 submarines currently carries around 1,100 warheads. Under the New START Treaty, each of the submarines will be modified so that they can carry only 20 missiles. The four empty launch tubes will be modified so that they cannot launch missiles; this will remove them from accountability under New START. As a result, the 14 submarines will count as a total of 280 deployed and non-deployed launchers, with 240 deployed launchers counting on the 12 operational submarines. The Navy plans to begin the process of reducing the number of launchers on each submarine in FY2015.

By the early 1990s, the United States had completed the deployment of 18 Trident ballistic missile submarines (SSBNs). Each of these submarines was equipped to carry 24 Trident missiles, and each missile could carry up to 8 warheads (either W-76 warheads or the larger W-88 warheads on the Trident II missile). The Navy initially deployed eight of these submarines at Bangor, WA, and all eight were equipped with the older Trident I missile. It then deployed 10 submarines, all equipped with the Trident II missile, at Kings Bay, GA. During the 1994 Nuclear Posture Review, the Clinton Administration decided that the United States would reduce the size of its Trident fleet to 14 submarines, and that 4 of the older submarines would be *backfit* to carry the Trident II missile.

The Bush Administration's 2001 Nuclear Posture Review endorsed the plan to backfit four of the Trident submarines so that all would carry Trident II missiles. It also indicated that, instead of retiring the remaining four submarines, the Navy would convert them to carry conventional weapons, and designated them "guided missile" submarines (SSGNs). The 2010 NPR also endorsed a force of 14 Trident submarines, although it noted that it might reduce that force to 12 submarines in the latter half of this decade. As was noted above, each submarine will deploy with only 20 missiles to meet the reductions in New START. As a result, the

U.S. ballistic missile submarine (SSBN) force may continue to consist of 14 Trident submarines, with 2 in overhaul, through New START implementation.

The SSGN Program

The Navy converted four Trident submarines (the USS OHIO, USS MICHIGAN, USS FLORIDA, and USS GEORGIA) to carry conventional cruise missiles and other conventional weapons. Reports indicate that the conversion process took approximately $1 billion and two years for each of the four submarines. The SSGNs can each carry 154 Tomahawk cruise missiles, along with up to 100 special forces troops and their mini-submarines.

The first two submarines scheduled for this conversion were removed from the nuclear fleet in early 2003. They were slated to receive their engineering overhaul, then to begin the conversion process in 2004. The first to complete the process, the USS OHIO returned to service as an SSGN in January 2006 and achieved operational status on November 1, 2007. According to the Navy, the GEORGIA was scheduled for deployment in March 2008, and the other submarines were scheduled to reach that status later in the year. According to Admiral Stephen Johnson, the Director of the Navy's Strategic Submarine Program (SSP), all four of the submarines had returned to service by mid-2008, and two were forward-deployed on routine patrols. According to the Navy, these submarines are likely to remain in service through the mid-2020s.

The Backfit Program

As was noted above, both the 1994 and 2001 Nuclear Posture Reviews confirmed that the Navy would backfit four Trident submarines so that they could carry the newer Trident II (D-5) missile. This process not only allowed the Navy to replace the aging C-4 missiles, it also equipped the fleet with a missile that has improved accuracy and a larger payload. With its greater range, it would allow the submarines to operate in a larger area and cover a greater range of targets. These characteristics were valued when the system was designed and the United States sought to enhance its ability to deter the Soviet Union. The Bush

Administration believed that the range, payload, and flexibility of the Trident submarines and D-5 missiles remained relevant in an era when the United States may seek to deter or defeat a wider range of adversaries. The Obama Administration has emphasized that, by providing the United States with a secure second strike capability, these submarines enhance strategic stability.

Four of the eight Trident submarines based in Bangor, WA (USS ALASKA, USS NEVADA, USS HENRY M. JACKSON, and USS ALABAMA) were a part of the backfit program. The ALASKA and NEVADA both began the process in 2001; the ALASKA completed its backfit and rejoined the fleet in March 2002 and the NEVADA did the same in August 2002. During the process, the submarines underwent a pre-planned engineered refueling overhaul, which accomplishes a number of maintenance objectives, including refueling of the reactor, repairing and upgrading some equipment, replacing obsolete equipment, repairing or upgrading the ballistic missile systems, and other minor alterations. The submarines also are fit with the Trident II missiles and the operating systems that are unique to these missiles. According to the Navy, both of these efforts came in ahead of schedule and under budget. The HENRY M. JACKSON and ALABAMA were completed their engineering overhaul and backfit in FY2006 and reentered the fleet in 2007 and 2008.

The last of the Trident I (C-4) missiles was removed from the fleet in October 2004, when the USS ALABAMA off-loaded its missiles and began the overhaul and backfit process. All the Trident submarines currently in the U.S. fleet now carry the Trident II missile.

Basing Changes

When the Navy first decided, in the mid-1990s, to maintain a Trident fleet with 14 submarines, it planned to *balance* the fleet by deploying 7 Trident submarines at each of the 2 Trident bases. The Navy would have transferred three submarines from Kings Bay to Bangor, after four of the submarines from Bangor were removed from the ballistic missile fleet, for a balance of seven submarines at each base. However, these plans changed after the Bush

Administration's Nuclear Posture Review. The Navy has transferred five submarines to Bangor, *balancing* the fleet by basing nine submarines at Bangor and five submarines at Kings Bay. Because two submarines would be in overhaul at any given time, this basing plan means that seven submarines would be operational at Bangor and five would be operational at Kings Bay. According to unclassified reports, the Navy began moving Trident submarines from Kings Bay to Bangor in 2002, and transferred the fifth submarine in September 2005. This change in basing pattern apparently reflected changes in the international security environment, with fewer targets within range of submarines operating in the Atlantic, and a greater number of targets within range of submarines operating in the Pacific. In particular, the shift allows the United States to improve its coverage of targets in China and North Korea. Further, as the United States modifies its nuclear targeting objectives it could alter the patrol routes for the submarines operating in both oceans, so that a greater number of emerging targets would be within range of the submarines in a short amount of time.

Warhead Loadings

The Trident II (D-5) missiles can be equipped to carry up to eight warheads each. Under the terms of the original START Treaty, which was in force from 1994 to 2009, the United States could remove warheads from Trident missiles, and reduce the number listed in the database, a process known as downloading, to comply with the treaty's limit of 6,000 warheads. The United States took advantage of this provision, reducing to six warheads per missile on the eight Trident submarines based at Bangor, WA. During the George W. Bush Administration, the Navy further reduced the number of warheads on the Trident submarines so that the United States could reduce its forces to the 2,200 deployed warheads permitted under the 2002 Moscow Treaty. The United States did not have to reach this limit until 2012, but it had done so by 2009.

The United States may continue to reduce the total numbers of warheads carried on its Trident missiles under the New START

Treaty. Unlike START, which attributed the same number of warheads to each missile of a given type, regardless of whether some of the missiles carried fewer warheads, the United States can deploy different numbers of warheads on different missiles, and count only the actual warheads deployed on the force. This will allow each missile to be tailored to meet the mission assigned to that missile. The United States does not need to indicate how many warheads are deployed on each missile at all times; it must simply report the total number of operationally deployed warheads on all of its strategic nuclear delivery vehicles. The parties will, however, have opportunities to confirm that actual number on a specific missile, with random, short-notice inspections. Moreover, the United States will not have to alter the platforms in the missiles, so it could restore warheads to its Trident missiles if circumstances changed.

Modernization Plans and Programs

The Navy initially planned to keep Trident submarines in service for 30 years, but then extended that time period to 42 years. This extension reflects the judgment that ballistic missiles submarines would have operated with less demanding missions than attack submarines, and could, therefore, be expected to have a much longer operating life than the expected 30-year life of attack submarines. Therefore, since 1998, the Navy has assumed that each Trident submarine would have an expected operating lifetime of at least 42 years, with two 20-year operating cycles separated by a 2-year refueling overhaul. With this schedule, the submarines will begin to retire from the fleet in 2027. The Navy has also pursued a number of programs to ensure that it has enough missiles to support this extended life for the submarines.

Trident Missile Production and Life Extension

The Navy purchased 437 Trident II (D-5) missiles through FY2008, and planned to purchase an additional 24 missiles per year through FY2012, for a total force of 533 missiles. It continued to produce rocket motors, at a rate of around one per month, and to procure alternation kits (known as SPALTs) needed

to meet the extended service life of the submarine. Although the Navy plans to deploy its submarines with only 240 ballistic missiles under New START, it needs the greater number of missiles to support the fleet throughout the their life-cycle. In addition, around 50 of the Trident missiles are available for use by Great Britain in its Trident submarines. The remainder would support the missile's test program throughout the life of the Trident system.

The Navy is also pursuing a life extension program for the Trident II missiles, so that they will remain capable and reliable throughout the 42-year life of the Trident submarines. As a result, the funding for the Trident II missile supported the purchase of additional solid rocket motors other critical components required to support the missile throughout its service life.

The Navy allocated $5.5 billion to the Trident II missile program in FY2008 and FY2009. This funding supported the purchase of an additional 36 Trident II missiles. The Navy spent $1.05 billion on Trident II modifications in FY2010 and requested $1.1 billion in FY2011. In FY2010, $294 million was allocated to the purchase of 24 new missiles, $154.4 million was allocated to missile support costs, and $597.7 million was allocated to the Trident II Life Extension program. In FY2011, the Navy requested $294.9 million for the purchase of 24 new missiles, $156.9 million to missile support costs, and $655.4 million to the Trident II Life Extension Program. The FY2012 budget included $1.3 billion for Trident II missile program. Within this total, $191 million was allocated to the purchase of 24 additional new missiles, $137.8 million was allocated to missile support costs, and $980 million was allocated to the Trident II Life Extension Program. This was the last year during which the Navy sought to purchase new Trident II missiles. The FY2013 budget requested $1.2 billion for the Trident II missile program. This total included $524 million for program production and support costs, and $700.5 million for the Trident II life extension program. The Navy requested $1.14 billion for this program area in FY2014. According to the Navy's budget documents, this allowed it to continue to purchase components, such as the alteration kits for the guidance and

missile electronics systems and solid rocket motors for these missiles. It requested $1.17 billion for FY2015 and an additional $1.1 billion for FY2016. According to DOD budget documents, the Navy plans to spend $5.8 billion on Trident II modifications through 2020.

W76 Warhead Life Extension

The overwhelming majority of Trident missiles are deployed with the MK4/W76 warhead, which, according to unclassified estimates, has a yield of 100 kilotons. It is currently undergoing a life extension program (LEP) that is designed to enhance its capabilities. According to some reports, the Navy had initially planned to apply this program to around 25% of the W76 warheads, but has increased that plan to cover more than 60% of the stockpile. According to recent estimates, the Department of energy has delivered more than half of the planned units of the new W76 warheads, and will complete production in 2019. The LEP is intended to add 30 years to the warhead life "by refurbishing the nuclear explosive package, the arming, firing, and fusing system, the gas transfer system, and associated cables, elastomers, valves, pads, cushions, foam supports, telemetries, and other miscellaneous parts." The FY2016 budget request for the Department of Energy includes $244 million for the W76 LEP.

Several questions came up during the life extension program. For example, some weapons experts questioned whether the warhead's design is reliable enough to ensure that the warheads will explode at its intended yield. In addition, in June 2006, an inspector general's report from the Department of Energy questioned the management practices at the National Nuclear Security Administration (NNSA), which is responsible for the LEP, arguing that management problems had led to delays and created cost overruns in the program. This raised questions about whether NNSA would be able to meet the September 2007 delivery date for the warhead, and, when combined with other technical issues, delayed the delivery of the first W76 warhead until August 2008. The Navy accepted the first refurbished warhead into the stockpile in August 2009.

W88 ALT 370 Program

While most Trident II missiles carry W76 warheads, a portion of the fleet carries the W88 warhead. This warhead, the last to be added to the U.S. nuclear stockpile, entered the force in the late 1980s. According to DOE, this warhead is also in need of work to address concerns with its safety and reliability. In particular, according to recent testimony, the W88 warhead is in the "development engineering phase for Alteration (ALT) 370 to replace the aging arming, fuzing, and firing components." This program is scheduled to produce its first production unit (FPU) in 2019. This program received $169.5 million in FY2014 and $165.4 million in FY2015. In August 2014, the Nuclear Weapons Council also decided to address potential problems with the warhead's conventional high explosive during the ALT 370 program. While NNSA has requested $220.2 million for the W88 ALT 370 program in FY2016, it has indicated that the additional funding for this program will come from offsets generated by reducing sustainment activities and the quantities of stored warheads for some other types of warheads. In essence, NNSA "identified areas where increased risk could be accepted to produce cost-savings within the current program—without additional funding—and without additional delays to future work."

The Ohio Replacement Program (ORP) Program

The Navy is currently conducting development and design work on a new class of ballistic missile submarines, originally known as the SSBN(X) program, but now known as the Ohio Replacement Program (ORP). This new submarine will replace the Ohio-class Trident submarines as they reach the end of their service lives. The Trident submarines will begin to retire in 2027, and the Navy initially indicated that it would need the new submarines to begin to enter the fleet by 2029, before the number of Trident submarines falls below 12. To do this, the Navy would have had to begin construction of its new submarine by 2019 so that it could begin to enter the fleet in 2029. However, in the FY2013 budget request, the Navy delayed the procurement of the new class of submarines by two years. As a result, the first new

submarine will enter the fleet in 2031 and the number of SSBNs in the fleet is expected to decline to 10 for most of the 2030s.

Costs and Funding

The SSBN(X) program received $497.4 million in research and development funding in the Navy's FY2010 budget. The Navy requested an additional $672.3 million in research and development funding for the program in its FY2011 budget proposal. The FY2012 budget included $1.07 billion to develop the SSBN(X). It expected to request $927.8 million in FY2013, with the funding of $29.4 billion between 2011 and 2020. However, with the delay of two years in the procurement of the first SSBN(X), the Navy budgeted only $565 million for the program in FY2013. It then budgeted $1.1 billion for FY2014 and $1.2 billion in FY2015. It has requested an additional $1.39 billion in FY2016, with $971.4 million allocated to submarine development and $419.3 million allocated to power systems.

The Navy had planned to begin the detailed design for the submarine and to begin advanced procurement of critical components in FY2015, with the seven-year construction period for the first submarine beginning in FY2019. This timeline has now been changed, in part to reduce near term costs, but also to reduce risks in the program. The Navy will now begin advanced procurement in FY2017 and begin building the first hull in 2021, rather than 2019. At the same time, it will continue to support the joint U.S./United Kingdom development of a common missile compartment, which both nations will use in their new SSBNs.

The Navy initially estimated that each submarine in this program could cost $6 billion to $7 billion in FY2010 dollars. It has worked to redesign the submarine and reduce the costs, with the plan to hold each submarine to around $4.9 billion, in FY2010 dollars. Officials in the Navy and analysts outside government have expressed concerns about the cost of this program, and about the effect that these costs may have on the rest of the Navy's shipbuilding plans. A study by the Congressional Budget Office indicated that the SSBN(X) program could cost a total of $97-$102 billion, in 2010 dollars, with $10-$15 billion for research and

development and $87 billion for the procurement of 12 submarines. A March 2015 GAO report assessing estimated the total acquisition cost of the SSBN(X) program at 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 has recently indicated that, using then-year dollars rather than 2010 dollars, the program is now estimated to cost $139 billion. It expects the first submarine to cost $14.5 billion, with $8.8 billion in construction costs and $5.7 billion in non-recurring engineering work. Subsequent submarines are expected to cost $9.8 billion in then-year dollars, which is equivalent to $5.2 billion in FY2010 dollars.

There is widespread agreement, in the Navy, at the Pentagon, and among defense analysts, that the costs associated with the Ohio Replacement Program could undermine the rest of the Navy's shipbuilding budget. At one point, Navy officials estimated that, if the Navy funded this program through its current, planned shipbuilding budget, it would have to forgo the acquisition of up to 32 other naval vessels. According to Navy Secretary Ray Mabus, unless Congress provides extra funding, "the production of 12 new ships to replace the Ohio-class submarines could 'gut' the Navy's shipbuilding budget for more than a decade." In testimony before Congress in February 2015, Navy officials noted that "the Navy continues to need significant increases in our topline beyond the FYDP [Future Years Defense Plan] … in order to afford the OR [Ohio replacement] SSBN procurement costs. Absent a significant increase … OR SSBN construction will seriously impair construction of virtually all other ships in the battle force: attack submarines, destroyers, and amphibious warfare ships."

In response to this growing fiscal pressure, Rear Admiral Richard Breckenridge suggested, in testimony offered in 2013, that Congress set up an annual $4 billion supplemental fund outside the Navy's budget to help support this program. Several Members of Congress have supported this proposal. Congress included language in the FY2015 National Defense Authorization Act establishing a National Sea-based Deterrence Fund (P.L. 113-

291, §1022). According to the legislation, money placed in the fund will be available for the design, construction, purchase, alteration, and conversion of "national sea-based deterrence vessels," which is a reference to ballistic missile submarines. The legislation also states that the Secretary of Defense has the authority to transfer up to $3.5 billion into the fund from unobligated funds in the DOD budget. Congress did not, however, appropriate increased funding for this effort, and the Secretary of Defense has not yet identified or transferred any money into this fund. In the FY2016 NDAA, (H.R. 1735, §1051), Congress expanded the authority to transfer funding. Most experts agree that, without increased appropriations, this fund may protect the Navy's shipbuilding budget from the costs of the Ohio Replacement Program, but that it would require reductions in other programs within DOD.

Force Posture

As a part of its effort to reduce costs, the Navy is designing the new submarines with only 16 ballistic missile launch tubes. The existing Trident submarines have 24 launch tubes, and each currently carries 24 missiles, although the Navy plans to reduce this number to 20 missiles on each submarine as the United States reduces its forces to comply with the New START Treaty. Congress questioned the Navy on this plan during hearings in April 2011, with some Members questioning whether the United States would be able to deploy enough warheads if it reduced the numbers of missiles on each submarine. Admiral Terry Benedict, the Director of the Navy's Strategic Systems Program Office, testified that the current international security environment, along with the Navy's ability to *upload* warheads onto Trident missiles, convinced him, along with other Navy and STRATCOM officials, that they could be comfortable with this configuration. However, Congress remained unconvinced. In the FY2012 Defense Authorization Act, it called for a new study of the plans for the SSBN(X). Congress indicated that the report should consider the possibility of deploying 10 or 12 submarines with 16 launch tubes on each and 8 or 10 submarines with 20 launch tubes on each.

Moreover, the study was to review not only the cost of each option, but also the ability of each option to meet the Navy's at-sea requirements for the SSBN force and the ability of each option to meet the nation's nuclear employment and planning guidance.

A report published in late 2011 indicated that the Office of Management and Budget (OMB) suggested that the Navy reduce the number of SSBNs in the fleet to 10, but increase the number of launch tubes on each submarine to 20. According to the OMB analysis, this could save the Navy $7 billion over the life of the fleet, by reducing acquisition costs and operating costs. It would not, however, undermine the submarines' mission because, with 20 missiles per submarine, the Navy would still be able to cover the full range of targets assigned to the Trident fleet. Analysts outside government have offered similar suggestions, noting that the Navy could save $27 billion over 10 years and $120 billion over the life of the fleet if the Navy built 8, rather than 12 submarines. Moreover, according to this analysis, the Navy would be able to deploy the necessary number of warheads on these submarines, even if it did not increase the number of launch tubes, by deploying more warheads on each of the Trident missiles on the submarine.

Generally, the number of launch tubes on the submarines should not affect the number of warheads carried by each submarine or the ability of the fleet to hold a range of potential targets at risk. Trident missiles can be equipped with 8 warheads each, but, in their current configuration, with 24 missiles on each submarine, the missiles carry only 4 or 5 warheads each, on average. This number would drop to 3-4 warheads per missile, on average, as the United States reduced to the levels in New START. If the new submarines carry only 16 missiles, rather than the 20 planned under New START, then they could deploy with 5-6 warheads per missile. In essence, the Navy would put the same number of warheads on each submarine, but would just spread them over a smaller number of missiles.

The Navy has noted that, as the United States reduces its forces to New START levels, the lower number of missiles per submarine will allow the United States to retain a larger number of

submarines, without exceeding the treaty's limit of 700 operational delivery vehicles. This will allow the Navy to maintain a fleet of 12 submarines, and to operate those submarines with continuous deployments from 2 bases. The Navy has argued that, if it reduces the numbers of submarines in the fleet, and alters its deployment patterns, it will not be able to meet its requirements, as these cover more than just the total number of warheads on the fleet or total number of warheads at sea at any time. Critics outside the government, however, question this approach, both because a fleet of 12 submarines will cost more to procure and operate than a fleet of only 8 submarines and because this fleet presumes that the United States must retain its current pattern of operations for the SSBN fleet for the next 50-60 years.

With 12 submarines in the fleet, the Navy can maintain 4-5 on station at any time, patrolling in areas where they would need to be to launch their missiles promptly after a presidential order. But critics question whether this pattern, and the "continuous at-sea" deterrent of 4-5 submarines, will be necessary in the decades ahead. They note that the United States will be able to maintain a secure second strike deterrent on the submarines, even if they cannot launch as many warheads promptly as they can launch today. Others however, continue to support the current operational patterns, and to argue for a fleet of 12 submarines into the future. For example, Congress, in the FY2013 Defense Authorization Bill (P.L. 112-239, §130) stated that "the continuous at-sea deterrence provided by a robust and modern fleet of nuclear-powered ballistic missile submarines is critical to maintaining nuclear deterrence and assurance and therefore is a central pillar of the national security of the United States." The legislation went on to indicate that "a minimum of 12 replacement ballistic missile submarines are necessary to provide continuous at-sea deterrence over the lifetime of such submarines.... "

Issues for Congress

This report focuses on the numbers and types of weapons in the U.S. strategic nuclear force structure. It does not address the broader question of why the United States chooses to deploy these

numbers and types of weapons, or more generally, the role that U.S. nuclear weapons play in U.S. national security strategy. This question is addressed in other CRS reports. However, as the Obama Administration reviews and possibly revises the plans for U.S. nuclear force structure, Congress could address broader questions about the relationship between these forces and the role of nuclear weapons.

Force Size

The Bush Administration argued that, because the United States and Russia were no longer enemies, the United States would not size or structure its nuclear forces simply to deter the *Russian threat*. Instead, nuclear weapons would play a broader role in U.S. national security strategy. The Obama Administration, in contrast, noted that there is a relationship between the size of the U.S. arsenal and the size of the Russian arsenal. The 2010 NPR states that

Russia's nuclear force will remain a significant factor in determining how much and how fast we are prepared to reduce U.S. forces. Because of our improved relations, the need for strict numerical parity between the two countries is no longer as compelling as it was during the Cold War. But large disparities in nuclear capabilities could raise concerns on both sides and among U.S. allies and partners, and may not be conducive to maintaining a stable, long-term strategic relationship, especially as nuclear forces are significantly reduced.

The Bush Administration's 2001 Nuclear Posture Review determined that the United States would need to maintain between 1,700 and 2,200 operationally deployed nuclear warheads. The Bush Administration also indicated that the United States would maintain in storage many of the warheads removed from deployed forces, and would maintain the capability to restore some of these warheads to the deployed forces to meet unexpected contingencies. The Obama Administration concluded, in its NPR, that the United States could reduce its forces to 1,550 deployed warheads, and agreed to do so under the New START Treaty, but it also planned to retain the capability to restore warheads to its deployed

forces. It also plans to retain many warheads in storage, although it has indicated that the size of the total stockpile could decline as the United States reduces its deployed forces to the New START limits.

The Obama Administration has also indicated that the United States may be able to reduce its numbers of deployed and nondeployed warheads further, but that it should do so in parallel with Russia. It indicated, in the 2010 NPR, that "large disparities in nuclear capabilities could raise concerns on both sides and among U.S. allies and partners, and may not be conducive to maintaining a stable, long-term strategic relationship." In June 2013, the Department of Defense completed a new study, as a follow-up to the NPR, to determine how deeply the United States might reduce its forces, and how it should deploy the remaining forces. Press reports indicate the Pentagon reviewed a number of alternatives in this study, with some contemplating reductions as low as 300 warheads, but the Administration concluded that the United States could reduce U.S. deployed strategic forces by about one-third, to a level of 1,000-1,100 warheads, if it did so along with Russia. They United States would not proceed with unilateral cuts in the U.S. arsenal.

Some analysts have questioned why the United States must maintain such a large force of nuclear weapons. They have questioned whether the United States would attack with such a large number of weapons if its own national survival were not at risk, and they note that only Russia currently has the capability to threaten U.S. national survival. They assert that the United States could likely meet any other potential contingency with a far smaller force of nuclear weapons. Some have concluded, instead, that the United States could maintain its security with a force of between 500 and 1,000 warheads. Others, however, dispute this view and note that the United States has other potential adversaries, and, even if these nations do not possess thousands of nuclear warheads, some may expand their nuclear forces or chemical and biological capabilities in the future. Some have argued that the also needs to assure its allies of its commitment to their security, and this goal could require a force of significant

size, regardless of the number of potential targets an adversary nation might possess.

Force Structure

When the Bush Administration announced the results of the 2001 Nuclear Posture Review, it indicated that the United States would retain a triad of ICBMs, SLBMs, and heavy bombers for the foreseeable future. The Obama Administration also offered continuing support for the retention of the strategic triad. Nevertheless, as the Obama Administration has outlined plans to modernize and replace the delivery vehicles in all three legs of the strategic triad, many analysts have begun to question whether the United States can afford to retain the triad and whether it can retain a robust deterrent without one of the current types of strategic delivery vehicles.

The Obama Administration indicated, in the 2010 NPR, that the United States would convert some of its bombers to conventional-only missions. This is consistent with the view, among some analysts, that, in the future, the bombers may be more important in the conventional mission. As was noted above, most discussions about the bomber force focus on how many bombers, and what types of bomber weapons, the United States needs to bolster its conventional long-range strike capability. There is little, if any, discussion about the role that bombers may play in either nuclear deterrence, or, if deterrence fails, in the launch of U.S. nuclear weapons. It is not surprising that some in the Air Force and Pentagon and some outside government have questioned the continuing need for nuclear-capable bombers.

The Obama Administration has indicated that the United States will retain 400 deployed ICBMs under the New START Treaty. Each will be equipped with a single warhead. Analysts have often argued, and the 2010 Nuclear Posture Review affirmed, that single-warhead ICBMs bolster crisis stability, and discourage efforts by an adversary to launch a disarming first strike, because the cost of the strike, as measured by the number of attacking warheads, would exceed the benefits, as measured by the number

of warheads destroyed. Moreover, these missiles will remain deployed at three ICBM bases.

Some analysts outside government have called for reductions in or even the elimination of the U.S. ICBM force. Some have argued that the Air Force could save up to $360 million per year if it reduced the ICBM force to 300 missiles. Others have noted that, under the current financial pressures, the Air Force may not be able to afford a new ICBM after 2030. Moreover, even if the financial pressures did not exist, some argue the Air Force should eliminate the ICBM force because it no longer serves U.S. national security needs. For example, in a study published in May 2012, the Global Zero Organization argued for the elimination of the ICBM force because it views these missiles as dangerous and destabilizing in the current security environment. It noted that "ICBMs can only support nuclear wartime operations against Russia" and that current generation ICBMs "fired from the existing bases, on their minimum energy trajectories," have to overfly Russia and China or fly near Russia to reach targets in potentially adversarial countries. It contends that, if U.S. missiles fly over or near Russia on their way to more southerly targets in Iran or Syria, Russia might be confused by ambiguous attack indications and might then launch its own retaliatory attack against the United States. Second, the report asserted that, because ICBMs are based in fixed silos that are vulnerable to destruction in an attack, they must depend heavily upon "launch on warning" to survive and retaliate in some scenarios. As a result, according to the report, ICBMs exacerbate the risk that the United States might launch its weapons on false warning.

Analysts who support the continued deployment of U.S. ICBMs disputed many of the assertions outlined in the Global Zero report. First, they noted that, although each individual ICBM silo may be vulnerable to destruction if targeted by several incoming warheads, an attack that threatened to destroy the entire U.S. ICBM force would have to consist of hundreds, if not thousands of attacking warheads. This is because the United States maintains nearly 450 ICBM silos hardened against nuclear blast, and an attacker would have to target two or three warheads against

each silo to ensure their destruction. Further, because the United States now deploys each Minuteman missile with only a single warhead, the attacker would have to expend two to three times as many warheads as he could hope to destroy. This calculation underpins the conclusion, which is widespread among nuclear policy analysts, that single-warhead ICBMs enhance stability and discourage attack because they are not lucrative targets.

The Obama Administration has also indicated that it plans to retain 14 Trident submarines until it begins retiring the Ohio-class SSBNs in the late 2020s. Moreover, the New START Treaty allows the United States to continue to reduce the warheads on each missile. It also allows the United States to eliminate some of the launch tubes by simply removing the gas generators that assist in the launch of the missiles. As a result, the United States will have a significant amount of flexibility in apportioning warheads among its SSBNs, and will not have to eliminate any submarines to meet the new START limits. Moreover, the Navy does not plan to alter the basic structure of its Trident fleet; it will continue to deploy its submarines at two bases, with a portion of the fleet deployed in the Atlantic Ocean and a portion deployed in the Pacific Ocean. As a result, with its ability to remain invulnerable to detection and attack, and with the increasing accuracy and reliability of its missiles and warheads, the Trident fleet will continue to represent the *backbone* of the U.S. nuclear force.

Some argue that the United States should reduce the size of its SLBM fleet and retain only 8 or 10 submarines. They argue that this reduction now, and the future acquisition of fewer replacement submarines, could save the Navy $6 billion-$7 billion over the next 10 years. They also note that this change need not reduce the number of operational warheads on SLBMs, because the United States would deploy each submarine with 24 missiles, rather than the 20 planned under New START, and could increase the number of warheads on each missile. However, with so few submarines, the United States might have to eliminate one of its submarine bases, leaving it with submarines based only in the Atlantic or only in the Pacific Ocean. Or the United States might have to reduce the number of submarines on station, and,

therefore, the number of warheads available to the President promptly, at the start of a conflict. These changes may not be consistent with current submarine operations and employment plans. President Obama and the U.S. military may want to consider the implications of these basing, operational, and policy changes, *before* deciding whether or not to reduce to 1,000 warheads, as opposed to choosing the warhead number first *then* deciding later how to base and operate the remaining nuclear forces.

Analysts outside government have also questioned the Administration's plans to replace the air launched cruise missile (ALCM) with the new long-range strike missile (LRSO) in the 2020s. As noted above, some argue that this missile will be redundant, as the Air Force is already planning to deploy a new penetrating bomber. They note that, during the 1980s, the United States deployed cruise missiles both to extend the service life of the B-52 bombers, which could no longer penetrate Soviet air defenses, and to provide a means to attack and destroy those air defenses prior to follow-on attacks with penetrating bombers. But, according to the program's critics, if the Air Force deploys 100 new bombers that can penetrate advanced air defenses, it will not need cruise missiles to destroy those defenses. Moreover, even if the United States does plan to attack an adversary's air defenses, it could do so with existing conventional cruise missiles, such as the extended range version of the Joint Air-to-Surface Standoff Missile (JASSM) missile.

The Air Force has disputed the assertion that the bomber and cruise missile capabilities are redundant. Air Force officials have noted that the two systems are complementary, with each providing different capabilities for the United States and different profiles that would complicate an adversary's attempts to defend against a U.S. attack. Some analysts also note that advanced air defense systems have proliferated among potential U.S. adversaries, and that these capabilities "make it harder for our forces to reach their targets." Deploying both penetrating bombers and long-range cruise missiles, therefore, will strengthen the U.S. nuclear deterrent.

The Cost of Nuclear Weapons

When the Obama Administration submitted the 1251 report to the Senate during the New START ratification process, it indicated that it expected to spend around $210 billion over the next 10 years (2011-2021) to maintain and modernize the U.S. nuclear arsenal. This total, however, did not include most of the costs of producing and procuring the next generation of submarines, bombers, and missiles, as these activities would occur after the timeframe contained in the report. Moreover, it became evident, as Congress reviewed the Administration's plans to modernize the nuclear enterprise, that it was difficult, if not impossible, to determine how much the United States spent each year on nuclear weapons, as the funding was divided between the Department of Defense and the Department of Energy, and, in many cases, was combined with funding for other, non-nuclear activities. In other words, the United States does not maintain a single, unified budget for nuclear weapons and other nuclear activities.

In response to both the growing concerns about the pending costs of nuclear weapons modernization programs and the confusion about how to calculate the annual costs of the nuclear enterprise, Congress directed the Congressional Budget Office (CBO) to estimate the costs of U.S. plans for operating, maintaining and modernizing nuclear weapons, the delivery systems, and the DOE nuclear weapons complex over the next 10 years. CBO issued its report in late 2013. It found that the United States was likely to spend $355 billion over the next 10 years on its nuclear weapons enterprise. This total included $56 billion for command, control, communications, and early warning activities and $59 billion for additional costs based on historical cost growth of similar programs. Neither of these categories had been included in the Administration's estimate in 2010. When CBO considered the same categories as the Administration, it estimated 10-year spending of $241 billion, a number close to the estimate provided by the Administration. CBO updated its estimate in January 2015, and reported that it calculated that the United States would spend $348 billion between 2015 and 2024; excluding command and

control and cost growth, the total that was comparable to the Administration's 2010 estimate was now $247 billion.

According to CBO, around $89 billion of its $355 billion total between 2014 and 2023 would go to the modernization programs. As with the Administration's estimate, the CBO estimate did not include procurement costs for most of these programs, as these would occur in the later 2020s and 2030s. The CBO study noted, however, that annual spending would increase from a total of around $18 billion in FY2014 to an average of $29 billion from 2021 to 2023 and that spending was "likely to continue to grow after 2023 as production begins on replacement systems." This result indicates that the United States could spend at least $30 billion per year on the nuclear weapons enterprise as it completes its modernization programs. This estimate is consistent with others that have been presented by organizations outside government. For example, in January 2014, analysts at the James Martin Center for Nonproliferation Studies estimated that the United States might spend $1 trillion, or an average of just over $30 billion per year, over the next 30 years, to modernize its nuclear enterprise. In addition, in a briefing prepared in May 2013, the Air Force estimated that the investments in nuclear modernization programs would peak in between 2025 and 2035, at approximately $30 billion per year.

While there now appears to be a broad base of agreement about the magnitude of the costs that the United States is likely to incur as it modernizes its nuclear arsenal, there is little agreement about whether the United States can, or should, proceed with all of these programs. Many analysts have noted that, with the passage of the Budget Control Act in 2011, the amount of funding available for defense spending will be nearly $1 trillion lower than expected when the Obama Administration first outlined the nuclear modernization program. In this environment, rising costs for nuclear weapons programs are likely to cut into funding for other Pentagon priorities. As noted above, the Navy addressed this problem when it noted that funding for the Ohio Replacement program would undermine the rest of the plans in its shipbuilding budget.

Moreover, this problem is not likely to disappear after the Budget Control Act expires in 2021. Frank Kendall, the Under Secretary of Defense for AT&L, noted in a hearing before the Senate Armed Services Committee that "the funding that we have requested from both departments, through the 5-year plan that we've submitted, is adequate to execute our plan during that period. After the end of that period, as we start to actually produce the systems I talked about, we're going to have an affordability problem that we have to deal with." He went on to say, "In 2021, we're going to start to have a problem finding ways to afford these systems."

Others, however, argue that the United States not only can afford to bear the costs of these systems, but cannot afford the costs of failing to modernize its nuclear arsenal. Admiral Haney, the Commander of Strategic Command, made this point in a hearing before the House Armed Services Committee, when he said that "achieving strategic deterrence in the 21st century requires continued investment in strategic capabilities and renewed multigenerational commitment of intellectual capital." He argued that "any cuts to that budget, including those imposed by sequestration, will hamper our ability to sustain and modernize our military forces." He noted that, as the modernization programs progressed, spending on nuclear weapons was likely to rise from around 2.5%-3% of DOD's budget to around 5%-6% of that budget in the late 2020s to 2030s. When asked whether the United States could afford to make this investment, he noted that other nations have been modernizing their forces and continued to pose an "existential threat" to the United States. He noted that "in order to maintain and sustain its strategic stability, it's very important that we have that kind of balance" with these nations. And he asked, "Quite frankly, the question really is, can we afford not to" proceed with the modernization programs.

FEATURES

STATEMENT BEFORE THE HOUSE ARMED SERVICES SEAPOWER AND PROJECTION FORCES SUBCOMMITTEE ON "GAME CHANGERS – UNDERSEA WARFARE" OCTOBER 27, 2015

STATEMENT BY BRYAN CLARK, SENIOR FELLOW, CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS

Today the U.S. Navy is dominant in undersea warfare. Its quiet submarines can operate with near-impunity throughout the world's oceans and most littoral waters. Its long-range surveillance systems are able to monitor many of the strategically or economically important maritime crossroads. And its antisubmarine warfare capabilities surpass those of competing militaries in lethality and capacity. As a result, today's U.S. defense strategy depends in large part on America's undersea advantage. Multiple Quadrennial Defense Reviews, National Military Strategies, and Congressional hearing statements highlight how quiet submarines, in particular, are one of the American military's most viable means of gathering intelligence and projecting power in the face of mounting anti-access and area denial (A2/AD) threats being fielded by a growing number of countries.

But America's undersea dominance is not assured—or permanent. U.S. submarines are the world's quietest, but new detection techniques are emerging that don't rely on the noise a submarine generates and may make some traditional manned submarine operations riskier in the future. America's competitors are likely pursuing these technologies even while growing and quieting their own undersea forces. To affordably sustain its undersea advantage well into this century, the U.S. Navy must accelerate innovation in undersea warfare by evolving the role of manned submarines and exploiting emerging technologies to field a new *family of undersea systems*.

How America Came to Dominate the Undersea

The U.S. Navy did not always *own* the undersea domain. It was an early adopter of submarine technology, but American boats were fewer and less capable than European countries until the middle of World War II. By that point, the U.S. Navy had grown a relatively large force of ocean-going U.S. submarines to sustain a successful counter-shipping campaign against the Japanese. Except for Germany and Russia, European submarine fleets had shrunk due to disrepair, combat losses, and capture. In the aftermath of World War II, the Soviet Navy had the world's largest Submarine Force, owing to its own construction program and that it gained control of about half the German fleet following its surrender.

With the addition of Germany's fleet, the Soviets also took possession of the most advanced submarines then in production. For example, the German Type XXI Uboat incorporated a snorkel to enable continuous submerged operation, as well as burst communications and X-band radar warning receivers (RWR) to reduce its vulnerability to detection by radar or signals exploitation. This caused great concern in the United States as leaders in and outside the Navy assessed the Soviets could reverse-engineer German submarines and produce them in large numbers to threaten U.S. and allied shipping or the U.S. homeland.

The U.S. Navy pursued ASW capabilities based on active and passive sonar to address the potential Soviet threat. Active sonar showed promise, but passive sonar was not initially effective against diesel submarines because snorkeling submarines sounded like diesel-powered surface ships, and submarines running on battery gave off very little radiated noise.

The U.S. Navy found passive sonar was much more effective against nuclear submarines. In initial exercises against the new USS Nautilus, ASW forces determined they could track the submarine by listening for the pumps and turbines that run continuously in its propulsion plant. Recognizing this potential vulnerability, the U.S. Navy started a methodical sound-silencing program for its nuclear submarines. When the Soviet Navy began fielding nuclear submarines, the American Navy exploited its *first*

mover advantage in passive sonar to establish the passive Sound Surveillance System (SOSUS) network off the U.S. coast and at key chokepoints between the Soviet Union and the open ocean.

The combination of passive sonar ASW systems and its own sound-silencing efforts gave the U.S. Navy a significant advantage over relatively noisy Soviet submarines. This overmatch, however, slowly began to erode in the mid-1970s after the Soviet Union learned of their submarines' acoustic vulnerability from the John Walker-led spy ring and obtained technology for submarine quieting from a variety of sources. Newer Soviet submarines such as the Akula and Sierra classes were much quieter than their predecessors, but were only fielded in small numbers before the Soviet economy began to falter, leading to delayed construction and inadequate sustainment.

In preparation for a time when more quiet submarines were in opposing fleets, the U.S. Navy began exploring other ASW technologies that did not depend on the sound a submarine makes, including new forms of active sonar and non-acoustic methods of detection. These efforts yielded some effective capabilities, such as low-frequency (less than 1000 hertz) active sonar, which was eventually installed on U.S. Navy Surveillance Towed Array Sensor System (SURTASS) ships along with their existing passive sonar arrays.

The urgency behind America's pursuit of new ASW technologies dissipated with the demise of the Soviet Union. Soviet submarine construction and overseas deployments largely stopped, and their advancements in submarine technology did not make their way into other navies. The U.S. Navy was left with undisputed superiority in the undersea domain.

Undersea Game Changers

Today, new competitors are rising to challenge America's undersea advantage. A resurgent Russia resumed overseas deployments of quiet submarines, a rising and revisionist China is fielding a growing fleet of conventional and nuclear submarines, and competitors including Iran and North Korea are expanding the use of mini-subs in their littorals. At the same time technological

advancements, many of them driven by rapid increases in computer processing power or *big data*, are empowering new undersea capabilities. Importantly, these new technologies are available to the U.S. military as well.

ASW Capabilities

Efforts to protect submarines from being detected since the Cold War have emphasized quieting, since passive sonar is the predominant sensor used for ASW. But today a growing number of new ASW systems do not listen for a submarine's radiated noise. For example, low-frequency active sonar is now widely used by European and Asian navies in variable depth sonar (VDS) systems and will be part of the U.S. Littoral Combat Ship (LCS) ASW mission package. Non-acoustic ASW technologies that detect chemical or radiological emissions or bounce laser light off a submarine are becoming more operationally useful due to improved computer processing and modeling of the undersea environment.

These active sonar and non-acoustic capabilities are likely to be best exploited by mobile platforms such as unmanned vehicles, aircraft, and ships because they are smaller than passive sonar systems. In contrast, to achieve long detection ranges passive sonars must be physically large so they can hear faint noise at the lower frequencies that suffer less attenuation. This makes fixed systems on the sea floor like SOSUS or towed systems such as SURTASS better able to exploit passive sonar improvements.

New ASW technologies, however, will not likely make the ocean transparent or dramatically increase the threat to American submarines in the next one to two decades. Turning a possible submarine detection into a successful ASW engagement involves sifting through a large number of possible submarine detections to find an actual target and then precisely placing an effective weapon on it. What new ASW capabilities could do is increase the chance an American submarine is detected and attacked (albeit ineffectively) in coastal areas where adversary ASW systems are concentrated. Meanwhile, U.S. undersea forces can take actions to defeat enemy ASW capabilities and reduce their vulnerability.

Platform Enhancements

The same advancements that are improving ASW capabilities will also enable a new generation of sophisticated counter-detection technologies and techniques. For example, against passive sonar a submarine or unmanned undersea vehicle (UUV) could emit sound to reduce its radiated noise using a technique similar to that of noise cancelling headphones. Against active sonars, undersea platforms could—by themselves or in concert with UUVs and other stationary or floating systems—conduct acoustic jamming or decoy operations similar to those done by electronic warfare systems against radar.

New power and control technologies are improving the endurance and reliability of UUVs, which will likely be able to operate unrefueled for months within the next decade. The autonomy of UUVs will remain constrained, however, by imperfect situational awareness. For example, while a UUV may have the computer algorithms and control systems to avoid safety hazards or security threats, it may not be able to understand with certainty where hazards and threats are and what they are doing. In the face of uncertain data, a human operator can make choices and be accountable for the results. Commanders may not want to place the same responsibility in the hands of a UUV control system—or its programmer.

As sensors and processing improve, UUVs will progressively gain more autonomy in operating safely and securely while accomplishing their missions. In the meantime, the U.S. Navy can expect to shift some operations to unmanned systems for which the consequences of an incorrect decision are limited to damage and loss of the vehicle, rather than loss of life or unplanned military escalation. These missions could include deploying payloads such as sensors or inactive mines, conducting surveillance or surveys, or launching UAVs for electronic warfare. For missions where a human decision-maker is needed, unmanned systems can operate in concert with submarines or use radio communications to regularly *check-in* with commanders.

Undersea Payloads

The ability of undersea platforms to conduct and coordinate operations will improve with the introduction of new onboard and offboard weapon, communication, and sensor systems. For example, the Navy's compact very lightweight torpedo (CVLWT) is a short-range weapon less than a third the size of the Mk-48 heavyweight torpedo; it could be used as a self defense weapon on submarines or employed by large UUVs quiet enough to carry them close to targets. Similarly, small UAVs such as the Experimental Fuel Cell (XFC) UAV have relatively short endurance but can be launched by submarines or UUVs close to adversary coasts. They can take advantage of continued miniaturization in electro-optical, infrared, and radar sensors to conduct surveillance or electronic warfare missions.

Communications are a longstanding vulnerability of undersea platforms. New or improved undersea communication methods will likely enable undersea platforms to communicate with each other, systems on the ocean floor, and the larger joint force without having to expose a mast. Acoustic communications are increasingly able to operate over operationally relevant distances with low bandwidth, while at shorter ranges LEDs and lasers can achieve nearly the same data rates as wired systems. And new floating or towed radio transceivers enable submerged platforms to communicate with forces above the surface without risking detection.

The same power, communication, and processing advancements that are benefitting ASW capabilities and UUVs are making possible a growing variety of deployable payloads that sit on the sea-bed or float in the water column. For example, payloads like the Forward Deployed Energy and Communication Outpost (FDECO) can act as a rest stop for UUVs where they can download data and upload orders while recharging their batteries. The DARPA Upward Falling Payload (UFP) program is building a module that holds missiles or UAVs. And portable sensors such as the Shallow Water Surveillance System (SWSS) and Persistent Littoral Surveillance (PLUS) system can be placed in areas such as

chokepoints where adversary submarines or UUVs are likely to travel.

The Next Chapter in Undersea Competition

While undersea research and development has been a distinct U.S. military advantage since the end of WWII, the wide availability of new processing and sensor technology and the increased exploitation of ocean resources are making undersea expertise more broadly available. This will result in increased undersea competition, even as U.S. forces are likely to retain a significant advantage for the next one to two decades. Some operational features of this competition are:

• A new predominant sensing technology. The effectiveness of traditional passive sonar will decline as submarines become quieter, their stealth is enhanced with countermeasures, and rivals deploy more unmanned systems that radiate little noise. While ASW relied primarily on passive sonar for the last 50 years, the dominant detection method by the 2020s may be low frequency active sonar, non-acoustic detection, or some other previously unexploited technique made possible by ongoing technological advances.

• Undersea families of systems. Submarines will increasingly need to shift from being front-line tactical platforms like aircraft to being host and coordination platforms like aircraft carriers. Large UUVs and other deployed systems that are smaller and less detectable could increasingly be used instead of manned submarines for tactical missions close to enemy shores including coastal intelligence gathering, surveillance, mining, or electronic warfare.

• Undersea *battle networks*. New longer-range sensors and emerging undersea communication capabilities will enable undersea fire control network operations analogous to those that use radio signals above the surface of the water. Undersea networks could also enable coordinated surveillance or attack operations by swarms of UUVs operating autonomously or controlled from a manned submarine or other platform.

• Seabed warfare: U.S. forces will need more immediately

available undersea capacity inside areas contested by adversary surface and air A2/AD networks.

Deployed and fixed sensors, payload modules, and UUVs supported by systems like FDECO could augment U.S. submarine capacity and be managed by them during a conflict. Increased reliance on these capabilities will create a competition in the ability to place or eliminate systems on the coastal seabed, including capabilities for rapidly surveying and assessing the sea floor.

How the U.S. Navy Should Respond

The U.S. Navy is already developing new technologies and operational concepts to prepare for the emerging era in undersea warfare. These efforts will need to transition into acquisition programs and fielded capabilities, however, to sustain America's undersea advantage. The Navy should consider the following actions:

• Achieve organizational alignment: Submarines, UUVs, and fixed and deployable sonars are funded and managed by different headquarters, divisions, and separate acquisition organizations within the Navy. To ensure the performance characteristics, networking requirements, and development schedules of these programs are aligned, the Navy should make its undersea warfare resource sponsor and acquisition organizations responsible for all undersea vehicles and systems once they transition out of research and development.

• Ensure ballistic missile submarine (SSBN) survivability: Sound silencing will likely decrease in importance as U.S. noise reduction efforts reach an affordable limit and new ASW detection techniques, such as low-frequency active sonar, become more common. While becoming noisier is not an option, since passive sonar will still exist, the design for the next SSBN should address other ASW capabilities through the use of onboard and offboard systems and tactics.

• Establish UUV design priorities: The Department of Defense (DoD) has pursued a large variety of UUVs during the past decade, mostly for mine clearing and ocean surveillance, launched

from surface ships or shore. These applications did not require particular sizes of UUVs. As UUVs become more integrated with submarines as part of a family of systems, the Navy should focus on UUVs that can use the submarine's ocean interfaces and conduct the most likely UUV missions. Specifically, the Navy should pursue the following UUV types as part of its undersea family of systems:

- Micro UUVs (about 6" or less in diameter) are inexpensive and improving in their endurance and on-board power. They could be procured and deployed in large numbers or swarms as weapons, to survey the ocean floor, or to interfere with enemy ASW operations.
- Small UUVs (about 12" in diameter) are commonly used today for surveys and minehunting, such as the Navy's Mk-18 UUV. They will be able to take on other surveillance or attack missions as part of the Fleet Modular Autonomous Undersea Vehicle (FMAUV) program and operate from submarines as well as surface ships and aircraft.
- Medium UUVs (about 21" in diameter) are the size of the Navy's Mk-48 submarine-launched torpedo. And while the Navy is not operating UUVs of this size today, the Modular Heavyweight Undersea Vehicle (MHUV) program plans to make the torpedo of the future able to be configured to conduct a range of missions, from mining and long-range attack to electronic warfare.
- Large UUVs (about 80" in diameter) such as the Navy's Large Displacement UUV (LDUUV) are designed to use the planned Virginia Payload Module (VPM) tubes in Block V Virginia-class submarines.

The LDUUV will provide a way for submarines to increase their sensor reach, expand their payload capacity, or deliver payloads into areas that are too risky or constrained for the submarine to reach.

- Extra-Large UUVs (More than 80" in diameter) in development would be designed to launch from shore or very large

ships with well decks or *moon pools*. They could be used for long-endurance surveillance missions or primarily as *trucks* to deliver other payloads and UUVs.

- Experience with LDUUV will help inform concepts for using XLUUV.
- Evolve attack submarines (SSN) for their new roles: Submarines will be central to the future family of undersea systems and their design should reflect submarines' growing use as host and command and control platforms.
- The Navy should have a plan for evolving the existing Los Angeles, Seawolf, and Virginia-class submarines to incorporate features that expand their payload capacity and ability to interface with unmanned systems. This plan should also ensure the Block V Virginia submarines are able to host a wide range of payloads in addition to strike missiles.
- Move from research to acquisition: As described above, the Navy is very actively pursuing new undersea capabilities and demonstrating them at sea.

But these new systems and concepts are slow to make it into acquisition.

Several projects over the last decade including the Mission Reconfigurable UUV, Advanced Deployable System, and Deep Water Active Deployable System were prototyped but never fielded. The Navy cannot continue to delay the transition of new undersea systems into wider operational use.

The coming era in undersea competition will require a reconsideration of how military forces conduct undersea warfare. In particular, a new family of undersea vehicles and systems will be essential to exploit the undersea environment. If the United States does not begin fielding this new family soon, it could fall behind rivals who will field their own new technologies and operational concepts to threaten America's use of the undersea.

IS THE U.S. NAVY TOO SMALL?

by Mr. Mark Cancian

This report is produced by the Center for Strategic and International Studies (CSIS), a private, tax-exempt institution focusing on international public policy issues. Its research is nonpartisan and nonproprietary. CSIS does not take specific policy positions.

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It's become a common talking point with Republican presidential candidates and think tanks: the U.S. Navy is too small and needs to grow. Although the overall size of the military has been an issue, the size of the Navy has received particular attention. In the latest Republican presidential debate, Carly Fiorina twice stated that she would increase the size of the "Sixth Fleet." Senator Marco Rubio, Governor John Kasich, Governor Bobby Jindal, Governor (and now former candidate) Scott Walker, and Dr. Ben Carson all criticized the current size of the Navy in various speeches and pledged to increase it. And it's not just Republican politicians. The 2014 National Defense Panel, a statutory, bipartisan panel of nongovernment experts, recommended increasing the Navy to between 323 and 346 ships,

arguing that the strategy exceeds the forces provided and that it was better to err on the side of too much rather than too little. Studies from several think tanks, including some from CSIS,[1] have also made the argument.

It's worth considering, then, what the size of the Navy is, how its current size compares with historical experience and other navies, how the Navy's size drives, and is driven, by various national security strategies, and how this fits into the broader political and international context.

How Big Is the Navy Today?

272 ships as of September 23, 2015 (technically, "deployable battle force ships"). The Navy is built around its 10 aircraft carriers (soon to be 11, when the *USS Ford* finally delivers next year), each carrying up to 90 aircraft. The centrality of the aircraft carrier has been controversial because of its high cost: about $12 billion per ship, and that excludes the cost of escorts and aircraft. Whether this is the right way to structure the Navy is beyond the scope of this paper. The Navy has 100 surface combatants to escort the carriers and conduct independent operations, 54 attack submarines, 14 ballistic missile submarines for nuclear deterrence, 4 cruise missile submarines for land attack, 30 amphibious ships for deploying Marines, and about 60 other ships for support and logistics.

We can give a definite answer to how many ships are in the Navy because there is an agreed ship counting methodology, which was established in the 1980s between the secretary of defense's staff and the Navy. The agreement specified which kinds of ships would be included and which would be excluded. A Navy proposal last year to expand the types of ships counted was not accepted by the Congress.

A caution is in order, however. Because of the judgment involved in deciding what to include, counting ships in foreign navies and in the U.S. Navy historically is not always straightforward. The Navy historical ship counts used here are compiled by the Naval History and Heritage Command and therefore constitute an official count, but many ships counted historically would not be

included by the current rules. Similarly, what's included in counts of foreign naval strength is not always comparable with the way U.S. ships are counted. For example, Coast Guard cutters are not included in the Navy ship count (since in the United States, the Coast Guard is a different service in a different government department), but similar vessels are often included in counts of foreign navies.

Is the Navy Small by U.S. Historical Standards?

The answer is yes and no. By the commonly used metric of number of ships, the Navy is at an historical low point. The Navy has not had this few ships since 1916, as Mitt Romney famously noted in the 2012 presidential debates. Today's count of 272 compares with 550+ during the Reagan administration and the 300s during the Clinton years when the Navy was coming down from Cold War levels.

Analysts point out that using ship numbers as a primary metric of naval strength leaves out a lot of important detail. Not all ships are alike. An aircraft carrier is far larger and more capable than a minesweeper, but both count as one ship. If one looks at tonnage—a surrogate for capability— the Navy is smaller than at points in its past but not as dramatically as the ship count might imply. Today the Navy has 273 ships weighing a total of 5.1 million tons. In 1975, the Navy had 559 ships weighing 5.7 million tons. So in 1975, the Navy had twice as many ships as today but only 10 percent more tonnage.

The reason for this numbers/tonnage disparity is that Navy ships have been getting larger over time. For example, today's Arleigh Burke–class destroyers (DDG-51s) weigh 9,000 tons; destroyers in the 1970s were half that size. In World War II, a 9,000-ton ship would have been a cruiser, the next larger class. Similarly, World War II fleet carriers weighed about 40,000 tons, whereas today's carriers weigh 90,000 tons. The Navy also tends to retire ships early in order to build more modern ships. Thus, ship counts tend to be lower, but capability (and often size) is greater.

Is the Navy Too Small for U.S. Needs?

It depends on the strategy that a president wants to implement. Classically, the Navy has been sized for two things: wartime combat operations and day-to-day forward deployments. Wartime combat operations entail surging large numbers of ships to a high-intensity conflict, for example a war on the Korean peninsula. The number of ships needed depends on a wide variety of factors but particularly the expansiveness of U.S. goals. The Obama administration's goals are to defeat an adversary in one region and "deny the objectives of—or impose unacceptable risk on—a second aggressor in another region." In plain English, that means the United States will defeat one opponent decisively enough that we impose terms on them, even change their regime. In the second conflict the United States will aim for less, for example, restoring the status quo before the conflict. The Republican presidential candidates are likely looking at a more ambitious goal in the second conflict, defeating the enemy there also, and that requires more forces across the board, including the Navy.

Day-to-day forward deployment of naval (and ground and air) forces, the other driver of force size, serves several purposes: to engage partners and allies, to deter potential conflicts, and if a crisis arises, to respond quickly. The crisis could be anything from relieving humanitarian disasters, to supporting coalition operations against countries like Libya, to rescuing American citizens caught in civil wars. Historically, the United States has maintained forward-deployed forces in three theaters: the Pacific, the Mediterranean and Europe, and the Indian Ocean/Middle East. To maintain a carrier battle group (a carrier and its escorts) forward deployed in each of those three regions continuously would require 14 to 15 carriers, given today's laydown of naval installations. In addition, there are a variety of other demands on naval forces. For example, submarines conduct nuclear deterrence and intelligence missions, and there are operations in other theaters such as South America and Africa. Meeting the demands of all these requirements together would require a Navy larger than its current size.

The Obama administration has decided not to maintain continuous carrier coverage in all three theaters but to gap the coverage particularly in the Mediterranean and Europe. As a result, it can execute its strategy with a smaller Navy, though with some risk.

On the other hand, unexpected real-world events like Russian aggression and Islamic State of Iraq and the Levant (ISIL) battlefield victories sometimes intrude. As a result, the Navy has sent more ships to Europe and the Middle East than it had planned. Like its sister services, it has struggled to meet the demands of the geographic combatant commanders. The Navy notes that half of its ships are typically at sea at any time, either forward deployed globally or training locally, and there's no spare capacity left. Admiral Jonathan Greenert, chief of naval operations until recently, noted that the Navy has in recent years been able to meet "about 45% of the global Geographic Combatant Commander (GCC) requests."[2] He continued, "Sourcing all GCC requests would require about 450 combatant ships with requisite supporting structure and readiness." Combatant commanders do not need to take supply into account when making force requests, so it is unsurprising that the Navy cannot fully meet all requests. Still, leaving 55 percent of demand unmet is concerning. The Navy hopes to meet this demand by growing in size. Its force structure objective is 308 ships, 36 more than are currently in the fleet. The Navy plans to reach that level in 2019 and maintain that fleet size for the next 20 years. However, this requires additional shipbuilding funds that may not be available. In particular, this expansion depends on the financing of the replacement for the Ohio-class ballistic missile submarines, which perform the national mission of nuclear deterrence but are extremely expensive. The Navy wants outside help in paying for this program.

However, the Obama administration has been constrained by the budget caps of the Budget Control Act (BCA) of 2011. The BCA cut $487 billion out of defense over 10 years (and a similar amount out of domestic spending). Subsequent ad hoc budget agreements have made further cuts. No administration could expand the Navy with these constraints. If future budgets are held

to the sequestration caps in the BCA, then there will be further cuts.

Is the US Navy Larger Than the Next Seven or So Other Navies? Isn't that Excessive? Yes and no. Yes, the U.S. Navy is larger than the next seven or so other navies (depending on how one counts), and most of these are our allies. In particular, our aircraft carriers are the largest in the world and more numerous than those of the rest of the world combined. The United States operates 10, soon to be 11, 90,000-ton aircraft carriers (in addition to 10 40,000-ton amphibious assault carriers). China, by contrast, has one 60,000-ton carrier (*Liaoning*, ex-Soviet *Riga*, and technically a training ship), and the Russian Federation operates *Liaoning*'s half-sister *Admiral Kuznetsov.*

No, that's not necessarily excessive because the U.S. Navy has global responsibilities that other navies do not. The U.S. Navy is expected to operate in the Mediterranean, in the Middle East, and in the Pacific and to have forces forward deployed at all times so that when crises erupt the United States can respond quickly. That takes a large navy. The U.S. Navy will also operate in the home waters of opponents. Opponents can bring their entire naval strength to bear while the United States can only use a portion of its strength because of ongoing global responsibilities. If there were conflict with China, for example, the Chinese could employ their entire naval force while the United States would have to leave at least some forces in the Atlantic and Middle East.

Isn't the Navy Much More Capable Now than in the Past?

Yes, much more. The F-35 now entering the fleet is stealthier than the previous generation of aircraft. Today's submarines are quieter. The cruiser and destroyer weapons are longer range and more accurate.

But our enemies are also more capable. We are in a situation that has been called the "Red Queen effect" in evolutionary dynamics. That is, we must run as fast as we can just to stand still. Because our potential enemies are also improving their capabilities, we are not gaining on them. In fact, the Chinese have greatly

increased their fleet capabilities over the last 20 years, and the Russians are trying to reverse their post–Cold War decay. Thus, we can't assume that greater quality will offset declining quantity. Further, ships can only be in one place at a time no matter how capable. As Stalin is said to have observed, quantity has a quality all its own.

ENDNOTES

1. For example: Maren Leed, *Amphibious Shipping Shortfalls: Risks and Opportunities to Bridge the Gap* (Washington, DC: CSIS, September 2014),

   http://csis.org/files/publication/140902_Leed_AmphibiousShipping_WEB.pdf; David J. Berteau, Michael J. Green, Gregory T. Kiley, and Nicholas F. Szechenyi, *U.S. Force Posture Strategy in the Asia Pacific Region: An Independent Assessment* (Washington, DC: CSIS, August 2012), http://csis.org/files/publication/120814_FINAL_PACOM_optimzed.pdf; and Michael J. Green, Kathleen H. Hicks, and Mark Cancian, *Pacific Rebalance 2025: An Independent Review of U.S. Defense Strategy in the Asia Pacific Region* (Washington, DC: CSIS, forthcoming).

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NO "COLD WAR TO END ALL COLD WARS" – PART 1

by Mr. Joe Buff

Joe Buff is a novelist with several submarine-related books to his credit. He is also a frequent technical/political-military contributor to THE SUBMARINE REVIEW.

Executive Summary

The persistent claims in some media and political quarters that America's nuclear submarines are *Cold War relics* is invalidated in this two-part article by a multi-pronged attack on both 1) the underlying flawed post-Cold War military history involved, and 2) the sheer bad logical syllogism inherent in these claims. The U.S. Navy's Submarine Force was instrumental in winning the Cold War against the USSR; the Soviet Union fell but this did not in any way make nuclear subs antiquated or irrelevant.

This is particularly true for America's survivable strategic nuclear deterrent ballistic missile subs, its SSBN fleet: The Russian Republic retained (or regained) all of the nuclear warhead stocks owned by the USSR in 1991. While steep reductions have been made by the U.S. and Russia alike, this has mainly been to reduce the Cold War *strategic* weapons. Recently, Russia has been modernizing her nuclear warheads and delivery systems, increasing in both capacity and capability these tools for not just nuclear deterrence but also nuclear blackmail and nuclear destruction. Russia's deployed *tactical* nuclear weapons, designed for use on local battlefields, outnumber NATO's by about ten to one.

The trend since 1991 across eastern EUCOM (U.S. European Command), and in CENTCOM (U.S. Central Command) as well, in the Russian Federation's repeated near-abroad aggressions—and in Moscow's ongoing interference in U.S.—supported Middle East peacekeeping efforts (including in Libya, and now Syria with its mounting cross-Med immigration crisis)—indicates that either

the Cold War never really ended, or a New Cold War by Russia has begun. Either way, we dare not send the U.S. Navy's Submarine Force into retirement. Other compelling national deterrence and defense needs also guarantee that nuclear subs must remain *front-line tools for peace maintenance and peace restoration*: 1) Nuclear armed China's non-transparent military rise and territorial expansionism, and her own nuclear arsenal expansion and modernization including (reportedly) the recent introduction of destabilizing, escalatory land-based MIRVed ICBMs; plus 2) multiple U.S./NATO/UN overseas contingency operations and containment challenges against brutal dictatorships, terrorists (and the state sponsors of terrorism), and other armed groups—such as in North Korea and Iran, and continuing in Iraq, Lebanon, Libya, Somalia, the Sudans, Syria, Yemen, and Afghanistan.

The danger of bloody conflict will always be prevalent so long as the world has a running supply of *talented, ambitious clinical sociopaths*, some of whom claw their way to absolute power, seize control of armies and arsenals, and commit aggressive wars and ethnic/religious genocides. Perhaps only nuclear weapons are frightening enough as a deterrent to force even sociopathic—and other—dictatorships (nuclear armed and nuke wannabes alike) away from hot war toward cold war and from rearmament toward disarmament. We have already seen that our nuclear submarines' superior designs and tactics can force a nuclear-armed adversary in a cold war onto the path toward (at least temporary, but decades-long) arms reduction and incrementally greater democracy. Thus, it is a U.S. national imperative that adequate funding be sustained for sufficiently numerous and promptly-built new SSBN(X) strategic deterrent subs (the OHIO-class replacements), more VIRGINIA-class fast attack SSNs in general, and the extended-hull SSGN-capable VIRGINIAs (with the Virginia Payload Module – VPM) in particular. These vessels and their crews remain vital to current and future national security, homeland defense, and world peace and prosperity.

Up North Calling: Key Trends in EUCOM Submarine Events vs. U.S. Logic and Rhetoric

In 1991, the dreary, gulag-infested Soviet Union broke apart. The lengthy Cold War between NATO and the Warsaw Pact came to an end. Courageous, self-sacrificing American and UK nuclear submariners, and their awesomely capable vessels, played a major role in this Cold War Victory. They pushed, and the Sovs fell. (France maintained her own independent force of SSBNs and SSNs.)

Best of all, the end of the Cold War was achieved without nuclear weapons being used in combat, without open warfare being fought in the heart of Europe, and with significant casualties being confined to brutal but limited proxy battles in far flung places such as Korea, Vietnam, Central America, the Middle East, Africa, and Afghanistan. It was a political, economic, and technological triumph for the West, in which ever-modernizing undersea warfare coupled with everything else, from multi-domain major weapons systems to Radio Free Europe to selective trade embargoes, to targeted foreign aid, to back-corridor diplomacy, produced the desired result after decades of tension and strife. The United States accordingly celebrated and congratulated itself—and most deservedly so!

Worth a special shout-out is that perhaps one of the most significant single achievements of this overall Cold War Victory was to greatly increase the *strategic depth* of the forces of freedom on the European continent, with excellent consequences for potential future U.S. declared nuclear deterrence policy. During the height of the military standoff between NATO and the Warsaw Pact, along the edge of the Iron Curtain that ran right through the middle of divided Germany, America refrained from renouncing the option for the first use of nuclear weapons for defense. At least one reason for this was because of the ever-present danger of an overwhelming assault by USSR-led Warsaw Pact conventional ground forces, driving for the English Channel. The distance from the Iron Curtain to the English Channel was less than 500 statute miles. Then, the geopolitical changes since 1991 that ended the Iron Curtain, expanded NATO eastward, and freed many republics

of the Union of Soviet Socialist Republics to become independent countries, moved the front line between freedom and tyranny about one thousand statute miles to the east. These same changes also greatly reduced the military manpower and other assets available under Moscow's control. The probability that a Russian Republic conventional ground onslaught from her own borders toward the English Channel would be *unstoppable* by conventional defenses alone appears to be low.

But some people (of many different ethnic groups and nationalities), born and raised under the system of Soviet Communism, saw and still see things differently. They felt that the U.S. had relatively little to do with the ultimate failure of a flawed and stifling economic system their own citizenry had *known* was doomed for years. They said and still say loudly that American triumphalism was mere bullying, not only short-term and childish but deeply offensive to ex-Soviets', now Russians' natural sense of personal pride and collective national ego. They emphasize that the USSR's predecessor-and-successor entity, Russia, boasts centuries of cultural and imperial greatness that are destined to continue despite—even egged on by—the fading chimera of U.S. *unipolarism*.

This article develops some solutions to what has become an apparent disconnect over time, between the evident current world situation on the one hand and sufficient funding to implement America's national undersea warfare policy and strategy on the other hand. Said disconnect is caused in part by public information flows that too often don't gain wide enough traction and *stickiness*. This disconnect is degrading national awareness of vital security tasks. Sometimes, failed or forgotten idea flows have led to what seems like *a domestic anti-submarine warfare of words*. That seeming disconnect has only recently, apparently, been redressed by the positive funding decisions of a United States Congress.

The *dangerous verbal ASW disconnect* can be characterized by contrasting in some detail, as we will further below, two broad tendencies of the past 25 years:

1. The repeated and continuing declaration by some commentators that *the "Russia threat" has been beaten once and for all and that America has "no more big enemies:"* This view has, in particular, fomented the belief that the U.S. Navy's nuclear submarine fleet could safely, permanently be cut in half (it was)—and that the remainder and their replacement vessels are *Cold War relics* that should be discontinued altogether as obsolete wastes of money, or thermonuclear warmongering symbols, or both.
2. The *ongoing military expansionism and interference with international peace processes by the Russian Federation:* This has been epitomized but by no means limited to the increasingly nationalistic/xenophobic, autocratic rule of Vladimir Putin since 2000. This expansionist jingoism is transpiring both in Russia domestically and throughout her near abroad and beyond. It has included, in rough chronological order, deadly armed conflicts instigated and/or supported by Moscow since 1991 in the North Caucasus, Moldova, the Balkans, Georgia, Azerbaijan, and Ukraine. It has also included ongoing (now escalating?) psychological-economic warfare with the Baltic States (Lithuania, Latvia, and Estonia). It also includes a revamping and revitalizing of the Russian Navy's nuclear and diesel/AIP submarine fleet (including new sub-launched thermonuclear ballistic missiles and cruise missiles). It furthermore includes the expansion of power-projection bases and military assets such as the attempted acquisition of several modern amphibious warfare ships from France, the seizing of advantageous naval basing/support territory on the Black Sea (Crimea) – and most recently (as of this writing in late October, 2015) the development of a military airbase at Latakia, Syria, close to an existing Russian naval base at Tartus (on Syria's Eastern-Mediterranean coast), in further support of brutal local dictator Bashar al-Assad.

Confronting Complexity: Pressing Need for the Broadest View, and Balance

Of course, other countries and sub-national entities besides Russia have presented, or do, or will present *serious strategic threats* to any American-led system of constructive, open world order, basic human freedoms, and stable peace. Those threating, destructive forces and trends all call for diligent governmental and societal education/learning, better understanding, and especially a more concerted regimen of *retaining cognizance* of not-so-old-fashioned, experience-driven, geopolitical parables and aphorisms. This would enable the American public and Congress to more fully grasp and support the inexorable, perpetual need for ample security spending for strong defense preparedness. As folks both rich and poor, and corporations large and small, all need to remember, *We must invest in defense in order to defend our investments and savings.* This essential spending must always include adequate budgeting for strong naval forces in general and for adequate nuclear submarine strategic-deterrent and fast-attack/land-attack forces in particular. The notion in some quarters that America's genuinely job-creating and honestly tax-paying defense industry is no more than some bloated, venal, politicized *sacred cow* must be debunked and debunked again; in the long run, it is a matter of life and death for us all.

The broad spectrum of world defense needs has to be seen as an integrated tapestry of readiness requirements that demand a global, holistic approach to financing, rather than as competing geographic theaters and competing acquisition expenditures that all want to hog the available funds. Much has been said and done, and more attention and action are needed, about China's maritime rise, North Korea's conventional and nuclear provocations, Iran's stubborn (and maybe still viable?) nuclear cravings and state sponsorship of terrorism, Libya's and Syria's unresolved civil wars, the mounting atrocities of ISIS, the continuing threat from al Qaeda, ongoing strains on the beleaguered State of Israel's self defense, ethnic cleansings (genocide) hither and yon, and various separatist movements (some peaceful and some quite bloody) on different continents. Compounding these human bad-behavior

phenomena are the destabilizing effects of global energy insecurity, and of rampant man-made and natural climate change. These include sea level rise and coastline inundations (including of naval bases), ice cap melting and altered sea routes, plus pandemic diseases and pestilence, famine, drought, rampant poverty—and consequent worldwide human migration crises, militant and organized-crime infiltrations, and terrorist recruitment. To cope successfully, given this plethora of inter-related defense demands, two traditional American traits have to stay at the fore: clarity of perception, and good teamwork. Two more of our greatest traits must not be allowed to fail us now: amazing ingenuity under stress, and resourcefulness in a crisis.

Over human generations the world order is always changing, in broad trends punctuated by discontinuous jolts. These jolts, such as the Arab Spring upheaval, are often not widely anticipated and are not necessarily democratizing. The fact is, nobody knows what sort of regime will be in power in twenty years in troubled/troubling countries such as China or Russia or Iran, and nobody knows today what might be the status then, if any, of some Islamic caliphate (or caliphates). Nor does anybody know now the ultimate 21st century outcome of today's pushing and shoving in the world between an American-led global system of *both win* compromise and engagement, and a *winner take all* confrontational system dominated by repressive, paranoid totalitarians. Extraordinary dangers demand extraordinary preparedness.

Some Facts of Existential Importance

This article focuses primarily on Russia. I discuss how the uncertainties and risks posed to American, Allied, and friendly vital interests, and to good world order, by Russia's anti-democratic, neo-kleptocratic expansionism and interference, are sufficient in themselves to prove something of existential importance: American nuclear subs are vital survivable nuclear deterrents, indispensable counter anti-access/area-denial (A2/AD) platforms, and most of all nobody's *relics*. Regime changes, of the sort we have seen in Moscow via the fall of the USSR *almost 25 years ago now*—and more recently in Iraq and then Libya, with

the removal of Saddam Hussein and Muammar Gaddafi—cannot be counted on soon to truly reform all the world's bad behaviors. This is particularly so when the international community currently contains (at a minimum) the large, aggressive nuclear power, Russia, that traces its forceful achievements and domineering psyche back to before Czar Peter the Great (1672-1725).

The recent series of leaders of the USSR/Russian Federation since the mid 1980s, Mikhail Gorbachev (for 6 years), then Boris Yeltsin (for 9 years), then Vladimir Putin (for 16 years and counting with a place-holding assist from Dmitry Medvedev), were each once proclaimed in the West as a democratist of his time. Today they can perhaps best be viewed as something else. They form a cohort of *next-gen* successors in a resilient, self-perpetuating Russia/Moscow/Kremlin-centered totalitarian bureaucracy. That system, though communism was dropped in favor of private ownership and free markets, still very much puts the power of the Russian state above the will of the people and their human rights. It rates territorial acquisition above both the safety of its own abused conscript soldiers, and above the lives and well being of Russia's diverse internal regions and external, sovereign neighbors.

Flawed Logic Leads to Bad Decisions and Wrong Actions

A *syllogism* is a fancy term for any chain of logic, whether that logic is correct or erroneous. A simple example is "A implies B is a true statement, and A is a true statement, therefore B must be true." This particular syllogism is as rock-solidly valid as logic can get. But logic sometimes becomes twisted into false, and consequently misleading, invalid reasoning—whether by an accidental misunderstanding or intentional rhetorical legerdemain (or even by adversary propaganda). But this present article is *not* about fixing blame; it is about helping avoid dangerous errors in defense budget right-sizings and final allocations.

By way of illustration, an example of flawed logic, popular in basic math textbooks, goes like so: "All men are mortal, and Socrates is not a man, therefore Socrates is immortal." This doesn't work, as proven by a *valid counterexample*: Actually-

mortal Socrates might well be a cat or a parakeet. The flawed syllogism involved is the incorrect claim that "A implies B, and not-A, together imply not-B."

One relevant instance of just such faulty thinking, recurrently encountered throughout the debate about U.S. defense needs subsequent to the end of the USSR, goes something like this: "American nuclear submarines helped win the Cold War. The Cold War is over. Therefore American nuclear submarines are relics." National defense gets into dire straits whenever such wrongful reasoning crops up. Yet it keeps cropping up.

(Technically speaking, we can dissect this claim into a flawed syllogism as follows: Let A be the statement "The Cold War is on." Let B be the statement "Nuclear Subs are Vital." The flawed logic about subs as Cold War relics amounts to claiming that because A implies B, then also not A implies not B. But this plainly doesn't work.)

The following are some actual examples from the media. Most are from The New York Times. I do *not* wish to single out that fine publication for negative criticism – rather, my wife and I have it delivered as our primary source of daily printed news, so I am familiar with its content over the years. I believe three examples demonstrate adequately the *defense flawed-logic problem* under discussion; other examples in newspapers, magazines, and blogs abound.

- *First example*: an editorial or op-ed I vividly remember reading on-line, from a Northeastern U.S. regional newspaper. It was published during the 2005 Base Reduction And Closure (BRAC) debate, about whether to close Groton, CT's Naval Submarine Base New London. I can't find it by a Google search now; perhaps it was subsequently taken down – which in Internet practice can be a form of retraction. I cite it here, but without attribution, because it is so very indicative of the problem. I recall it had the punchy title "Nobody Hunts for *Red October* Any More." The premise was that Russia had become a true, lasting friend of democracy and the West. Thus, there was no more need for the heroic espionage and undersea jousting

by SSNs—let alone the strategic nuclear deterrent patrols by SSBNs—that were depicted in the late Tom Clancy's classic. Thus, so the opinion piece's reasoning went, there was no more need for the sub base in Groton.

- *Second example*: indirect but telling, the New York Times op-ed "Highly Enriched Danger," published March 21, 2014, by Alan Kuperman and Frank Von Hippel. It argued that the very existence of Highly Enriched Uranium (HEU) in American nuclear submarine (and aircraft carrier) propulsion reactors presents such great dangers to world peace (nuclear accident, terrorist theft, loophole to weapons non-proliferation) that the U.S. Navy should change back to lower purity (i.e., non weapons grade) reactor fuel. The piece emphasized post-Cold War nuclear disarmament aspirations in, I think, something of a geopolitical vacuum. Its thesis would also have set back American naval submarine propulsion system design, and tactical capabilities, by decades. This is because HEU allows for massive net cost savings over the lifetime of the VIRGINIA class and the future SSBN(X) class, while also permitting much greater continuous operational availability of each vessel. This better cost/benefit performance, per hull constructed and for the fleet overall, is achieved by HEU allowing the *life-of-ship reactor core* design. A life-of-ship rector core avoids the need for the *multiple* periodic, lengthy, expensive (and hazardous) dockyard stays required to replenish the (highly radioactive and toxic) Low Enriched Uranium (LEU) spent fuel rods. Such refueling layovers mean added opportunities for said rods to easily be turned into spectacular dirty bombs *in situ* by determined terrorists, by them simply using a conventional high-explosive bomb in a truck or delivery drone. Though details are highly classified, it also seems likely there would be important sacrifices of overall ship's mission success-and-survival capabilities (and/or yet other excessive design, fabrication, and maintenance costs), if the Navy were to revert to using a bulkier (and noisier?) reactor system with the substantially weaker pro-

pulsive-work density of LEU, compared to the preferred HEU.

- *Third example*: the editorial "How to Pay for a 21-st Century Military" which ran in The New York Times on December 20, 2008. It claimed there was "plenty of fat in the defense budget" because of "unneeded weapons systems." One key recommendation in the piece was "Halt production of the Virginia class sub." It said they were "modeled on the cold-war-era Seawolf" as if that was something bad, ignoring the many transformational advances (and major cost savings) of VIRGINIA over SEAWOLF. It called the VIRGINIA-class program "little more than a public works project to keep Newport News, Va., and Groton, Conn., naval shipyards in business."

The second example above seems to miss the most vital point altogether, which is that any such nuclear fuel changeover from HEU back to LEU would, by substantially increasing total lifetime costs per vessel, significantly reduce the affordable number of American (and UK) SSNs/SSGNs and SSBNs in commission in the foreseeable future. That future has already for some time been projected to be one where the size of the U.S. Sub Force fleet will be too small for the global demand signal. (This is not a new problem. Nor is the unhelpful suggestion of our subs using LEU instead something new—it was mentioned in The New York Times for August 29, 2000, in an op-ed by disarmament expert James Clay Moltz, "The Kursk Was in Dangerous Company.")

Granted the third example dates back to 2008—but it was published soon after Russia was responsible, among various other belligerent acts to be detailed below, for a violent and bloody war of conquest against the former Soviet Republic of Georgia, in the South Caucasus. That war, clearly and cynically provoked by the Kremlin against a post-Cold-War independent country, reignited one of the Caucasus's bloody *frozen conflicts* from the early 1990s—in which Moscow shared much original blame. The Kremlin's method was to *liberate* (occupy) sovereign Georgian territory (South Ossetia and Abkhazia) and leave Georgian borders

destabilized. The motive was to deny Georgia the right of self-determination, by negating the viability of her application to join the European Union and NATO.

To bring matters up to the present, a reading of selected items in COMSUBLANT's Undersea Warfare News e-mail daily suggests that funding (and timing) on Capitol Hill, for SSBN(X) ships and more VIRGINIA-class ships (including extended-hull VIRGINIA versions with the Virginia Payload Module – VPM – to make them SSGN-capable), continues in a long-term precarious state. And this is despite Russia's recent military annexation of Ukraine's Crimean Peninsula, plus Moscow's ongoing (as of this writing) sponsorship of bloody territorial separatism/conquest in eastern Ukraine.

What is to be done in this domestic ASW war of words? How can we best protect America's overall defense readiness?

Demolishing The Flawed ASW Rhetoric: Two Prongs Besides "Going Up North" Again

The bogus claim that "America's nuclear subs are Cold War relics" can perhaps be reversed most convincingly by resorting over and over to clear logic and established facts. But this only works if audience attention can be earned, and held, long enough for people to listen and understand, and then vote their consciences. This laudable goal is being served by submarine supporters far and wide, in part via the many and varied discussions extant re the indispensable mission roles played by the U.S. Sub Force ever since the "Evil Empire" of the USSR fell – the ongoing survivable strategic deterrent role of SSBNs being foremost among them. A brief overview is worth repeating here, for thoroughness and clarity of this article's perspective.

Though the Cold War might (or might not) be *over*, America's nuclear subs continue to be essential tools for peace-maintenance and peace-restoration. This claim can be validated convincingly in at least two ways:

- *Global Contingency Operations:* As Sub Force leaders, the Submarine Industrial Base Council, and Naval Submarine League and U.S. Submarine Veterans, Inc., members

have long helped impart to Congress and around the country, there are lots of other things nuclear subs are needed for besides winning cold wars against nuclear-armed evil empires. These other missions, successfully completed to *bring home the bacon* innumerable times since 1991, include intelligence, surveillance and reconnaissance (ISR); indications and warnings; special operations support (SPECWAR); Tomahawk cruise missile land attack (such as USS FLORIDA's 2011 firing of 93 cruise missiles against Libyan dictator Muammar Gaddafi's air assets); oceanic mapping/sampling for environmental and resource protection; mine-laying and minefield penetration; counter-terror and anti-piracy/anti-smuggling ops; downed-pilot lifeguard duty; undersea, surface, and aerial drone launch and/or control; anti-surface warfare (ASuW) and sea lines of communication (SLOC) protection; and persistent access to areas that are subjected by adversaries to anti-access/area-denial (A2/AD) weapons systems. The indispensable Sub Force missions also include 4,000 (and counting) safe and effective strategic nuclear deterrent patrols, in a world where nuclear warheads and their intercontinental delivery systems unfortunately continue to abound and proliferate.

- *China's rise:* China's rapid development toward a modern nuclear navy is an example of an emerging near-superpower competitor, thermonuclear ICBM armed, whose long-term regional and global intentions are not yet transparent. I do not wish to demonize China for following her own vision of *Manifest Destiny*, nor to condemn China for her frankly brilliant execution of the teachings of A.T. Mahan and Theodore Roosevelt. It nevertheless does seem reasonable for people in various countries to feel qualms about China's expanding maritime territorial claims (her construction of artificial island bases in disputed local seas in particular), her growth in global power projection capabilities, and her repeated use of non-lethal or semi-lethal force at sea. China as a potential/encroaching threat, with

> growing naval forces including a burgeoning nuclear submarine fleet that includes SSBNs, certainly justifies continuing to fund a robust U.S. Navy Submarine Force.

A Frontal Assault on the "Cold War Relic" Claim

Perhaps the most direct, (and valid) way to attack the flawed logic that argues wrongly for the discontinuance, or further downsizing, of the U.S. Navy Submarine Force as Cold War relics, is to refute the claim that *the Cold War is over*—along with its accompanying, pernicious insinuation that this *ended-ness* is permanent. What if the Cold War with Russia were not over, even though the Soviet Union imploded down to the Russian Republic? Or, what if a new Cold War with (by) Russia (and/or with China for that matter), were to have already broken out, or be breaking out now, or lie just around the corner? Nuclear subs would then be just as much the essential, effective peace-and-survival tools going forward that they proved to be in the past. This makes it absolutely imperative to replace the OHIO-class SSBNs smartly, and build VIRGINIA-class SSNs and extended-hull VIRGINIA SSGNs numerously.

Let us posit, and justifiably celebrate, that the First Cold War did indeed end when the USSR ended. Subsequent events are showing that *the "First Cold War" did not end all cold wars.* Nor, alas, did it make the world safe for democracy, at least not yet. These concerns will be the focus of the remainder of this article.

Better Grasping EUCOM Security Trends by Connecting More Dots

One potentially harmful side effect of American (and wider Western) society's forward-looking and peace-loving nature is having an overly short, overly optimistic collective memory regarding national defense policy and politics. Many commentators over the decades have noted how we Americans, and other NATO members as well, naturally crave rapidly ending any war in which we become involved, even if the underlying larger conflict remains unresolved. Naturally enough, we want to stop the killing—but then we rush into a period of disarmament to enjoy a

well-earned *peace dividend*. The same commentators (each in their day) note how the killing then all too soon resumes. World War I as a causal/enabling factor led to World War II; World War II similarly led to the Cold War. The end of the Cold War led to (or at least coincided with) recurring wars with various Islamic extremists, ranging from al Qaeda to the Taliban to Saddam Hussein (two wars with Saddam, or three if we include the 1980s Tanker War after he invaded Iran), to Hamas and Hezbollah and the Islamic State of Iraq and the Levant (ISIL), plus other insurgencies or civil wars in Yemen, Somalia, Libya, Syria and elsewhere.

We the People need to figure out a good way to preserve all our many admirable qualities, while *curing* what I think of as our *ill-advised craving to retire prematurely from our de facto duty as the world's policeman and arsenal of democracy*. Just as crime will never cease short of some unattainable utopia, war will never cease so long as deteriorating social conditions, inter-ethnic bigotry, and sheer chance combine to let *soulless, murderous sociopaths* seize political power. By doing so, a few of them do gain control over massive armies and arsenals and then use them for slaughter—whether in nation-state dictatorships; or in failing, failed, or rogue states; or in terrorist, drug lord, or other armed groups. *While not repeating mistakes we made in Afghanistan and Iraq, we must not let ourselves become paralyzed against well-planned, adequately resourced, broad coalition operations that are needed—and have both achievable goals and good exit strategies—in the future.*

More broad public education and dialogue seem to be key, with a greater focus on today's and tomorrow's defense challenges and problems. Well-publicized, mass-market studying of military history in and of itself—perhaps because it needs to appeal best to commercialized, politicized pop culture audiences—has tended to become either a self-complacency building celebration of past victories, or a self-loathing building condemnation of past failures. Too much of either has the bad side effect of fomenting a contagious look-to-the-past, head-in-the-sand *future war denial* on

the part of voters. Alas, this does not help promote learning of life-saving preparedness lessons for the next (inevitable) war.

One (purely illustrative, but, again, telling) example of this collective *short memory* in the West, regarding Russia's belligerent conduct since the Berlin Wall fell in 1989, crops up in a recent news article in The New York Times. The person quoted, perhaps surprisingly since Estonia felt Stalin's boot in the USSR after it felt Hitler's in the Third Reich, is Estonia's president, Toomas Henrik Ilves.

"Tensions Surge in Estonia Amid a Russian Replay of Cold War Tactics," by Andrew Higgins, ran on October 6, 2014. It discusses how, on September 5, a squad of Russian security operatives made a shallow penetration of Estonian territory to kidnap Eston Kohver, a Estonian internal security officer, and threw him in a Moscow prison on nonsensical charges of spying. The article quotes President Ilves as saying, "Is this the beginning of something [renewed Cold War-like tensions] or a one-off? Time will tell. You can't draw a line until you have two points."

The article then notes portentously that on September 18, Russia seized a fishing vessel from neighboring Lithuania, in what Lithuania insists were international waters. As the reporter quite correctly says, "Russia added another point of reference."

(Poor Mr. Ilves was subsequently tried in Moscow and sentenced to a long prison term. Later—in an incident right out of one of John le Carre's Cold War spy novels—he was exchanged for a Russian operative arrested in the West.)

A more thorough review of publicly available information on Russian Federation military activity since 1991 will establish that there have been, in blaring public view all along, many other points of reference to prove that Cold War-style tensions never ended, or at least if they ended they almost immediately resumed. Nor is this *Russia Behaving Badly* thesis some mere myth, perpetuated by *Old Cold Warriors* or *Neo-Conservatives* in the West who allegedly have vested commercial, professional, or political interests in trying to prolong a long-dead conflict. Detailed discussions on Russian post-Cold War aggression and interference, with page upon page of scholarly footnotes, abound

in academic journals and books, and in other publications generally seen as *liberal*.

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THE CASE FOR A USS LEVERING SMITH

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The Navy's ship naming conventions have become quite flexible, recognizing changes in both technology and politics. Battleships have left the fleet, but not the need to honor the states of the union with namesake warships. State names were given to Trident ballistic missile submarines, but not exclusively so, as one is named the USS HENRY M. JACKSON, after the late senator from Washington State. The Seawolf class originally continued the tradition of naming attack submarines after fish, but then came USS CONNECTICUT and then USS JIMMY CARTER, our 39th president, and the Virginia class now has a USS JOHN WARNER, the former Navy Secretary and Senator from Virginia. There are aircraft carriers named after presidents of both political parties, members of congress who fought for the defense budget, and the two great theater commanders of World War II, Admiral Nimitz and General Eisenhower.

Once destroyers were named after our war heroes, although that is no longer totally the case, as soon there will be USS LYNDON B. JOHNSON, a Zumwalt class destroyer named for our 36th president. The newest Independence class Littoral Combat Ship is to be USS GABRIELLE GIFFORDS, named for the Arizona Congresswoman who survived an assassination attempt. And each of the sites attacked on 9/11 – New York, Arlington, and Somerset County—are recognized in the name of an amphibious warfare ship.

The Navy does more with ship names than honor national geography, experience, and politics. It also honors its own history in the perpetuation of heroic ship names such as ENTERPRISE

and KEARSAGE and the recognition of naval leaders like Burke and Zumwalt. It is fitting too that the Navy now honors its technological leaders with ship names, people who helped create the modern Navy. USS HOPPER (DDG-70) recognizes the important contributions of Rear Admiral Grace Murray Hopper who helped develop early computer hardware, programming languages and the first computer networks. USS WAYNE E. MEYER (DDG-108) honors Rear Admiral Meyer who shepherded the Aegis system through its development and onto our main surface combatants. And there was USS HYMAN G. RICKOVER (SSN-709), named after the admiral who led the effort to develop nuclear propulsion for the fleet.

In this vein, it is time to honor the naval officer most responsible for the successful development of the Fleet Ballistic Missile (FBM) which is the mainstay of our nuclear deterrent, the weapon system that has assured our national survival against our most dangerous adversaries for nearly six decades: Vice Admiral Levering Smith. There have been six versions of the FBM, the POLARIS A-1, A-2, and A-3, the POSEIDON, and the TRIDENT I and II, the first five of which were developed under Smith's direction. To take these missiles to sea, the Navy acquired 41 Polaris SSBNs and later 18 Ohio class SSBNs. In addition, there were bases in Scotland, Spain and Guam as well as the United States, tenders, test ranges, and related communications systems that had to be developed and built. It was and still is a massive undertaking.

In 1955, the Navy lacked authorization for its own ballistic missile when the US began racing the Soviets in that new means of long range nuclear strike capability, and it was forced to team with the Army to build a sea-based version of Jupiter, the Redstone Arsenal's liquid fueled intermediate range ballistic missile. The thought of this giant missile on a ship or submarine with its highly combustible liquid fuels concerned then Captain Levering Smith, who joined the Special Projects Office (now the Strategic Systems Projects Office) soon after its establishment, and he began pushing SP and the Navy to start what became Polaris, a smaller, safer, solid fueled missile. Then, as SP's

Technical Director, he managed the complicated development effort to integrate the missile and its fire control system on a nuclear powered submarine, all of which was done to an exacting schedule. The first SSBN, USS GEORGE WASHINGTON, went on patrol in November 1960, five years after the official program start. A line officer converted to aviation engineering duty, Levering Smith served almost 22 years in SP, the final 12 as its Director, retiring as a Vice Admiral.

Despite the race with the Soviets, there were many who did not believe it was the Navy's task to enter the ballistic missile arena. Yet without the Polaris innovation, our nuclear forces likely would have remained vulnerable and the balance of terror delicate. The Air Force's switch from liquid to solid fuel missiles was provoked by Polaris, and together the much improved survivability of Polaris and Minuteman then enabled the accelerated retirement of SAC's vast but inherently vulnerable force of intermediate range B-47s, leaving the more survivable, intercontinental range B-52 as the mainstay of the bomber leg of what we now call the Triad. Levering Smith therefore played a central role not only in the FBM program but also in the general transformation of our nuclear force structure that occurred in the late 1950s and early 1960s.This was Levering Smith's greatest contribution.

Decades after Polaris, we still depend upon the FBM system for our ultimate security. In fact, the Navy's new class of ballistic missile submarines is its number one priority. The Ohio Replacement Program is a costly but vital undertaking. It may seem to be too soon to start naming boats in this new class of SSBNs, but it is well past time for a USS Levering Smith.

APPARENT FAILURE MODE OF THE PRESSURE-HULL OF THE ISRAELI (INS) SUBMARINE DAKAR

by Mr. Bruce Rule

Bruce Rule, for 42 years, has been the lead acoustic analyst at the Office of Naval Intelligence. In 2003, he wrote the Navy position-paper on the acoustic, dynamic and temporal characteristics of submarine pressure-hull and bulkhead collapse events. In 2009 he provided the Navy with the first reanalysis of acoustic detections of the loss of the USS SCORPION in 40-years which confirmed that disaster was the results of a bettery explosion.

Bruce Rule was the lead acoustic analyst at the Office of Naval Intelligence for 42 years. In 2003, he wrote the Navy position-paper on the acoustic, dynamic and temporal characteristics of submarine pressure-hull and bulkhead collapse events. From 2007 to 2015, he analyzed open-source acoustic data to determine why several submarine loss events occurred.[1,2]

A June 2013 MIT doctoral thesis in Ocean Engineering[3] describes failure modes for the hydrostatic collapse of test cylinders. One mode involves deformation and failure along the entire length of the cylinder.

A former British T Class diesel submarine recommissioned as the INS DAKAR was lost in the Mediterranean in Jan 1968 while in transit to Israel. A schematic derived from imagery obtained when the wreck was located in 1999 indicates the DAKAR pressure-hull appears to have failed linearly along a significant part of the entire length of the structure: “from the control room to the stern.”[4]

One of the main propulsion electric motors was imaged near the bow. Collectively, these observations indicate the DAKAR pressure-hull collapsed—initially well aft—at great depth creating

a high-velocity water-ram that tore the motor loose from its mounting.

When SCORPION collapsed at a depth of 1530-feet, an after compartment was *telescoped* within a forward compartment by a distance of 50-feet in less than 0.112 seconds: the duration of the compression phase of the collapse event, i.e., half the reciprocal of the bubble-pulse frequency of 4.46 Hz. Those values correspond to an average forward velocity of 300 mph for the after compartment.

The collapse depth derived from detection of the acoustic bubble-pulse frequency are known for THRESHER, SCORPION and the Soviet NOVEMBER K-8. Respectively, those values in feet—compared to the estimated collapse depth - are: 1950/2400 actual, 1050/1530 actual, and 1250/2020 actual. Actual collapse depth exceeded predicted collapse depth by an average of 44 percent.

If the DAKAR pressure-hull survived by a similar margin beyond the predicted collapse depth of 626-feet, collapse would have occurred at about 900 feet (400 psi). This assumption is consistent with the condition of the wreck – especially the location of the propulsion motor—and indicates the pressure-hull of the DAKAR was intact until it collapsed.

No submarine pressure-hull or internal compartment collapse event bubble-pulse frequency, the duration of the initial collapse-expansion cycle of air within a collapsing structure - has exceeded 0.3 seconds. Half that value, the 0.15 second duration of the collapse phase of the event, is the period within which all structures internal to the pressure-hull would be completely destroyed.

Since 0.15 seconds also is the sum of the minimum human retinal and cognitive integration periods, no crew lost to collapse of a submarine pressure-hull or internal compartment at great depth would be aware of the event. That assessment includes the crew of the INS DAKAR.

The main section of the DAKAR wreck, the stern section and the sail (fin) are within a debris field with a diameter of about 800-feet at a depth of 9514-feet (4) after falling as separate sections

through about 8600-feet of water, an observation consistent with conclusions derived from analysis of acoustic detections of the loss of SCORPION and imagery of that wreck: all sections of hydrostatically destroyed submarines sink nearly vertically. Note: the dynamic forces associated with structural collapse at great depth are sufficient to cancel all pre-existing directions of motion.

ENDNOTES

1. *THE SUBMARINE REVIEW*, SUMMER 2012, pp, 141, Letter to the Editor, SCORPION.

2. THE SUBMARINE REVIEW, SPRING 2012, Article, pp. 98-106, "Russian SSBNs - A 'Dead Man' Launch Capability?"

3. MIT DOCTORAL DISSERTATION (OCEAN ENGINEERING), JUNE 2013: "ANALYTIC AND NUMERICAL STUDY OF UNDERWATER IMPLOSIONS" Author of dissertation: Lynn Andrew Gish. B.S., United States Naval Academy (1993) M.M.E, Catholic University of America (1994) S.M., Massachusetts Institute of Technology (2004) Naval Engineer, Massachusetts Institute of Technology (2004)

4. http://www.submarines.dotan.net/dakar/search/

SUBMARINE NEWS FROM AROUND THE WORLD

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From the September 2015 Issue

TAIWAN – Major Procurement Programs Reaffirmed

In late August 2015, AMI received information that Taiwan continues to update its plans for the future of the Republic of China Navy (ROCN). The majority of the Information received reaffirms current thinking and planning within the ROCN. The following programs are now or still being considered:

Diesel Electric Submarines: The Kwang Hua 8 Submarine Program continues to move forward at a slow pace. In October 2014, Taiwan's Ministry of National Defense (MND) announced that it was reviewing ROCN proposals for a US$4.9B program to build four indigenously designed diesel electric submarines. The MND has also announced that this indigenous program would run in tandem with the continued requests to the US Government for a US solution, which has been in the works since the beginning of the US Bush Administration in 2011 although no progress has been made.

In regards to the indigenous approach, the research and development center (R&D) Ship and Ocean Industries apparently is developing the design and the China Shipbuilding Corporation (CSC) will be awarded the construction contract. In late August 2015, the MoND submitted a US$90M budgetary proposal to continue the design phase. Chungshan Institute of Science and Technology (CSIST) will be tasked with the development of the combat system.

The new submarine is estimated to be around 1,500 tons with the first entering service by 2025. Construction would have to begin no later than 2017 or 2018 if the ROCN intends on commissioning the first unit in 2025. This long design and construction period can be expected when considering this will be Taiwan's first attempt to design and build its first submarine. AMI

estimates that all four units will not enter service until around 2030. As the initial requirement was for eight units there may be a second batch after 2030. However, that will depend on the success of building, testing and operating the first four units.

Although the ROCN will utilize all local companies in every phase of the program, there is no doubt that the US submarine builder General Dynamics could be involved in the design and construction phase and systems houses such as Lockheed Martin and Raytheon will help develop and supply combat systems solutions for the program.

REGIONAL UPDATE

VIETNAM

Hanoi Class (Kilo 636) Diesel Electric Submarine (SS): On 30 July 2015, the third and fourth Hanoi class (Kilo 636) submarines, HAIPHONG (HQ-184) and DA NANG (HQ-185) were commissioned into the Vietnamese People's Navy (VPN) at a ceremony at Cam Ranh Bay Naval Base.

The fifth and sixth units, KHANG HOA (HQ-186) and BARIA VUNG TAU (HQ-187) will be delivered by the end of 2016 ending the program. There are no indications at this time that the VPN will order additional units following the delivery of the final units in 2016.

INTERNATIONAL

Shipyard and System House Updates

AMI is currently tracking shipyard and system house consolidation, merger, reorganization and joint venture highlights within the defense industry. The following are the highlights for the months of August and September 2015:

PIPAVAV/ZVEZDOCHKA: In late July 2015 India's Pipavav Defense and Offshore Engineering signed an agreement with Russia's Zvezdochka Ship Repair Center (part of United Shipbuilding Corporation) to establish a joint venture (JV) for the refit of the Indian Navy's (IN) nine Sindhughosh (Kilo 877EKM) class diesel-electric submarines (SSK).

Until now, modernization programs for the IN's Kilo class have meant the submarines had to be taken to Zvezdochka for the three-year long overhaul. One unit had undergone the modernization at Hindustan Shipyard Limited (HAL), however this took nine years to complete.

The new JV, owned 51/49 percent, the majority being with Pipavav, once established, will be responsible for these modernization programs and should allow, with the Russian assistance, work to be completed in a reasonable timeframe; more in line with the 3 year time line. Additionally, savings will be found in the lower transportation and labor costs associated with in-country repair capabilities.

This, of course, is assuming the JV does go through and a repair contract for the submarines is realized. In that event, the first unit to receive a modernization would still transfer to Russia for the work to be done under observation of the Indian workers as a training program. Subsequent work would then occur in India.

Combat, Sensor, and Integration System Developments

AMI is currently tracking combat, sensor and integration systems developments. The following are the highlights for the months of august and September 2015:

UUV WIRELESS CHARGING: In late August 2015, the US Navy (USN) announced that it is developing ways to recharge unmanned underwater vehicles (UUV) using wireless technology. The ability to wirelessly recharge a UUV's batteries, while remaining in the water, would significantly decrease the time between missions and increase the overall utility of the system.

The Naval Surface Warfare Center, Carderock Division (NSWCCD) is the technical lead for the program and hosted teams from Naval Undersea Warfare Center, Division Newport (NUWC DIVNPT) and Space and Naval Warfare Systems Command SPAWAR Systems Center Pacific (SSC PAC) to simulate full capabilities of the Midsize Autonomous Research Vehicle (MARV).

DID YOU KNOW?

UNITED STATES: On 15 August 2015, the USN announced that the 26th Virginia class nuclear powered attack submarines (SSN) will be named the USS IDAHO (SSN 799). On 01 August 2015, the USN commissioned the 12th unit of the class, USS JOHN WARNER (SSN 785), in Norfolk, Virginia.

From the October 2015 Issue

New Player in the A26 Submarine Program

In mid-September 2015, AMI received information that the Polish Navy (Marynarka Wojenna – MW) was considering the Swedish A26 design for its submarine program. Once thought to be a close competition between ThyssenKrupp Marine (TKMS) of Germany and DCNS of France, the MW apparently has begun to look at the A26 as an option. First steel was cut for the Royal Swedish Navy's (RSwN) first hull on 04 September at Kockums Shipyard in Karlskrona.

Considering the A26 will probably begin to slow the MWs program again as the sea service considers how it will match its requirements with a new design. The Request for Proposals (RfP) for the Polish program was expected in 2015 and a construction contract in 2016.

Poland is now the third foreign country to show an active interest in the A26 harking back to the times of the Viking Program before cancellation. In mid-September 2014, AMI received information that the Royal Netherlands Navy (RNIN) intended to join Norway and Sweden in a new construction submarine program. The RNIN's first submarine is scheduled for delivery by 2023. In January 2015, Damen Shipyards Group of the Netherlands and Saab of Sweden signed an exclusive teaming agreement for the Walrus class submarine replacement program for the Royal Netherlands Navy (RNIN).

Prior to these announcements, all three countries were planning for future submarine programs to replace their respective existing forces with the Polish now being the fourth. The Dutch were in the early planning stages to replace the four Walrus class beginning in 2023. The Norwegians were working on Project 6346

(Ny Ubat) (new Uboat) to replace the six units of the Ula class. A decision was made in late 2014 build a new class rather than further modernize the Ula class. A new construction solution was estimated to begin in 2017 with the first unit entering service after 2021. At the time, the Swedish were in the process of developing the new A26 design to replace its two Sodermanland and two Gotland class. The program was expected to start in 2016 with first deliveries around 2021. As mentioned earlier, first steel was cut in early September 2015.

All told, if the Polish enter the program, the four navies have a requirement for a total of 17 submarines and all with similar procurement timelines. It makes sense that all four would join forces in order to reduce costs (design savings and economies of scale for 17 hulls) and reduce risk for all four partners. This is similar to the now defunct Viking program that was cancelled in 2007 in which Sweden, Norway and Denmark were members. Denmark has since eliminated a submarine capability in their navy.

With the individual submarine programs expected to start over the next several years; Poland, Norway and the Netherlands will need to finalize their requirements in the near term. AMI anticipates that all four programs will utilize a similar hull, the Swedish A26, with national variances for each country. To date, only Sweden's program is solid as first steel has been cut; for the other three potential partners, only time will tell if they join the program. However, it does appear that it is the most sensible solution.

INDONESIA

Still Considering Russian Submarines

As of late September 2015, AMI continues to receive information that the Indonesian Navy (TNI-AL) is again considering the procurement of Russian submarines. These submarines would be procured under the 2015-2019 strategic plan even though 2016 defense spending levels will drop around 6% (US$490M) from 2015 levels.

The TNI-AL continues to make its case for a force of 12 submarines to protect its large archipelago and currently operates two aging Type 209 (Cakra class) submarines delivered in 1981 and overhauled in South Korea in 2004 and 2006. The sea service is in the process of procuring up to three Improved Chang Bogo (Type 209) submarines from South Korea under a 2012 US$1.2B agreement. The three units will/are being built at South Korea's Daewoo Shipbuilding and Marine Engineering (DSME) and Indonesia's PAL Shipbuilding. This will bring the Type 209 force to five units, leaving the TNI-AL short seven hulls.

This shortfall of hulls is why the consideration for Russian submarines continues among many circles in Indonesia. In fact, when Indonesia decided to procure the Chang Bogo from South Korea, the other offer on the table was Russia's Kilo and Amur classes.

Again in January 2014, the sea service made a visit to Russia to discuss an offer made by Russia for a combination of new construction Kilos (probably the Kilo 636.3 variant) and used units of the 877 and 636 variants. However, on 12 March 2014, the Russian option was again ruled out due to the poor condition of the used submarines. There was also the belief that more new construction submarines from Russia would interfere with Indonesia's long term plans to become more self sufficient in naval construction including the building of the Chang Bogo in country.

The reconsideration again for Russian submarines probably represents a new offer from Russia for either the latest Kilo model (636.3) now being built for the Russian Navy or the Amur class which has never been exported. With the defense budget dropping (although slowly), it could be that Russia is offering extremely good credit conditions for this sale, which could lead to more hulls after 2019. Considering the three Chang Bogos (when complete), the two existing Cakra class (Type 209s) and two new Kilo/Amurs, the TNI-AL will still be short five hulls.

AMI believes that this seven hull shortfall in a time of declining budgets may be putting pressure on the TNI-AL to move forward with a Russian purchase if under the right circumstances

such as a fast delivery schedule and the right financing program (countertrade agreements, interest rates and terms etc.). Indonesia is also familiar with Russian defense purchases as it continues to procure air and land systems through countertrade agreements.

If Indonesia does decide to move forward with the Russian submarines, AMI expects that the deal could be done as early as 2016 for what will probably be either the Amur or the Kilo 636.3. To sweeten the deal, the Russian Navy could transfer one of their new construction units up front similar to what France did with Egypt when it transferred a French Navy FREMM frigate to Egypt.

DID YOU KNOW?

Brazil: On 02 September 2015, the final section of the pressure hull for the Brazilian Navy's (Marinha do Brasil – MdB) first Riachuelo (Scorpene) class submarines BNS RIACHUELO (S 40) was delivered to Itaguai Construcao Naval (ICN). The next phase of equipment and systems installation is underway.

From the November 2015 Issue

INDIA

Kalvari (Scorpene) Class Submarine (Project 75): On 06 October 2015, sources indicated that the Indian Navy (IN) was considering the procurement of up to four additional Project 75 Kalvari (Scorpene) class submarines to follow the six units in various stages of construction (first conducting sea trials) at Mazagon Dock ltd (MDL). The sea service is increasingly concerned about the declining numbers of the Submarine Force which is now down to 15 hulls.

Continuation of the Scorpene production line at MDL appears to be the quickest solution to stopping the degradation of the Submarine Force and increasing fleet numbers in the medium term. In 2005 when the Scorpene program began, the IN had originally planned for a total of 24 units although that number soon became unrealistic and was eventually reduced to six while looking to other options (Project 75I/76) and now a Nuclear Powered Attack Submarine (SSN).

If in fact the IN decide to build four additional units of the Scorpene design, it will be independent of the Project 75I program in which a Request for Proposals (RfP) is due to be released in 2016.

The decision of whether to continue with the Scorpene design will need to come quickly in order to avert any stoppage in construction between unit six and unit seven. In order to achieve this, the IN will need to release an RfP to MDL in 2016 for the four units of Project 75. MDL will also vie for Project 75I although AMI believes that 75I may go to a different yard. It will make much more sense to utilize two yards in order to increase the production rate and thus increase the Submarine Force faster.

AMI estimates that the first six Scorpenes should enter service by around 2019 I there are no further delays. Assuming that unit seven starts by 2017 and the construction phase is faster than the first six units (four years versus ten), he first unit should enter service in 2021.

As mentioned earlier, MDL was shortlisted for Project 75I in addition to Hindustan Shipyard Ltd (HSL0, Cochin shipyard Ltd (CSL), Pipavav Shipyard Ltd (PSL) and Larsen & Toubro (L&T). AMI believes that one of the other four yards will build Project 75I submarines if MDL continues on with the Project 75 Scorpene hulls.

PAKISTAN

Chinese Submarine Deal Finalized

On 24 July 2015, AMI received information that Pakistan and China agreed to terms on a US$4B-US$5B deal for the procurement of up to eight Chinese designed submarines for the Pakistani Navy (PN). Financial agreements were concluded during a meeting between Pakistan's Finance Minister, Ishaq Dar and Chinese state owned China Shipbuilding and Offshore International Company Ltd's (CSOC), Zu Ziqin.

According to multiple sources and Pakistani Minister for Defense Production Rana Tanveer Hussain in early October 2015, the final agreement has been concluded following financial agreements, which was the final phase of the negotiating process.

The financial terms include Pakistan making payments in four installments to China. The technology transfer agreements were concluded in 2014.

On 01 April 2015, Pakistan's Prime Minister Nawaz Sharif approved the government-to-government deal for the eight submarines from China. The eight units will be built in China in addition to Pakistan's Karachi Shipbuilding and Engineering Works (KSEW) with Chinese assistance. The Chinese-built units will be built at either the Wuhu or Jiangnan Shipyards.

Four hulls are planned to be built at each location although it is possible that China could build additional units (of the remaining four) if Pakistan falls behind on its building schedule. This will be the most aggressive naval building schedule. This will be the most aggressive naval building program for KSEW to date.

With the contract signature now in place, the first four units that will be built in China could start the construction phase in early 2016 with delivery of all four by 2022. The first Pakistani unit could start by the end of 2016 and commission in 2021. The remaining three units of the class (assuming all Pakistani construction) could commission from 2022 through 2025.

AMI estimates that the majority of all combat and sensor systems will be of Chinese origin with some of the components being built in Pakistan. Pakistan's Prime Minister did announce in April that the PN was considering the Yuan (Type 041) and the export S20 design although it is still unconfirmed as of this writing (not released publicly).

The new submarines will displace around 2,300 tons and armed with YJ-82 anti-ship missiles and a combination of Yu3 and Yu-4 torpedoes. The biggest question will be if the PN wants to have an Air Independent Propulsion (AIP) capability, which was stipulated in the early days of the program. Since 2007, rumors have persisted that some of the Chinese Yuan (Type 041) class are using an AIP system developed by the No. 711 Research Institute. If this technology is available, then the PN will most likely integrate it into the program, and hence the final design selected. Pakistan could also utilize Tognum MTU diesel engines in lieu of

Chinese diesels. China used MTU diesels in its song class and builds MTU engines under license.

The Pakistani's have also decided to utilize the Chinese Beidou-II (BDS-2) satellite navigation network.

TURKEY

MILDEM Indigenous Submarine: Expected to follow the Reis (Type 214) class submarine program beginning around 2026. The conceptual design phase start date has yet to be determined. However, AMI expects it to start around 2021 with the RfP being released in 2024 in order to begin construction in 2026 following Type 214 construction.

AUSTRALIA

SEA 1000 Program Manager Announced, Design Selection Late 2015/Early 2016

On 28 October 2015, the Australian Department of Defence Secretary Dennis Richardson and Australian Defence Force (ADF) Chief Air Chief Marshal Mark Binskin announced that retired US Navy (USN) Rear Admiral Stephen Johnson has been appointed as General Manager of Submarines.

In his role, the Admiral will be in charge of the Royal Australian Navy's (RAN) SEA 1000, the acquisition of 8-12 (requirement is for 12) new submarines under the Future Submarine Program. He will oversee the competitive evaluation process (and construction phase) that will choose the submarine design for the program as well as the sustainment for the six Collins class submarines currently in service.

The design decision is expected to be made in late 2015 or early 2016 with the three contenders being the Japanese Soryu design, the Thyssenkrupp Industrial Systems (TKIS) Type 216 and the DCNS Shortfin Barracuda design. All three contenders have expressed a willingness to build all or some the submarines in South Australia, a promise that continues to be made by many Australian politicians to shipbuilding industry.

Although a decision on the design has yet to be finalized, a key requirement for the program is for a US derived combat

system. This requirement may in fact lead to the Soryu design as the Japanese also use US systems or derivatives of US systems. The US has never put a submarine combat system in French or German-built submarines and it would probably not occur in this case as well.

The timing and building location for SEA 1000 is critical to Australia's naval shipbuilding base with ASC already beginning to reduce its staff and work force as the Hobart class Air Warfare Destroyer (AWD) (SEA 4000) reaches maturation. In addition to SEA 1000, the RAN is also awaiting decisions on the Future Frigate and Offshore Combat Vessel Programs that will surely affect the workforce at ASC, BAE and Austal.

REGIONAL UPDATE

As of mid-November 2015, the following are highlights of the Asia Region:

VIETNAM: **Hanoi Class (Kilo 636) Diesel Electric Submarine (SS):** In late October 2015, Russia's Admiralty Shipyard launched the sixth and final Hanoi Class (Kilo 636) submarine for the Vietnamese People's Navy (VPN). The BARIA VUNG TAU (HQ-187) will be delivered by the end of 2016 ending the program. There are no indications at this time that the VPN will order additional units following the delivery of the final units in 2016.

DID YOU KNOW?

TURKEY – On 10 October 2015, the first steel was cut on the TNF's first Reis (Type 214) class submarine, TCG PIRIREIS, at Golcuk Naval Shipyard.

UNITED STATES – On 10 October 2015, the United States Navy's (USN) thirteenth Virginia class Nuclear Powered Attack Submarine (SSN), USS ILLINOIS (SSN 786) was christened at General Dynamics Electric Boat in Groton, Connecticut.

THE SUBMARINE COMMUNITY
A PERSPECTIVE FROM A FORMER JUNIOR OFFICER

by David W. Williams, Lieutenant, USN (Separated)

The author is a former NROTC scholarship officer, qualified in submarines and nuclear power. He served in the 1960's, qualifying on USS BONEFISH (SS-582) and then in nuclear power on USS NATHANAEL GREENE (SSBN-636) Blue in 1967. Duties on NATHANAEL GREENE included M Division Officer, Ship's Submarine Qualification Officer, Engineering Officer of the Watch, and Officer of the Deck. He is a lifetime member of the Naval Submarine League.

As a former cold war submarine officer, I have for several years read with interest the articles in THE SUBMARINE REVIEW. Occasionally there are articles addressing officer training, qualification, and retention, but each has skirted or not addressed aspects that I believe may be crucial. Admittedly, my experiences and evaluation are anecdotal and possibly out of date, but I submit them as constructive criticism in the interest of improving the officer corps.

The two factors I have not seen adequately addressed very well are retention rate, and required areas of training and qualification. These are not independent but interrelated.

Retention rate during my submarine days was very poor on the nuclear boats. Having been TDY for six months on a diesel before attending sub school and Nuclear Power Training (NPT), and going to another diesel for my first regular tour, I found a group that worked hard and played hard. Demands were heavy, but there was also time to socialize and to relax. For example, during my interview with the Squadron Commander to complete my qualification in submarines, he suggested I relax and enjoy myself for a few months. Also, after pinning on my dolphins and being thrown off the pier by the crew immediately after morning quarters, the Captain said I looked like I needed a day off, and sent

me home. I cannot imagine such conversations or comradery in nuclear subs.

Shortly before my resignation became effective, the Navy was offering a bonus of one year's salary for nuclear officers to extend active duty obligation for four years. I did not even consider this for more than a few seconds. A junior officer shipmate, who was an USNA graduate, accepted, and later confided in a hushed tone that he thought he had made a mistake. NATHANAEL GREENE'S wardroom in my 2 ½ years aboard never had more than three or four officers who intended to make a career in nuclear subs; even one of the Navigators resigned.

The principal reasons, as I evaluate the situation for low retention rate, can be abbreviated into (1) a brutal workload that pushed one to or past endurance, (2) an atmosphere of fear, for lack of a better word, engendered by Naval Reactors (NR), (3) essentially no hope of shore duty or Postgraduate School, and (4) being asked, really demanded, to master the engineering plant and also the operations and weapons systems and tactics in the forward part of the ship.

It is my considered evaluation that, even during the late 1960's, it was not possible to achieve the level of proficiency demanded in both engineering and operations/weapons, and still perform all the collateral and administrative duties required. Today, with the introduction of weapons and missions that I can only imagine (as most of the information is classified), I can envision officers who are hopelessly swamped. I feel sure the level of complexity of all equipment and operations, including the reactor plant with a lifetime core, is such that we really do need to have engineering specialists who are not unrestricted line officers.

I do not remember whether it was a written or unwritten rule on GREENE, but all qualification checkoff interviews were <u>not</u> done on watch. Because of the high officer turnover, the engineering Officers of the Watch (EOOW) were almost always on port-and-starboard watches (six hours on and six hours off) for at least one month into patrol, allowing essentially no time for checkoffs for Engineering or Submarine qualification or re-qualification. Even after progressing to one-in-three watches, an

Engineering officer standing watches forward as Officer of the Deck (OOD) underway had great difficulty just keeping up with departmental, (re)qualification, and collateral duties. It was seldom possible to get even three or four hours uninterrupted sleep a day, usually less. Many times I was in a kind of controlled mental fog, albeit well trained, during which time I was able to perform adequately only by forcing alertness, or, thankfully, occasionally being prompted or corrected by my fellow watch standers. My fellow Engineering officers shared this experience. In my civilian career twenty-five years later, I developed a close friend who had served on a nuclear submarine and a nuclear aircraft carrier in Engineering, and he had the same experience.

Addressing the idea that Naval Reactors (NR) engendered an atmosphere of fear is, I am sure, heresy to most of our readers. Although the word itself may be a little strong, the atmosphere of intimidation and negative leadership, the feeling that whatever you did was not enough, was forced down from the top to the junior officers and the enlisted men. For example, when being grilled by NR during Operational Reactor Safeguards Examinations (ORSE), when did an examiner ever say "good answer" or even "that's correct"? We were always questioned to the level of detail when you had to say "I don't know." To some this is called motivation, but it also causes, intentionally, I think, humiliation … which can lead to an opposite effect: demotivation. What is needed is positive leadership, not negative leadership and harassment. My experience admittedly is forty-five years or so ago, but the Navy and NR change slowly. A more recent book[1] in 2003, Dark Waters by Lee Vyborny and Don Davis, says:

> "One of Rickover's major failings was that he helped drive away a large number of such talented officers, costing the navy several generations of leaders."

This was written about forty years after I served, but it indicates my criticism may still be valid.

Another book, by Woodman and Conley[2] in 2014, discusses in part the long-term negative impact of Admiral Rickover by the

following partial quote from *Command of the Seas*[3] by Secretary of the Navy Lehman, published in 1988:

> "Rickover's legendary achievements were in the past. His present viselike grip on much of the Navy was doing it much harm. I had sought the job [SecNav] because I believed the Navy had deteriorated to the point where its weakness seriously threatened our future security. The Navy's grave afflictions included loss of a strategic vision; loss of self-confidence, and morale; a prolonged starvation of resources, leaving vast shortfalls in capability to do the job…all resulting in cynicism, exhaustion, and an under-current of defeatism.…"

When I completed submarine school, a detailer from Washington, D.C., talked to our class. As I recall, there were about 1000 nuclear trained officers and 997 sea billets, and he then named the few individual officers then on shore duty, including one in postgraduate school in Monterey. Not much had changed five years later upon completion of my obligated service, when a detailer, who was calling me to convince me to commit to four more years and the monetary bonus, confessed I had another ten years of continuous sea duty if I stayed on active duty. It was also emphasized that I needed to promptly complete qualification for Engineer.

As stated in Item (4) at the beginning of this article, I really think it is not possible to achieve and maintain the required level of proficiency in the Engineering Department, and also achieve and maintain a comparable level as a forward watchstander (with aspirations for command). Woodman and Conley[4] discuss the separation of the engineering billets from the *executive branch* (command, navigation, and sonar in U.K. submarines) billets, but are very diplomatic in not saying the U. S. Navy should do the same. In my opinion, they do, however, indirectly endorse it in part by quoting Secretary Lehman as above.

Conclusion

The U. S. Navy should have nuclear engineering specialists that do not have the additional demands of forward watchstanding, and are not unrestricted line officers (whose career path includes forward watchstanding and eventual command at sea). We should also have training for forward watchstanders in weapons, navigation, communication, reconnaissance, tactics, etc., on a level comparable to that in nuclear power. This is a bitter pill to swallow and digest, but I submit we will be a lot better off if we give it serious consideration.

ENDNOTES

1. Lee Vyborny and Don Davis, Dark Waters: An Insider's Account of the NR-1, The Cold War's Undercover Nuclear Sub, New American Library, 2003. (Page 167).
2. Richard Woodman and Dan Conley, Cold War Command: The Dramatic Story of a Nuclear Submariner, Seaforth Publishing [U.K.], 2014. (Pp. 170-171).
3. John F. Lehman, Jr., Command of the Seas, Charles Scribner's Sons, 1988. (p. 1).
4. Richard Woodman and Dan Conley, Cold War Command: The Dramatic Story of a Nuclear Submariner, Seaforth Publishing [U.K.], 2014. (Pp. 167-168).

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ON PATROL WITH RATS

by CAPT Edward S. Little, USN, Ret.

In the early days of the SSBN Polaris Patrols each crew was assigned a medical officer. They were good shipmates and provided some interesting interactions with the crew. The medical community required the assigned medical officers to complete a project during their time aboard. During the 16th patrol of USS ROBERT E. LEE (SSBN 601) (Gold) the medical officer embarked on a project to investigate a reported problem that wounds were slow to heal in a closed submarine environment.

The project involved the use of white rats. About 30 rats were procured. Fifteen were quartered on the tender, moored in Holy Loch, Scotland, in an open air environment during refit. The other fifteen were to be aboard during the patrol. Both groups participated in an identically controlled experiment. (The first in the open air environment on the tender and the second in the submerged environment of the submarine during patrol). Each regimen included the following protocol. After about 10 days each rat was put to sleep, an incision was made on the stomach, and the wound was sutured. After about two to three weeks each rat was euthanized and the scar tissue was excised and tested for strength. This was done by attaching a small container to the scar tissue and measuring the amount of milliliters of water poured in resulting in the rupture of the tissue. The two results were then to be compared to evaluate the reported problem. When the ship got underway the rats were quartered in cages in the missile compartment.

Our Captain made it absolutely clear to the medical officer that he was responsible to assure the rats were properly secured. The rats got a lot of attention from the crew. Each was appropriately named and there was much concern voiced about their future. To the amazement and sport of the crew the rats got particularly annoyed and angered when a crew member stood in front of the cage and opened the velcro on their submarine coveralls making a ripping noise. Unfortunately this was done a

lot and resulted with the rats becoming agitated, snarling, and charging the cages. While the medical officer did his best to retain order, his control was brought under question during one battle stations drill. Over the 1 MC was heard "Doctor to the missile compartment. Rats are loose." Fortunately he did manage to capture the errant rats. The retrieval of all the rats was of vital importance.

The ship was to return to the continental US after the patrol for overhaul and the Captain had to certify that no rats were aboard. A Deratting Certificate was required to be submitted to the quarantine inspecting officer on arrival. This also required that each carcass was accounted for after the test and fully documented. As we were good nukes a procedure using a two man verification and sign off at the trash disposal unit was put in place when each rat carcass was returned to the deep. The results of the test, although performed under the most stringent circumstances, was not conclusive in determining the fact that wounds healed more slowly in the enclosed environment of a submarine.

THE SUBMARINE REVIEW

THE SUBMARINE REVIEW is a quarterly publication of the Naval Submarine League. It is a forum for discussion of submarine matters. Not only are the ideas of its members to be reflected in the **REVIEW**, but those of others as well, who are interested in submarines and submarining.

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The League prepares **REVIEW** copy for publication using Word. If possible to do so, accompanying a submission with a CD is of significant assistance in that process. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the **REVIEW**.

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Comments on articles and brief discussion items are welcomed to make **THE SUBMARINE REVIEW** a dynamic reflection of the League's interest in submarines.

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LETTER TO THE EDITOR

Comment re: "Respect for Authority-Overrated?"

Dear Editor,

I enjoyed RADM Dave Oliver's story "Respect for Authority – Overrated?" (THE SUBMARINE REVIEW, August 2015 issue, page 116) very much. There is a small technical error in the story which I presume results from his reliance on a reference that appears to be somewhat questionable. Oliver lists a number of submarines that have "blown themselves to kingdom come", including USS BASS (SS 464). USS BASS was SS 164 not SS 464. Bass was not destroyed in a battery explosion but rather suffered from a battery fire in the after battery compartment in 1942 while operating off Panama. Twenty-five crew died of asphyxiation. She was decommissioned in 1945 (See Dictionary of American Fighting Ships and Blair's Silent Victory). SS 464 was to be USS CHICOLAR, a Tench class submarine but she was canceled before construction began. USS COCHINO was lost at sea as a result of her battery explosion, but USS POMODON was repaired and resumed service.

John F. O'Connell
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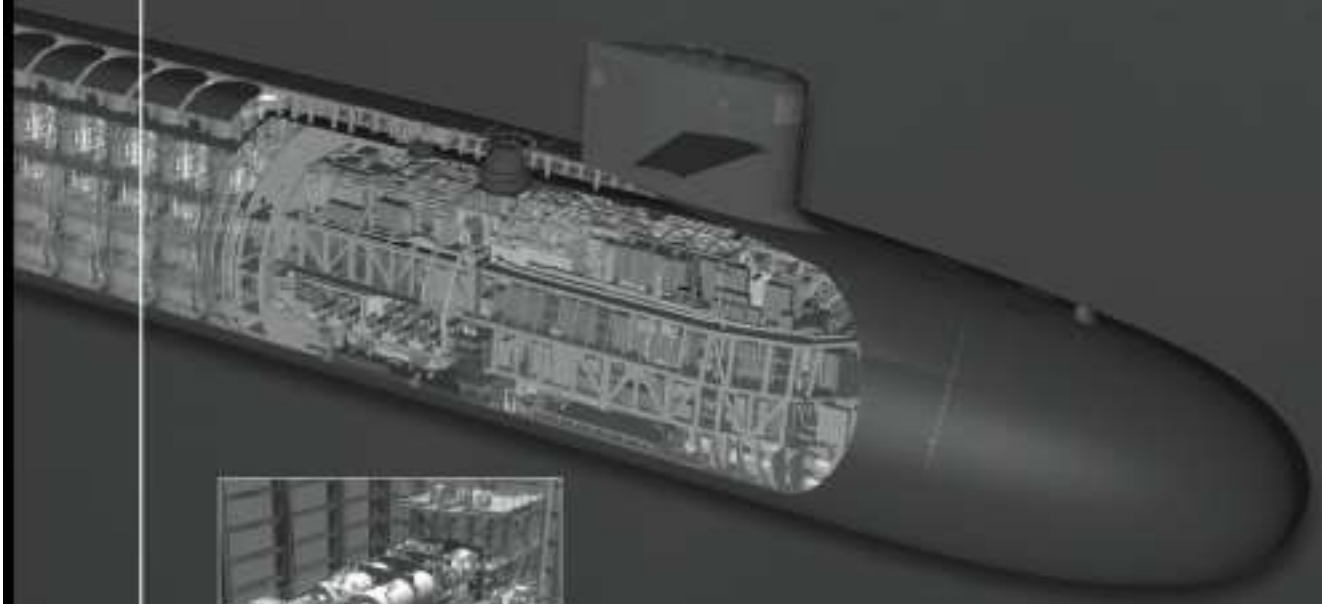

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