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FROM THE EDITOR

This issue of THE SUBMARINE REVIEW continues the magazine's emphasis on Submarine Nuclear Deterrence. A major FEATURE treats the subject as the basis for the Nation's Nuclear Posture in this post-Cold War era. An inherent conclusion is that Nuclear Deterrence is vital for national survival. This article consists of excerpts from a larger study on The Evolving U.S. Nuclear Narrative by the Center for Strategic and International Studies, a respected Washington national security analysis group. The study was requested by a senior Defense official

The study is thoughtful and reasoned; and is very important. Given that obvious importance it is probably appropriate to question why this work, and others like it to come, was considered necessary. One big reason was illustrated by the group analysis. They found a fundamental lack of understanding of rationale for our nuclear posture even among those responsible for maintaining those forces. How then, can we expect the general public, and their voting representatives, to understand enough, in numbers large enough, to support the coming necessary investment in nuclear posture forces. The issues to be faced are complex and represent choices between the nation's social and defense needs; between levels of conventional and nuclear forces and even between types of nuclear forces. Dependence on parochial arguments will probably not be sufficient to carry any particular viewpoint.

In order for readers of these pages to be useful participants in these debates, and it is vital that all do so, it will be necessary to become familiar with the concepts called out in these excerpts.

Also on the subject of U.S. Nuclear Posture is a Bibliography from an uncorrected, and not yet published, manuscript by Mr. Joe Buff. It is a valuable research asset for all interested in deeper study. If others have additions which they feel would be useful additions, please forward them to the Editor of this magazine. My own favorite for such an addition is On Not Confusing Ourselves subtitled *Essays on National Strategy in Honor of Albert and*

Roberta Wohstetter, edited by Andrew W. Marshall, J.J. Martin and Henry S. Rowen.

In addition to its study on Nuclear Posture the Center for Strategic and International Studies has also completed a study on Undersea Warfare in Northern Europe. That study is also excerpted here. It is a useful summary for those of us more familiar with the subject, but there is great benefit in having that information in one place. It is also a very important unclassified reference in any arguments which can be made to the public for tactical submarines, in addition to the strategic force. One point not often heard about Submarine Deterrence is the peacetime corresponding, and additive, contributions to Deterrence from the forward deployed undetected SSNs as well as the open ocean undetected SSBNs.

The article by Captain John Zimmerman on innovation in the acquisition business has been recommended by several who have reviewed it as being a valuable lesson-to-be-learned in all aspects of our business.

This will be my last set of Comments as your Editor. I am being relieved by Captain Mike Hewitt at the end of this month. It has been my honor and my pleasure to serve the submarine community these past years. I look forward to keeping up with all the outstanding progress being made by this larger community of submarine designers, builders and operators to be covered in future issues of THE SUBMARINE REVIEW.

Thanks for everything,

Jim Hay
Editor

FROM THE PRESIDENT

The national elections held in November 2016 resulted in the Republicans being in control of the House of Representatives, the Senate, and the Presidency and the country is watching closely as the President-elect goes about the business of selecting a Cabinet and those who will provide him counsel as he assumes the mantle of leadership as Commander-in-Chief and begins to govern this United States of America during a dynamic time in our history.

As this letter is being written, the Defense Budget picture is uncertain. While hoping for a budget agreement before the Congress adjourns for the holidays, the expectation is that a second Continuing Resolution will be put into place to fund the government until the new administration and new Congress are in place. Unless specifically addressed by a Congressionally approved "anomaly", the Continuing Resolution could have significant impact on the Navy's Shipbuilding Plan, including critical submarine programs. Navy leaders are working hard to ensure that the Congress is well informed concerning the potential impact of these critical budget decisions.

A number of these critical budget issues were touched upon by our speakers at the Annual Submarine League Symposium held at the Gateway Marriott in Crystal City in late October and the long term effect of budget uncertainty will continue to complicate the way forward. The good news is that the Submarine Force leaders are united and have a clear vision of the way ahead.

In the fleet, the men and women who operate and maintain our submarines continue to excel, responding to myriad challenges in response to Combatant Commander tasking around the world. From the Arctic to the Indian Ocean, from the North Atlantic to the Western Pacific, and along the all the sea lanes that connect them, our submarines provide stability in an uncertain world. Our Attack submarines and Strategic Deterrent submarines meet the highest standards of combat proficiency and operational readiness in the execution of their missions in defense of our nation and our

national interests.

And the future is bright. USS ILLINOIS (SSN786) was commissioned on 29 October 2016, with First Lady Michelle Obama as the ship's sponsor, becoming the thirteenth VIRGINIA Class Submarine to join the fleet. USS WASHINGTON (SSN787) will soon follow in 2017 and USS COLORADO (SSN788) was christened on 3 December 2016. The VIRGINIA Class Program is executing smoothly, delivering two ships per year, all ahead of schedule and all under budget. This is a tribute to the superior skill and work ethic of our shipbuilders and to the outstanding leadership and management within *Team Submarine*.

The OHIO Replacement Program continues to receive strong support from Congress and is uniformly viewed as the number one priority program within the Navy and within the Department of Defense. The transition to detailed design to support construction start in 2021 will require a focused effort by all on *Team Submarine* and that effort is certain to be forthcoming from all of the members of the team.

THE SUBMARINE REVIEW seeks to inform and engage our members and others who participate in decision making regarding our nation's security and the need for a strong Navy. We encourage your feedback as we strive to improve its value of to our members. In addition, as you view our periodic NSL Updates or visit our web site, we encourage constructive criticism on how we may better serve you.

I look forward to seeing you all in the new year and I ask that you keep our military personnel in your thoughts and prayers as they defend our freedom around the world.

John B. Padgett III
President

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PH:(703) 256-0891 Toll Free (877) 280-7827 Fax: (703) 642-5815 E-mail: subleague@navalsubleague.org
Web Page: www.navalsubleague.org

FEATURES

PRAGMATIC ESSENTIALS OF 21st CENTURY NUCLEAR POSTURE
America's Post-Post-Cold-War Deterrence Challenges

By
Joe Buff, MS, FSA

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THE EVOLVING U.S. NUCLEAR NARRATIVE

COMMUNICATING THE RATIONALE FOR THE ROLE AND VALUE OF U.S. NUCLEAR WEAPONS, 1989 TO TODAY

PROJECT DIRECTORS
Clark Murdock
Rebecca K.C. Hersman

PRINCIPAL AUTHORS
Rebecca K.C. Hersman
Clark Murdock
Shanelle Van

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www.csis.org

Executive Summary

Managing and operating the nation's nuclear weapons, forces, and delivery systems is an enormous responsibility and among the most demanding of military missions. The men and women responsible for executing that mission—for acting as the custodians of the nuclear arsenal of the United States—must perform difficult and sometimes tedious tasks in highly challenging environments and under demanding expectations. They do so amid a changing *nuclear landscape* that has, since the end of the Cold War, seen the role of nuclear weapons in U.S. national security strategy decline as the concept of deterrence has become increasingly abstract in the twenty-first century.

Over the last few years, many observers, including key Department of Defense (DoD) officials, have commented on the need for DoD to better communicate a more compelling rationale for why the U.S. nuclear arsenal remains essential to the post–Cold War strategy of the United States and to the security of the American people. Those airmen and sailors who comprise the nuclear workforce, and who are asked to dedicate their lives in

service of their mission, deserve a persuasive explanation as to why their unwavering stewardship of the U.S. nuclear arsenal will matter as long as these weapons exist in the world. In the assessment of some, including this study's authors, a coherent narrative about the fundamental role of U.S. nuclear weapons has not been sufficiently stated and promulgated across the force. This is to the detriment of efforts to respond to the broader challenges facing the nuclear enterprise, as a compelling rationale contributes to a healthier, more vibrant, and better motivated nuclear workforce. Recognizing this need, the Office of the Deputy Assistant Secretary of Defense (DASD) for Nuclear Matters endorsed the three objectives of this study:

1. Track the changing historical narrative for U.S. nuclear weapons as it has evolved from 1989 to the present.
2. Evaluate the current narrative's strengths and weaknesses.
3. Articulate a rationale that better meets the needs of the U.S. Air Force and Navy forces responsible for supporting and executing the U.S. nuclear mission, inclusive of the mid-level commanders, the junior officers, and the enlisted.

To be clear, this study does not make new nuclear policy. At its core, this study aims to create a dialogue with the nation's nuclear personnel about the rationales for the U.S. nuclear arsenal that already exists—some of which have been stated at the highest levels of leadership—to ask what the nuclear forces actually hear, what works and what does not, and what motivates them on a daily basis. Over the course of the research effort, however, it also became evident that, while the message matters, the individuals who deliver the rationale, the means by which it is communicated, and the context in which it is received are also important.

TRENDS IN THE HISTORICAL NUCLEAR NARRATIVE

To assess the evolving historical narrative for U.S. nuclear weapons, this study juxtaposes an overview of the international security environment with the statements and decisions made about the arsenal between 1989 and the present. Who said what,

and when? What was happening in the world at the time, and did these statements represent a shift in nuclear policy at the time? For the purposes of this study, this period between 1989 and the present is divided into three eras:

Era 1: Decline and Dissolution of the Soviet Union (1989–2001)

The Soviet Union's sudden collapse relieved the United States of its primary strategic threat and caused an immense shift on the international stage.

Era 2: 9/11 and Terrorism, Afghanistan and Iraq Wars (2001–2010)

In the wake of 9/11, the United States embarked on a *Global War on Terror* and plunged into wars in Afghanistan and Iraq in 2001 and 2003, respectively, as it fought to subdue a new generation of extremists and state sponsors of terrorism.

Era 3: Growing Great- Power Competition in an Era of Rising Disorder (2011– Present)

Although the beginning of the third era is harder to determine, relations with Russia and, to a lesser extent, China began to deteriorate even as the threat posed by non-state enemies metastasized and grew in severity.

Tracing how the U.S. nuclear policy narrative has evolved through these three periods reveals more consistency than change, even though the years since the fall of the Berlin Wall and collapse of the Soviet Union have seen a range of turbulent international events. Moreover, despite the highly polarized political climate of recent decades, the shifts and differences in the arc of the nation's nuclear narrative do not correspond to predictable partisan patterns. The most fundamental articulations of U.S. nuclear weapons' role, function, posture, and priority—the four key characteristics of the U.S. nuclear arsenal identified and defined in this study—have remained more or less the same through Republican and Democratic administrations; namely:

- The role and salience of U.S. nuclear weapons is declining, even as they remain critical to deterring the most dangerous current and imagined nuclear threats.
- As long as these weapons exist in the world, the United States must retain its arsenal safely, securely, and effectively.

These topline messages are also accompanied by other prominent narrative themes and countervailing narratives that, in some cases, reflect a shifting degree of consensus across the nuclear and national security communities:

- While deterrence remains important, the arsenal serves mostly as a hedge against future threats that may arise.
- As a greater number of current threats can be met with conventional capabilities, a greater share of the deterrence burden will be placed on conventional capabilities.
- Nuclear weapons do not necessarily deter twenty-first-century threats, such as non-state actors or rogue states.
- The U.S. nuclear arsenal requires attention and investment, even as reductions take place.
- The United States must lead in reduction efforts if it wants nonproliferation to succeed.

BUILDING A COMPELLING RATIONALE

As the research progressed, it became clear that the effectiveness of the rationale for U.S. nuclear weapons has only partially to do with the words used to articulate it. Feedback from operational personnel overwhelmingly points to the significant influence of other factors in determining whether the rationale reaches the forces clearly and precisely, with a real impact. The message matters, but the individuals who deliver the rationale, the means by which it is communicated, and the context in which it is received are also important. As such, taking the historical nuclear narrative as its starting point, this study came to ask four questions:

1. Is the existing rationale the right one?
2. Is the rationale tailored to specific audiences with appropriate detail and specificity?
3. Is the rationale suitable but being improperly communicated?
4. Is the rationale communicated effectively within the mission but undermined outside of the mission?

In answering these questions, the study team identified a number of disconnects and challenges not only in the rationale for nuclear weapons over time, but in the way that narrative is perceived, internalized, and remembered over time by various audiences. These challenges naturally fall into six basic categories:

Message

Is the message clear, persuasive, and consistent?

- In many cases, U.S. nuclear weapons policy is described in highly sophisticated strategic logic that is not very accessible to the general public or the junior nuclear personnel. It is both rife with concepts and jargon that are not routinely defined and explained—for example, *deterrence*, *hedge*, *strategic stability*, *escalation*—and heavily caveated.
- The rationale tends to focus on what nuclear weapons will not do and is dominated by descriptions of decline, reduction, and diminishment.
- This review found few examples of an affirmative case for the role of U.S. nuclear weapons in U.S. national security across the time period from 1989 to the present. The only affirmative rationale that emerged during this time frame was the important role the U.S. arsenal plays in assuring partners and allies. Too little effort has been made to state the critical, albeit more limited, role of nuclear deterrence.
- These issues of complexity, caveating, and negative framing are remarkably consistent across all three eras. While some interviewees hold strongly to the notion that such narratives can be attributed to certain leaders, administrations, or time frames, the review of the historical rec-

ord found no such correlation. The challenges are bipartisan.

Audience

Who comprises the audience for the rationale? Is the message tailored to them?

- The rationale must reach diverse communities throughout and beyond the operational forces. A compelling rationale must reach and resonate across the total force, not just the nuclear operational community.
- The audience for the rationale is both vast and comprised of numerous communities with varying levels of interest in and familiarity with nuclear weapons. It includes those in the services who execute the nuclear mission: the mid-level commanders, the junior officers, and the enlisted. It also encompasses their conventional counterparts, their families and friends, other members of the general public, the scientific community and the broader nuclear enterprise, and Congress.
- Junior and mid-grade officers are linchpin communicators—required to understand and recommunicate a compelling rationale—in speaking to these various audiences.

Messenger

Who is speaking this narrative and, just as important, who is not? Is the communicator clear, persuasive, and disciplined?

- Clear statements from the highest possible echelons of policymaking—the president, the secretary of defense, the secretaries of state and energy—carry a weight all their own, especially in terms of priority and strategic vision. What senior leadership says matters, but what they do not say also matters. Silence can be deafening.
- Those closest to the nuclear personnel in the chain of command are most responsible and thus accountable for communicating the rationale for U.S. nuclear weapons. The message will not get through to them if someone in the chain of command just one or two levels above in seniority

decides the personnel do not need to hear it. They are the ones who must *make good* on the words from senior leadership.

- Junior officers, who begin as message receivers, quickly become messengers themselves in training the next generation of nuclear personnel. Junior and mid-grade officers, who are charged with distilling complex policy statements and translating them into a sense of purpose and mission for their subordinates, need targeted and refined messages coupled with resources, materials, training, and support. The success of current efforts will depend on whether they are properly equipped to execute their role as re-messengers.

Mechanism

Is the message communicated effectively and appropriately through appropriate tools and forums that ensure that the message reaches its intended audience intact?

- Speeches, congressional testimony, media statements, and official documents, strategies, and reviews are the traditional mechanisms for establishing and communicating the nuclear narrative and for helping the *inside the beltway* policy elites, congressional members and staff, and high-level media and international audiences communicate with each other. But the detailed and caveated rationales to explain the role of nuclear weapons, the trade-offs between competing priorities, the complexities of deterrence in the post–Cold War era, or even the priority that military services put on the nuclear mission are a high-risk gamble to translate through trickle-down methods.
- The initial messengers at the beginning of the chain have yet to adapt their methods to new forms of communication that speak to audiences in highly personalized ways, such as blogs, personalized news alerts or feeds, and social media. Key messages are reaching the operational forces third-or fourth-hand at best, via communicators who may not be highly knowledgeable on the issues.

Volume and Dissonance

What is the volume of the message and how much noise must it overcome to be heard? Are competing voices and narratives crowding out the narrative?

- The problems with the mechanisms by which the rationale is conveyed to the nuclear forces are compounded by an oversaturated information landscape.
- It is crucial to not talk *inside a nuclear silo* without listening to what is being said or is left unsaid by and to the rest of the force. Synergies can and should be found across virtually every geographic region.
- Countervailing narratives can also contest and undermine the topline rationale. The nuclear policy community, both within the United States and internationally, is diverse and divided. Competing narratives, even within the nuclear mission space, can lead to a crowded message board.

Context

What is the context or environment in which the message is communicated? Does it reinforce or undermine the message?

- The importance of how well the context in which a message is received *fits* the message itself cannot be overstated. No matter how *right* the words or the means of delivery may be, they will only be received and internalized in a positive environment—one of sufficiently supportive command leadership, educational opportunities and training support, and investment of time and resources—that encourages such strategic thinking.
- The nuclear workforce looks closely at the alignment of words and deeds to determine if the narrative is credible, sustainable, and persuasive. The *say-do* gap creates the impression that the words are hollow, which undermines the credibility of the narrative and fosters cynicism and low morale. Again and again, interviewees pointed to the gap between words (rationale) and deeds (funding, leadership

attention, and personnel practices) as a fundamental problem with the rationale for nuclear weapons.

- A deeper dive into the various communities that comprise the nuclear forces shows that they each have their own deeds that carry the most impact and meaning depending on their service culture, deployment location, and operational activity.
- There is a *say-do-believe* gap. Overcoming perceptions that the message is not reflected in actions will take patience: it will require creating an affirmative context for the rationale, undoing and remedying the various pieces of the say-do gap, and doing so in a continuous, sustained effort that conveys to the nuclear workforce that this commitment is lasting.

A COMPELLING RATIONALE

The proposed rationale for U.S. nuclear forces set forth in this study reflects the authors' effort to capture the themes that resonated most strongly with the target audience. In developing it, the authors have sought to adhere to the following *dos* and *don'ts*:

Do:

- Develop a rationale that is affirmatively, rather than negatively, framed
- Use language that is clear and direct and does not require a sophisticated understanding of nuclear policy
- Use topline messages that can be employed consistently with a wide range of audiences (the public, the Congress, the armed forces) but can also be tailored to various audiences through additional specificity
- Look to the future, not the past, as the source of challenge *and* opportunity
- Remember that words accompanied by meaningful and appropriate actions are always the most effective message

Don't:

- Use jargonistic or theoretical language
- Appear nostalgic about the Cold War or suggest the future lies in a return to the past

- Criticize the audience in terms of knowledge, education, or interest

Overview of the Rationale

Today, the United States faces a nuclear landscape of complexity, uncertainty, and risk. While nuclear dangers have certainly receded from the high-water mark of the Cold War, the nuclear optimism of the post–Cold War era has declined as well. Today, the United States no longer faces a single primary adversary from one region of the globe, but rather a diverse set of nuclear dangers spanning at least three geographic regions and potentially with global reach. These dangers include:

- Nuclear attack by a nuclear-armed state
- Growing nuclear intimidation and coercion by regional powers
- Renewed and potentially expanded nuclear competition among great powers
- Risk of nuclear intimidation and use by nonstate actors and extremists
- Growing frustration regarding global disarmament
- Continued strategic uncertainty

The full proposed rationale appearing in Chapter 4 of this study seeks to articulate the role, function, posture, and priority of the U.S. nuclear arsenal in addressing the important challenges and problems that drive and constrain its place in U.S. national security strategy. To emphasize that the U.S. nuclear arsenal confers both power and immense responsibilities on the United States, the rationale builds on each of these elements and themes:

Our nuclear forces provide a critical foundation for U.S. power and influence in the world and serve as the only existing credible defense against nuclear destruction, ensuring that the U.S. homeland will remain protected when the nation's conventional forces carry out their responsibilities overseas.

U.S. nuclear weapons force our adversaries to consider that the benefits of attacking the United States or our allies are far

outweighed by the risks and costs, so that restraint becomes a better option than aggression. As such, our nuclear forces offer our allies the option to trust in the United States' nuclear protection rather than acquire their own nuclear weapons.

An effective U.S. nuclear arsenal must be credible, flexible, survivable, responsive, and reliable. The value of U.S. nuclear weapons relies on their being permanent and persistent, as well as visible and demonstrable, so that they signal the United States' resolve to not only discourage aggression, but to also defend itself and its allies as necessary.

The United States respects the awesome responsibilities that accompany the custodianship of nuclear weapons, holding itself to the highest possible standard for responsible nuclear stewardship. As long as nuclear weapons exist in the world, the United States will shoulder these responsibilities and serve as the nuclear counterweight to those with malicious intentions.

The United States has given our nuclear forces profound responsibilities and in turn has set the highest possible expectations. Our forces require the investment of time, resources, and attention by leadership at all levels, as well as commitment to a climate that fosters personal responsibility, accountability, and innovation.

COMMUNICATING A COMPELLING RATIONALE FOR U.S. NUCLEAR WEAPONS

Interviews and roundtables repeatedly stressed the need for not only a new nuclear narrative, but also a detailed strategy to improve how leaders and policymakers talk about nuclear weapons, communicate their importance, and create a context in which such a compelling rationale can be heard, understood, shared, and believed. This study recommends the following next steps:

1. Develop and communicate an affirmative and compelling rationale for the U.S. nuclear arsenal that articulates the role, function, posture, and priority of U.S. nuclear weapons in U.S. national security.

2. Set the tone from the top. A new nuclear narrative cannot be compelling if not fully and formally owned and communicated by the president and the president's most senior national security advisers. Give the message authority, and have it come from the highest authorities.
3. Direct the rationale for U.S. nuclear weapons to the whole force, not just the nuclear operators.
4. Create an education-based context for communicating a compelling rationale, not just a public affairs plan.
5. Cultivate and encourage strategic and policy knowledge through opportunities for education and training earlier in the officer development process and beyond the nuclear force alone.
6. Focus on the re-communicators: the junior and mid-grade officers.
7. Close the gap between messenger and audience.
8. Distribute the rationale widely and via diverse communication modes that are short and easily accessed.
9. Make better use of operational exercises across the nuclear force to engage senior leaders, build stronger connections between operators and support elements, and demonstrate priority. These are huge missed opportunities.
10. Match words with meaningful actions.

The recommendations generated by this study are intended to be practical and implementable, but they will not be simple. They will require sustained efforts—not only to find the *right* words, but also to create and foster a proper context in which those words can take root—at every level of leadership. Only a meaningful realignment of words with concrete actions will form a compelling rationale for the continued role and value of U.S. nuclear weapons. The airmen and sailors who carry out the nuclear mission every day on behalf of the American people deserve no less.

EVOLUTION OF THE HISTORICAL NUCLEAR NARRATIVE
CHAPTER 1

The past 27 years—which encompass the demise of the Soviet Union, the September 11 attacks, the Iraq and Afghanistan wars, the rise of competing nations, and a powerful surge in instances of nonstate terrorism—have had a profound effect on the way the United States reflects upon, views, and articulates its reasoning for its nuclear capabilities. U.S. nuclear policy today is not the U.S. nuclear policy of the Cold War; neither is it the nuclear policy of 15 or even 10 years ago. Without an understanding of the global security threats under which t hose policy decisions were made, and without the broader circumstances in which certain words were said, any analysis of the narrative surrounding U.S. nuclear weapons would be incomplete. The threats and the words are inextricably linked.

This report therefore analyzes the evolving historical nuclear narrative while simultaneously juxtaposing it against an overview of the international security environment that has provided the backdrop for, and directly influenced, the statements and decisions made about the arsenal between 1989 and the present. (See Appendix D for the full timelines.) Who said what, and when? What was happening in the world at the time, and did these statements represent a shift in nuclear policy at the time? Though far from a complete recounting of history, the timelines do seek to highlight and provide a better sense of the global threats facing the United States, the evolution of nuclear capabilities elsewhere in the world, and the notable incidents that affected the organization and efficacy of the nuclear enterprise.

A CHANGING SECURITY ENVIRONMENT

This study divides the years between 1989 and the present into three *eras*, the first spanning from 1989 to September 11, 2001; the second from September 11, 2001 to the end of 2010; and the third from 2011 through the present. These divisions were chosen

along defining moments in the international security environment. The 1989 fall of the Berlin Wall, as the iconic image symbolizing the end of the Cold War, and the al-Qaeda-sponsored terror attacks of September 11 provided natural bookends for marking the first and second eras. The beginning of the third era proved more difficult to pinpoint. It seems, however, that with the launch of the Prague Agenda (to move toward a world without nuclear weapons) and the Nuclear Security Summit process (to deter nuclear terrorism around the globe), as well as the signing and ratification of the New START (Strategic Arms Reduction Treaty), 2010 ended as a high-water mark for nuclear optimism. By 2011, the Arab Spring was taking hold in the Middle East, prompting North Atlantic Treaty Organization (NATO) intervention in Libya. Relations with Russia had begun to deteriorate significantly, ultimately leading to Moscow's decision to terminate cooperative nuclear projects with the United States and intervene militarily in Ukraine and Syria. In Asia, China's more aggressive posturing, North Korea's provocative behavior, and new revelations about Pakistan's nuclear capabilities suggested a nuclear security environment that appeared more complex, chaotic, and risky than it had been in the preceding years.

Era 1: Decline and Dissolution of the Soviet Union (1989–2001)

The first era saw an immense shift on the international stage when the Soviet Union's sudden collapse relieved the United States of its primary strategic threat. By 1991, the Cold War was over, and it had left the United States as the singular superpower, with tens of thousands of weapons in its nuclear stockpile. While the preceding decades had been defined by constant anxiety and present dangers, this period instead simmered with a buildup of emerging powers in pursuit of nuclear and other nonconventional capabilities that threatened to destabilize the new international system.

As the Soviet Union's central government failed, so too did its infrastructure for securing its expansive nuclear, biological, and chemical weapons stockpiles collapse—leading to increased risk that the chaos of the new political system would give opportunity

to third parties seeking to acquire such arms. U.S. observers at the time feared that weakened control mechanisms over Soviet tactical nuclear weapons, deterioration of nuclear facilities, and unemployment of nuclear scientists might leave materials and knowledge vulnerable to exploitation, theft, or misuse. Of additional concern were the tens of thousands of nuclear warheads, as well as components of other weapons of mass destruction (WMD), left by the former Soviet regime in the newly in dependent republics. Though Belarus, Kazakhstan, and Ukraine signed the Lisbon Protocol in May 1992, actual implementation of the agreement proved thorny, with Ukraine in particular requiring compensation and extensive security assurances from Russia and the United States before it would relinquish what was then the third-largest nuclear arsenal in the world.[1] In response to both of these proliferation risks, the United States established the Nunn- Lugar Cooperative Threat Reduction (CTR) Program to assist Russia in safeguarding and eliminating these weapons of mass destruction.[2] Simultaneously, the United States also led in cooperative international initiatives to prevent the further proliferation of nuclear weapons: after signing START I and II treaties with Russia in 1991 and 1993 to initiate bilateral drawdowns of the two nations' respective nuclear forces, the United States also pushed for the renewal of the Nuclear Non-Proliferation Treaty (NPT) in 1995.[3]

As one threat to the U.S. interests fell into decline, others sought to fill its space. The Gulf War, the United States' first major post–Cold War military operation, shed light on Iraq's burgeoning chemical weapons program and illustrated the new, wider range of chemical, biological, radiological, and nuclear (CBRN) threats opposing the United States. Several nations—China, France, India, and Pakistan—conducted nuclear tests, and Pakistan publicly admitted that it had the ability to make a nuclear weapon. The unpredictable leadership of *rogue regimes* such as Iran and North Korea actively sought nuclear capability, while a series of breaches at U.S. nuclear laboratories sparked worries that the nation's nuclear secrets were vulnerable to theft, particularly by the Chinese. Additionally, nonstate actors came to the fore as

instances of terrorism, most notably the World Trade Center bombing in 1993 and the Oklahoma City bombing in 1995, demonstrated the danger that individuals or groups could pose should they acquire weapons of mass destruction.

Yet, in spite of this rising tide of states and rogue actors, it was clear in the wake of the Cold War that the United States now possessed a nuclear arsenal, some 23,000 weapons at the start of George H. W. Bush's presidency in 1989,[4] that was disproportionate to the existing threat. Absent the Soviet Union, the existential threat that animated the role of nuclear weapons in U.S. strategy, the U.S. arsenal's function—to deter a nuclear attack through the retaliatory threat of unacceptable damage—seemed misaligned with a security environment that was trending in the right direction for U.S. interests. As various government officials noted in the mid-to-late 1990s, nuclear weapons had not played so small a role in U.S. security strategy "at any time since their inception."[5] In 1995, then Senator Joe Biden sharply criticized those "nuclear theologians in the Pentagon and elsewhere," with their "old-time religion," who would instead prefer to see the status quo maintained. Even 7,000 warheads, he said, was "a level as seemingly obsolete as a statue of Lenin on a square in Saint Petersburg."[6]

Like Senator Biden, other policymakers largely welcomed the change and advocated for the continued decline of the U.S. nuclear stockpile. They reimagined the function of nuclear weapons (see T able 1.1), circumscribing its place within U.S. national security strategy in favor of placing more of the burden of deterrence on conventional weapons, which they deemed capable of meeting a greater number of the threats to the United States. In this emerging post–Cold War security environment, many believed that, increasingly, the United States' conventional military capability could deter and counter most, if not all, credible threats. Retired U.S. Army Gen. Andrew J. Goodpaster and retired U.S. Air Force Gen. Lee Butler testified to this effect before the Senate Governmental Affairs Committee:

Table 1.1. Narrative Themes in Era 1

	Role	Priority	Function	Posture
Era 1 1989–2001: Decline and Dissolution of the Soviet Union	Salience of nuclear weapons at lowest point since their inception A greater number of current threats can largely be met with conventional weapons Trend that more threats can be covered by conventional capabilities seems likely to continue	Reduced prominence of nuclear-relevant threats allows for cost-cutting and downsizing of nuclear enterprise Emphasis on reducing the stockpile of nuclear weapons, not defining the role of the re-maining weapons	Deterrence still important, but arsenal mostly a hedge against future threats and reversal of positive trends Nuclear arsenal deters WMD acquisition and use by allies under nuclear umbrella as well as rogue states and dictators Assurance of allies emerging as a primary rather than secondary justification for U.S. nuclear forces	United States will have nuclear weapons as long as other states do Maintenance of nuclear triad required for "hedge" to manage uncertainty "Lead but hedge": Reduce deployed forces, but retain stockpile and non-strategic weapons as a hedge

Note: For full matrix, see Appendix C.

The roles of nuclear weapons for purposes of security have been sharply narrowed in terms of the security of the United States. Now and in the future they basically provide an option to respond in kind to a nuclear threat or nuclear attack by others. In the world environment now foreseen, they are not needed against nonnuclear opponents. Conventional capabilities can provide a sufficient deterrent and defense against conventional forces and in combination with defensive measures, against the threat of chemical or biological weapons. As symbols of prestige and international standing, nuclear weapons are of markedly reduced importance.[7]

The change would allow for a commensurate downscaling of the nuclear enterprise, which would adjust accordingly with the new requirements of the Stockpile Stewardship and Management

Program. There would be, in other words, "fewer weapons, fewer types of weapons, no production of new types of weapons, an aging stockpile, a production capability in need of modernization, and no nuclear testing."[8] The nuclear mission post-1992, as one former senior military official interviewee described it, seemed to DoD to be "a 'sunset mission' that would eventually go away."

A range of policymakers, including Secretary of Defense Richard Cheney, nonetheless kept an eye on the "uncertain future,"[9] cognizant that positive trends in the former Soviet Union could reverse and that unanticipated crises might arise elsewhere in the world. While they believed that the posture of the arsenal could and should be adjusted to fit the changed circumstances, they did not push for the complete elimination of U.S. nuclear weapons. The United States, they determined, must "lead but hedge." That is, it must simultaneously lead the world toward "further reductions and increased weapons safety and improved relations" and "[hedge] against the possibility of reversal of reform in Russia."[10] William J. Perry, then deputy secretary of defense, noted the necessity of these precautions in 1993: "Not only do we need to maintain a deterrent in place, but we need to have some capability to reconstitute our nuclear forces above the levels which you are now driving them to in the START I and the START II, to hedge against the possibility that such an unfriendly regime might not only reassert the military power, but might begin a buildup of nuclear forces."[11]

Era 2: 9/11 and Terrorism, Afghanistan and Iraq Wars (2001–2010)

The second era begins with the September 11, 2001 attacks on the World Trade Center in New York, the Pentagon in Washington, and a commercial airplane in Pennsylvania, and ends with the United States' ratification of New START in 2010. In the wake of 9/11, the United States embarked on a "Global War on Terror" and plunged into the wars in Afghanistan and Iraq in 2001 and 2003 as it fought to subdue a new generation of extremists and state sponsors of terrorism. The two wars' subsequently dismaying results embroiled the United States in the turmoil of the Middle

East for much of the decade, though President Barack Obama's reassessment of U.S. foreign policy sought to shift the nation's attentions and to usher in both a rebalance to East Asia and a reset with Russia.

Shortly after the 9/11 attacks, the United States launched Operation Enduring Freedom in Afghanistan against the Taliban and al Qaeda. Within two months, coalition forces recaptured Kandahar—a victory that appeared to have marked the fall of the Taliban's rule and the start of reconstruction. But a resurgence of the Taliban over the next several years frustrated efforts to establish a stable system of governance and scale back the American presence in Afghanistan.[12] In March 2003, the United States turned toward Iraq, which preoccupied national attention for the next decade. Despite the capture of Saddam Hussein in December 2003, the Iraq War continued, with a *surge* of troops committed in 2007, until President Obama formally ended the combat mission in 2010.[13] The demands of global terrorism and two grueling wars naturally diverted attention and resources away from a nuclear mission that focused on less urgent and less likely threats, even though the latter had more existential implications.

In the meantime, the nuclear ambitions of other parties challenged nonproliferation efforts. Unlike Libya, which voluntarily disclosed and began dismantlement of its WMD programs in 2003 after pressure from the United States,[14] Iran maintained its illicit programs in the face of crippling sanctions. North Korea withdrew from the Non-Proliferation Treaty in 2003 and conducted nuclear tests in 2006 and 2009.[15] Further, intelligence sources found that al Qaeda and other extremists actively plotted CBRN attacks and learned crude procedures for making chemical agents.[16]

States elsewhere in the world also rose to the status of economic and strategic power houses. China, in particular, had become the world's second-largest economy by the end of 2010[17] and had adopted an aggressive stance on territorial disputes that resulted in tension with several neighbors. The Obama administration's rebalance to Asia recognized the growing importance of this region and the need to work closely with allies to maintain security.

Most U.S. thought leaders maintained in this era that the United States could proceed in reducing its nuclear stockpile. Conventional capabilities had improved by leaps and bounds—while the still-vast U.S. nuclear arsenal "[continued] to reflect its Cold War origin."[18] The September 11 attacks, for some, highlighted the question of whether the United States should rely on nuclear weapons to meet the evolving needs of the twenty-first century. Nuclear terrorism loomed large. It seemed unclear at the time, however, whether nuclear weapons would deter terrorists. Secretary of Defense Donald Rumsfeld expressed this very doubt in 2002, saying:

> Today our adversaries have changed. The terrorists who struck us on September 11 were clearly not deterred by doing so from the massive U.S. nuclear arsenal. In the twenty-first century, we need to find new ways to deter new adversaries that will most as suredly arise. That's why President [George W.] Bush is taking a new approach to strategic deterrence, one that will combine deep reductions in offensive nuclear forces with improved conventional capabilities and the development and deployment of missile defenses capable of protecting the U.S. and our friends and forces deployed from limited missile attacks.[19]

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Table 1.2. Narrative Themes in Era 2

	Role	Priority	Function	Posture
Era 2 2001–2010: 9/11 and Terrorism, Afghanistan and Iraq Wars	Proactive shifting of deterrence from nuclear to conventional capabilities	Nuclear arsenal in need of revitalization, but "War on Terror" took precedence Increasing alarm, particularly about the National Nuclear Security Administration (NNSA) and the labs, about the pernicious effects of lack of attention and investment	Nuclear weapons do not deter twenty-first-century terrorist organizations and rogue states, which make illogical cost calculations Hedge even more appropriate given an increasingly complex security environment Need to reassure allies that might otherwise consider nuclear option a policy priority	United States will have nuclear weapons as long as other states do Overhaul of nuclear capabilities for flexibility in addressing new threats New Triad will encompass more than offensive nuclear forces Though arsenal will shrink, it must remain safe, secure, and reliable

Note: For full matrix, see Appendix C.

Some policymakers believed that the United States could actively shift away from dependence on nuclear weapons for deterrence (see Table 1.2). Rather than argue for such a reduced dependence, however, the Bush administration emphasized the need to adapt the U.S. deterrence posture to new threats. Yet the initiatives laid out in the congressionally mandated[20] 2002 Nuclear Posture Review (NPR)—which included a design of a reliable replacement warhead (RRW), as well as a New Triad that encompassed the ability "to defeat emerging threats such as hard and deeply buried targets (HDBT), to find and attack mobile and relocatable targets, to defeat chemical or biological agents, and to improve accuracy and limit collateral damage"[21]—eventually petered out. The 2002 NPR was a classified review with no unclassified companion document, which sharply limited coherent public discourse on the emerging policy and yet fueled opposition among an already- skeptical audience of stakeholders. Many of the

review's key proposals, which quickly leaked to Bush administration opponents, w ere met with skepticism and criticism from some corners. The country as a whole was preoccupied with the wars in the Middle East. The appetite for investing in nuclear weapons, especially in the middle of this era, was at an all-time low. One former senior civilian official interviewed for this report reflected on the absence of attention to and consensus on nuclear weapons during this era, saying, "In 2004/5 to 2008, I was in the depth[s] of despair."

A number of public Air Force incidents, most notably the 2007 accidental transportation of nuclear-tipped cruise missiles from Minot Air Force Base (AFB) in Minot, North Dakota to Barksdale AFB in Bossier Parish, Louisiana,[22] illustrated the growing management and organizational challenges gripping the nuclear enterprise, even as the United States would continue to reduce the role of nuclear weapons in U.S. national security. The concern that the enterprise was then, as one former senior civilian official interviewee put it, "on the ragged edge of being unable to provide a 'safe, secure, and effective' nuclear force" led to a public review of the DoD's role in nuclear weapons management. The 2008 Schlesinger Report observed a "loss of attention and focus, downgrading, dilution, and dispersal of officers and personnel" in DoD's approach to the nuclear mission, and attributed this to a "failure to appreciate the larger role of deterrence—as opposed to warfighting capability."[23] At the same time, the deterrence function received less emphasis while the assurance of allies, now a policy priority, was described as "[playing] an irreplaceable role in reducing proliferation."[24] As long as other states had nuclear weapons, so too would the United States.

Toward the end of this era, discussions on the role of U.S. nuclear weapons increasingly focused on reducing the dangers of nuclear terrorism and proliferation, both of which were seen to pose a higher risk to U.S. national security than a direct nuclear attack. President Obama's focus on nuclear security and four successive nuclear summits greatly raised awareness of nuclear security and terrorism challenges and increased the available

capabilities to deal with these issues. In 2010, the continued perceived decline in strategic nuclear threats, even amid the rising concerns about nuclear terrorism by nonstate and rogue actors, made further reductions possible. President Obama's vision of a world without nuclear weapons captured the world's attention and raised expectations in much of the international community that such a day could be near at hand. In hindsight, ratifying New START with Russia in 2010 represented the high-water mark for nuclear optimism. When George W. Bush began his presidency in 2001, the United States possessed over 10,500 weapons in its nuclear stockpile; at the end of 2010, 5,066 remained.[25]

Era 3: Growing Great- Power Competition in an Era of Rising Disorder (2011– Present)

This third and final era starts with the United States' ratification of New START at the end of 2010 and continues through the present. It has been an era of unpredictable threats. As offensive military operations in Iraq wound down, nonstate enemies such as the Islamic State of Iraq and the Levant (ISIL) confounded expectations by rapidly ascending to power through astonishing acts of violence, and old adversaries—namely Russia, China, and North Korea—employed novel, effective methods to challenge the United States and regional partners through both military and nonmilitary means.

The upheaval and unrest foreshadowed by the December 2010 protests in Tunisia erupted as a wave of revolutions swept through the Middle East in 2011, toppling several rulers in the region[65] and inciting the ongoing Syrian Civil War. The fighting within Syria has divided the country into warring factions, with parts of the territory held by the Syrian government, the Islamic State, the al-Qaeda- affiliated al-Nusra Front, the Kurdish People's Protection Units (YPG), Hezbollah, and other insurgencies.[27] Despite a U.S. warning in 2012 that use of chemical weapons by the regime of Bashar al-Assad would cross a "red line," the United States declined to respond with military force after 1,400 civilians were killed in a chemical weapons attack by the Syrian government in August 2013—opting instead for a U.S.-Russian framework for

eliminating Syria's chemical weapons arsenal. Since 2014, the United States has led coalition forces in airstrikes against ISIL in Syria and Iraq, while also calling for President Assad's resignation.

As Syria crumbled into civil war, other world events w ere likewise shifting the nuclear landscape. The power vacuum created by the ouster of Ukrainian president Viktor Yanukovych in 2014, precipitated by his rejection of a political and economic treaty with the European Union in exchange for closer ties with Russia, allowed Russia to annex Ukraine's Crimean Peninsula. Russian president Vladimir Putin followed the invasion with "nuclear saber rattling," plainly "reminding" the West that "it's best not to mess with [Russia]" given its status as "one of the leading nuclear powers";[28] declaring the addition of 40 new intercontinental ballistic missiles (ICBMs) to Russia's nuclear arsenal; and beginning a multibillion- dollar nuclear modernization program.[29] A year later, over U.S. objections, Russia also injected itself into the Syrian conflict, conducting airstrikes and directing cruise missiles against the rebel groups challenging Assad. Russian aggression and its demonstrated willingness to abrogate state sovereignty have prompted NATO to announce that it would be reevaluating its nuclear weapons posture.[30] North Korea also made troubling progress in developing its nuclear weapons program and declared in January 2016 that it had tested a hydrogen bomb (despite evidence to the contrary).[31] Further, Pakistan adopted a new doctrine, called "Full Spectrum Deterrence," for its nuclear posture, which envisions a range of nuclear responses to conventional attacks by India.[32]

Table 1.3. Narrative Themes in Era 3

	Role	Priority	Function	Posture
Era 3 2011–Present: Growing Great-Power Competition in an Era of Rising Disorder	United States will keep nuclear weapons as a deterrent against nuclear attack, but long- term policy is to work toward eliminating nuclear weapons	As long as U.S. nuclear weapons exist, they must be safe, secure, and effective United States will fund modernization despite bud get cutbacks Severe lapses in nuclear enterprise demonstrate consequences of previous low prioritization	United States must lead in reduction efforts if it wants nonproliferation to succeed Communicates that enemies cannot escalate their way out of failed conventional aggression U.S. nuclear arsenal primarily exists to prevent war and reassure allies The function of nuclear weapons within deterrence still shrinking as the definition of deterrence strategy expands	As long as any other state has nuclear weapons, it will be necessary for the United States to retain nuclear weapons Triad deters future foreign leadership from seeking nuclear advantage Reductions and modernization each independently important

Note: for full matrix, see Appendix C.

These increased nuclear and other unconventional threats in the international security environment, combined with the recognition that the nuclear enterprise had suffered the consequences of past low prioritization, have instigated a slow but steady change in the conversation surrounding U.S. nuclear weapons. The exigencies of the present era, particularly the recent downturn in U.S.-Russia relations, have led to greater acknowledgment of the role of nuclear weapons in U.S. national security. Many of the most familiar narrative themes from the preceding

eras have carried through to this period. Per President Obama's direction, the long-term policy of the United States is to work toward a world without nuclear weapons, though the United States will retain a nuclear deterrent against nuclear attack and keep its weapons safe, secure, and effective as long as any other nation has an arsenal as well (see T able 1.3).

At the same time, another round of scandals across the nuclear enterprise in 2013 drove the morale and image of the operational nuclear force into yet another trough, suggesting that lessons observed in the prior era had not translated into lessons learned, and prompting extensive review and rethinking among those responsible for the nuclear weapons complex.

In 2015, the Obama administration has remained committed to leading in nuclear reduction efforts to promote nonproliferation around the world, while seeking to temper disarmament expectations absent Russian cooperation, and has pledged strong support for modernizing an aging nuclear arsenal. Nevertheless, with a modernization bow wave fast approaching even as the government seeks to reduce the overall cost of defense under the pressures of the bud get caps,[33] there is increased scrutiny on the future of the arsenal. Plans remain for the United States to modernize its weapons, which, at the end of 2013, numbered some 4,804.[34] In 2014, Chuck Hagel, then secretary of defense, firmly stated the Department's commitment to the nuclear enterprise: "Our nuclear deterrent plays a critical role in ensuring U.S. national security, and it's DoD's highest priority mission. No other capability we have is more important…. Consistent with President Obama's guidance, our policy is to reduce the role of nuclear weapons in our nation's security strategy and to seek the peace and security of a world without nuclear weapons."[35] Numerous officials have, over the years, further restated the assertion that the arsenal not only reassures the United States' allies but communicates "to potential nuclear-armed adversaries that they cannot escalate their way out of failed conventional aggression."[36]

The narrative of this present era continues to take shape as the U.S. Air Force, Navy, and the broader defense establishment reflect, with greater interest than has been evident in quite some

time, upon why U.S. nuclear weapons matter. The same former senior civilian official who commented that he was previously in the "depth of despair" agreed that there has been tangible change: "The consensus today on the role and value of nuclear weapons is as good as it has been in years…. In 2009, I never thought we would be where we are in 2015…. The state of the enterprise is the best I've seen in 15 years." Junior and mid-level officers interviewed in the study also tend to speak positively about the uptick in attention and express hope that the progress continues. Whether the narrative proves to be more effective than the forms that preceded it has yet to be seen, but analysis of the historical narrative across time shows that even these early developments—especially when placed within the context of the past quarter century—are greatly encouraging.

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CHAPTER 4
A Compelling Rationale for U.S. Nuclear Weapons in the Twenty- First Century

An effective rationale for U.S. nuclear weapons must answer five essential questions.

- What are the most important challenges and problems that both drive and constrain the role and importance of nuclear weapons in U.S. national security?
- Given these challenges, what is the fundamental purpose or role of U.S. nuclear weapons in its twenty-first-century national security strategy?
- How does the U.S. nuclear arsenal and its associated infrastructure and delivery systems fulfill this role?
- What capabilities and attributes must the U.S. nuclear force possess to perform these functions with confidence?
- When faced with difficult trade-offs, how willing are policymakers to make difficult choices necessary to demonstrate commitment through the allocation of time, attention, and resources?

In answering these questions, this rationale must be consistent, clear, declarative, and simply stated in terms that resonate outside of the confines of the nuclear policy community. Roundtable discussions with young officers and stakeholders across the nuclear enterprise make clear that such a rationale would be more readily absorbed across the force and allow young officers and enlisted personnel to re-communicate this narrative to peers, subordinates, family members, and communities much more effectively. This approach marks a departure from some of the language, concepts, and vocabulary of prior statements and will require patience and flexibility from the nuclear policy elite.

The following proposed rationale for U.S. nuclear forces reflects the authors' effort to capture the themes that resonated most strongly with the target audience. In developing it, the

authors have sought to adhere to the following *dos* and *don'ts* that emerged from our research:

Do:

- Develop a rationale that is affirmatively, rather than negatively, framed
- Use language that is clear and direct and does not require a sophisticated understanding of nuclear policy
- Use topline messages that can be employed consistently with a wide range of audiences (the public, the Congress, the armed forces) but can also be tailored to various audiences through additional specificity
- Look to the future, not the past, as the source of challenge *and* opportunity
- Remember that words accompanied by meaningful and appropriate actions are always the most effective message

Don't:

- Use jargonistic or theoretical language
- Appear nostalgic about the Cold War or suggest the future lies in a return to the past
- Criticize the audience in terms of knowledge, education, or interest

PROPOSED RATIONALE

The following narrative articulates the essential elements of a compelling rationale for the U.S. nuclear arsenal using the themes and concepts (**highlighted in bold**) that resonated most strongly with roundtable participants:

Today, the United States faces a nuclear landscape of complexity, uncertainty, and risk. While nuclear dangers have certainly receded from the high-water mark of the Cold War, the nuclear optimism of the post–Cold War era has declined as well. Today, the United States no longer faces a single primary adversary from one region of the globe, but rather a diverse set of nuclear dangers spanning at least three geographic regions and potentially with global reach. These dangers include:

• **Nuclear attack by a nuclear- armed state**—which while relatively unlikely, remains the primary existential threat to the United States and our way of life.

• **Growing nuclear intimidation and coercion by regional powers** that hope to use their own nuclear capabilities to reshape their regions to their advantage and limit the ability of the United States to exercise power and influence in those regions.

• **Renewed and potentially expanded nuclear competition among great powers**—namely, China and Russia—as they seek to expand and improve their nuclear capabilities and increase the relative role and importance of nuclear weapons in their own national strategies, despite our efforts to do the opposite.

• **Risk of nuclear intimidation and use by non-state actors and extremists** who continue to seek nuclear capabilities and may show little (if any) restraint in using such weapons to further their violent agendas.

• **Growing frustration regarding global** disarmament and efficacy of the Non-Proliferation Treaty (NPT) from increasing numbers of nonnuclear armed states that view the great powers, including the Unite**d States, not as nuclear protectors** but rather as sources of nuclear danger.

• **Continued strategic uncertainty** that leaves open the prospect that the future could take an even more dangerous turn and for which we could be ill- prepared to respond quickly and effectively.

In a world with nuclear weapons, U.S. nuclear forces provide a critical foundation for U.S. power and influence. Faced with such a world, U.S. nuclear weapons serve as a powerful insurance policy by ensuring that, no matter how the threats or enemies change in an uncertain world, the United States has the freedom of action to defend itself and respond. Our nuclear arsenal **under-**

writes the United States' national survivability against its greatest threats, providing the only existing credible defense against nuclear destruction and ensuring that no enemy can see benefit in attacking or holding hostage the U.S. homeland. The United States' nuclear forces therefore act as a **backstop to U.S. conventional power**, allowing their conventional brethren to carry out their responsibilities overseas without worry that the country will go unprotected. Nuclear weapons provide awesome, world-altering, destructive power and bring with them awesome responsibilities. As long as nuclear weapons exist in the world, the U.S. will shoulder these responsibilities and serve as the nuclear counterweight to those with malicious intentions. Failure to do so would leave the world a far more dangerous place.

U.S. nuclear weapons perform these essential roles by forcing any adversary to consider that **the benefits of attacking the United States are far outweighed by the costs.** The U.S. arsenal provides an **assured nuclear retaliatory force** against any enemy state, ensuring that, should an adversary seek to disarm the United States through nuclear first strike, the United States will always have the option of responding in kind. The possibility of such a devastating response factors into every adversary state's calculus in deciding whether launching a military attack on the United States. **It *raises the bar* for that state, creating risks and costs so much greater than any gains to be achieved** that restraint becomes a better option than aggression.

The United States' extension of its **nuclear protection to its allies strengthens those ties and forms the basis of the under lying security relationships,** making the United States an essential provider of global security and stability in the world. U.S. nuclear weapons help bind the United States together with its closest allies based on shared interests and values as well as risks and threats. It provides those friendly states that might otherwise feel compelled to acquire their own nuclear weapons the option to **instead trust in the United States' nuclear guarantees**, empowering them to go without nuclear capabilities while also feeling secure and supported. The U.S. nuclear arsenal thus

enables the U.S. alliance system, allowing it to serve as a cornerstone in the overall nonproliferation framework.

Finally, the United States holds itself to the highest possible standard for **responsible nuclear stewardship**. U.S. nuclear weapons are entirely defensive in character, **designed to prevent attacks, not to initiate them**. The United States will never brandish its nuclear weapons, use them as a source of coercion or intimidation, or seek to further regional aggression through their use. The United States maintains the highest expectations for the safety, security, and command and control of its nuclear weapons and seeks at every step to demonstrate what it means to be a responsible nuclear power. The United States **sets an example** by leading in international efforts to establish and enforce norms in protecting nuclear materials and working to reduce the dangers that existing nuclear arsenals pose to the world.

The value and reliability of nuclear weapons in shaping the decisions of potential adversaries depends on their perception that the **capability is credible and their use in response to a threat is plausible.** Similarly, U.S. decision makers must feel confident that nuclear weapons provide the President with a range of suitable **options that meet the needs of the situation and discourage, rather than encourage, continued aggression**. Our nuclear weapons must inspire confidence in our leaders and allies and fear in our adversaries. To do this, U.S. nuclear forces must, in aggregate, possess a number of essential attributes. The U.S. nuclear force must possess the necessary capabilities to be **credible** (i.e., inspire confidence that these weapons can and will be used if necessary), **flexible** (i.e., able to produce a variety of plausible options and alternative responses appropriate to and commensurate with the threat at hand), and **survivable** (i.e., fully capable against the full spectrum of first- strike attacks so that no adversary can believe a disarming strike is possible). In addition, the U.S. nuclear arsenal must be **permanent and persistent** so that no adversary believes that windows of opportunity to attack the United States will open. These capabilities must also be **visible and demonstrable** so that when a potential adversary questions U.S. intentions in defending itself and its allies, the

United States can signal its resolve and remind potential adversaries of the risks involved. Finally, these capabilities must be responsive. They must able to adapt and adjust to new threats, emerging technological surprises, or potential opportunities in ways that cannot be fully anticipated today.

The United States has given our nuclear forces profound responsibilities and in turn has set the highest possible expectations. These responsibilities and expectations cannot be met on the cheap. Our forces cannot perform their mission without the **investment of time, resources, and attention by leadership** at all levels. At times, this calls for difficult trade-offs and sacrifice to ensure that the nuclear enterprise receives the priority it needs to succeed. Facing long-delayed modernization requirements across the force, the United States today faces just such a challenge of trade-off and sacrifice. But these sacrifices can and will be made when the nation's fundamental security hangs in the balance. Modernization and recapitalization of our nuclear infrastructure and delivery systems is essential but insufficient for building the nuclear force of the future. The nuclear force of the future depends fundamentally on our commitment to and investment in the human capital of the enterprise—the men and women who develop, maintain, operate, and support our nuclear arsenal. Sustaining a highly motivated and highly skilled workforce requires meaningful dialogue; appropriate training, education, and exercising across the force; sufficient opportunity for career and professional development; and a climate that fosters personal responsibility, accountability, and innovation. This is our commitment to our force and our pact with the American people. We can do no less.

PRESERVING PEACE WITH STRATEGIC DETERRENCE

AUGUST 1, 2016

By Mary Ryan, Curator,
U.S. Naval Undersea Museum

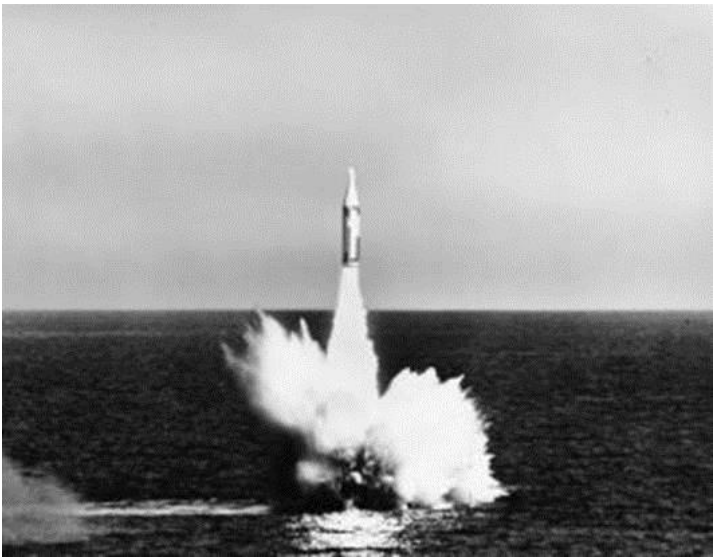
Imagine working for years to design and build something you hope fervently never to use. The U.S. Navy does just that with the nuclear submarine-launched ballistic missiles that form the foundation of the Navy's strategic deterrence program. Deterrence strategy aims to prevent a possible nuclear attack by demonstrating the ability to retaliate. To be credible, a deterrent must work exactly as promised; but should one ever be used, deterrence has failed.

In a few weeks, the U.S. Naval Undersea Museum will open a large new exhibit, "Preserving Peace: The Navy's Strategic Deterrence Program," that tells the story of this program from its beginnings in the 1950s through today's modernization efforts. The program's rich history made developing an exhibit with wide interest and appeal as easy task. The permanent new exhibit weaves together many topics and themes, from Cold War history and missile and submarine technology, to feel-good stories of success against all odds and the personal experiences of submariners who carry out deterrence patrols.

President John F. Kennedy watches the launch of a Polaris A2 missile, November 16, 1963. "Once one has seen a Polaris firing, the efficacy of this weapons system as a deterrent is not debatable," he avowed.

The Cold War transformed nuclear weapons into the symbol of a country's might, military prowess, and technological capability. As tensions between the United States and Soviet Union escalated in the 1950s, the two superpowers began stockpiling nuclear arsenals. This arms race drove the creation and evolution of sea-based strategic deterrence.

Between 1956 and 1990, the Navy's Special Projects Office (today Strategic Systems Programs) brought six generations of ballistic missiles to life: Polaris A1 (1960–1965), Polaris A2 (1962–1974), Polaris A3 (1964–1979), Poseidon (C3) (1971–1992), Trident I (C4) (1979–2005), and Trident II (D5) (1990–present). New generations introduced technological advances that made fleet ballistic missiles more powerful. With relatively minor changes in size, the Special Projects Office significantly increased missile accuracy, range, and warhead capability.



USS GEORGE WASHINGTON (SSBN 598) fires one of two Polaris A1 missiles in the first submerged missile launch off Cape Canaveral, July 20, 1960.

Creating an effective sea-based deterrent also meant designing the submarine to launch them. The Special Projects Office fashioned the first ballistic missile submarine, USS *GEORGE WASHINGTON* (SSBN 598), by inserting a missile compartment into the middle of a fast attack submarine. In the span of eight years, the Navy built five classes of Polaris submarines (many were later converted for Poseidon missiles) that carried out deterrence patrols between 1960 and 1993. These 41 submarines, named for prominent historical figures, came to be known as the "41 for Freedom." The 1980s and 1990s brought the newest generation of ballistic missile subs: the mammoth, 560-foot-long *Ohio*-class.

PACIFIC OCEAN (Nov. 7, 2015) A Trident II D-5 ballistic missile is launched from the Ohio-class ballistic missile submarine USS KENTUCKY (SSBN 737) during a missile test at the Pacific Test Range. The launch, the 156th successful test flight of an unarmed Trident II D5 missile, was part of a Demonstration and Shakedown Operation (DASO) in the Pacific Test Range to validate the readiness and effectiveness of an SSBN's crew and weapon system. (U.S. Navy photo/Released)

Kings Bay, GA. (March 20, 2013) The Ohio-class ballistic missile submarine USS RHODE ISLAND (SSBN 740) returns to Naval Submarine Base Kings Bay after three months at sea. (U.S. Navy photo by Mass Communication Specialist 1st Class James Kimber/Released)

Although the Cold War ended in 1991, Navy strategic deterrence continues in full force. In September 2014, the Submarine Force celebrated the completion of 4,000 strategic deterrence patrols, a significant milestone that translates to an average of 71 patrols carried out each year since 1960. Navy leadership has written eloquently about the importance of maintaining strategic deterrence capabilities in today's uncertain world. The Navy is also looking ahead to the future of sea-based deterrence with the Trident (D5) Life Extension Program and the Ohio-class Replacement Program.

Interest piqued? "Preserving Peace: The Navy's Strategic Deterrence Program" opened August 19 at the U.S. Naval Undersea Museum. Explore the full story and discover how strategic deterrence succeeds every day in accomplishing its sole goal of preserving peace.

ARTICLES

CENTER FOR STRATEGIC & INTERNATIONAL STUDIES (CSIS)
Excerpts from
UNDERSEA WARFARE IN NORTHERN EUROPE
A Report of the CSIS International Security Program

PROJECT DIRECTOR
Kathleen H. Hicks

AUTHORS
Kathleen H. Hicks
Andrew Metrick
Lisa Sawyer Samp
Kathleen Weinberger

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Chapter 1 The Russian Navy: Undersea Activities and Objectives

Russia's dissatisfaction with the post—Cold War order has manifested an increasingly antagonistic foreign policy, as witnessed most recently in Ukraine and Syria.[1] Direct military action on land has been accompanied by probing air and maritime incursions in or near the airspace and territorial waters of NATO allies and partners. The Russian military's buzzing in April 2016 of a U.S. destroyer (DDG), USS DONALD COOK, in the Baltic Sea is the latest in a series of increasingly reckless Russian behaviors.[2] Similar to its snap exercises on land, Russia's air and sea maneuvers serve to test the responses of allied and partner forces while simultaneously creating a numbness to such activities; demonstrate Russian capabilities by exercising risky military tactics; send a signal regarding Russian dissatisfaction with the increased U.S. and allied presence along NATO's eastern flank and intolerance of any Swedish and Finnish plans to draw closer to NATO; and reinforce Russian claims to a sphere of influence.[3] Russia's current foreign policy trajectory, emphasizing

an increasingly aggressive stance vis-à-vis the United States and Europe, is unlikely to change in the next decade.

Following the country's poor performance during the 2008 Russia—Georgia War, the Russian military made significant investments in the reorganization of its forces and modernization of its equipment. In Ukraine and Syria, Russia featured sophisticated artillery and combined arms capabilities that had been augmented with new or repurposed technologies, such as unmanned aerial systems (UAS), to improve targeting and lethality. Russia has also demonstrated a range of effective electronic warfare capabilities that include jamming of satellite navigational devices and communications systems and distributing propaganda en masse via cell phone messages. Such investments have increased the efficacy of Russia's military in a cost- and time-effective manner.

A number of key deficiencies and obstacles remain, however, and will continue to inhibit the Russian military's capability and capacity. Low birth rates in the early post-Soviet period, along with a decline in the prestige of military service and retention issues, has led to a personnel shortfall that is further complicated by Russian military plans to phase out conscription and shift to a fully professional force. Russia has long relied on a system of two-year conscription to fill out its military. This was shortened to one year in 2008 and has been described as the beginning of a "slow-motion disaster" for the Russian military personnel system.[4] The Russian Navy and the Submarine Force has been, to some extent, insulated from the issues currently facing the Russian Army. The highly technical nature of these positions means that the Russian Submarine Force is overwhelmingly manned by professional contract sailors and officers. The Russian officer education system has generally produced very competent commanders who are intimately familiar with the capabilities of their submarines and crews. This familiarity is coupled with a high risk tolerance in carrying out their assigned missions.

Russia's economic downturn also represents an undeniable challenge for the military. As a result of sanctions, plummeting oil prices, systemic inefficiencies, and the dramatic devaluation of the

ruble, the Russian economy has weakened substantially since 2014. In turn, the Russian military is facing increasing budgetary constraints and has twice been targeted for budget reductions since 2015. Some investment areas, such as procurement, are suffering more than others, though this may not remain the case should economic difficulties persist. Submarine construction, for example, has so far been prioritized and shielded from the effects of the military's belt-tightening.[5] The State Armament Program (SAP) 2011–2020 allocates 26 percent of its 19.4 trillion rubles to the navy, totaling five trillion rubles.[6] Overall, Russia appears willing to accept some trade-offs with regard to its domestic social spending in favor of continued investments in a strong military and an activist foreign policy agenda.

Likely in recognition of these constraints, Moscow has been shrewd in how it exercises its military power, aiming to get as much *bang for the ruble* as possible and relying on its strategic nuclear deterrent to underwrite any shortcomings with its conventional forces. In Northern Europe, for example, the Russian Navy's use of submarines to signal presence, reach, and power achieves an effect that is disproportionate to the forces committed. Indeed, Russia has a long history of emphasizing its maritime capabilities for the purpose of strategic signaling and targeted provocations.

RECENT RUSSIAN UNDERSEA ACTIVITIES

A number of maritime incidents have showcased Russia's use of the undersea domain as part of a broader strategy of coercion aimed at its neighbors, NATO, and the United States. These incidents include the probable territorial violations of Swedish and Finnish waters by Russian submarines; submarine activity near the UK submarine base at Faslane, Scotland; and reported suspicious activity near undersea infrastructure in the North Atlantic.

In a highly publicized incident in 2014, the Swedish Navy spent a week searching the Stockholm archipelago in the Baltic Sea with helicopters, minesweepers, and 200 service personnel after an alleged spotting of a Russian submarine in Swedish territorial waters.[7] The Swedish government has not offered any

definitive conclusions regarding the incident, but open source reporting suggests that an emergency radio call (in Russian) was detected by Sweden's intelligence service.[8] Of course, this would not be the first time Russia has breached Swedish territory, nor is it likely to be the last. Another highly publicized incident occurred in 1981— the so-called Whiskey on the Rocks affair—in which a Soviet S-363 *Whiskey*-class submarine spent 10 days stranded on a rock in Swedish waters.[9]

Russian submarine sightings in Sweden have taken on an almost Loch Ness–like mystique. While the frequency of supposed sightings likely gives too much credit to the supportable operating tempo of the Russian Navy, it is highly probable that the 2014 incident was in fact a Russian submarine. In this case, Russia could have been signaling its displeasure at Sweden's growing ties to NATO; the alleged incursion occurred just a month after Sweden signed a host-nation support agreement with NATO at the Summit in Wales. This signal fits into a broader pattern of Russian rhetoric and actions vis-à-vis Sweden. It was recently revealed, for example, that Russia conducted a mock nuclear attack on Sweden during a 2013 war game. The Russian ambassador to Sweden also ominously warned of "*countermeasures*" should Sweden join the alliance.[10]

A similar incident occurred off the coast of Finland in April 2015. In response to reports of a possible foreign submarine, the Finnish Navy dropped small-depth charges to issue a warning to the intruder. As in the Sweden incident, no official attribution was ever declared by the Finnish government.[11] Although this incident does not appear to have been as purposeful or egregious a violation of sovereignty as the Sweden incident, unofficial reporting has strongly suggested that the undersea object was, in fact, a Russian submarine.[12] Reports suggest that Russia semi-routinely skirts the edges of Finnish waters as submarines transit the Gulf of Finland from their base near St. Petersburg. These patrols and deliberate skirting of Finnish waters may serve to test the Finnish Navy's undersea sensing capabilities. Increased Russian undersea activity has also been observed in the North Atlantic. Beginning in late 2014, the Royal Navy reported

suspected Russian submarine activity off the coast of Faslane, Scotland, the location of the United Kingdom's only submarine base and home of the entirety of the British nuclear deterrent: *Vanguard*-class submarines equipped with Trident missiles. Due to a lack of nationally owned, land-based antisubmarine warfare (ASW) assets, the United Kingdom requested allied assistance to track the suspected incursion.[13] Such reports are especially disquieting for the British government as they reflect Russia's potential ability to hold at risk the British nuclear deterrent and underscore the fact that the UK, a historically preeminent maritime power, is currently without fixed-wing maritime patrol aircraft (MPA). The Russian Ministry of Defense has denied any involvement in the three suspected cases of undersea territorial violations in Sweden, Finland, and the United Kingdom.

Press reports indicate that Russian submarines have likewise been operating in exceptionally close proximity to undersea cables in the North Atlantic and elsewhere. This has raised concerns among U.S. officials that Russia may be planning to exploit these key transoceanic linkages through tapping or injection of cyber payloads or by severing them outright.[14] Such capabilities would also be highly damaging in the Baltic Sea, given the large number of undersea data and power cables crisscrossing the region. There have been several reported incidents of Russian naval vessels disrupting the construction of the NordBalt (formerly SwedLit) submarine power cable, resulting in diplomatic complaints from both Sweden and Lithuania.[15]

The lingering uncertainty surrounding all the incidents described only increases the deterrent effect of Russia's submarine activity. The ambiguity inherent in submarine warfare lends itself to a sense of Russian undersea omnipresence. This is sufficient to fulfill Russia's ambition to signal that it considers the Baltic Sea, North Sea, and Arctic as falling within its sphere of influence and that it possesses the capability to hold at risk key allied and partner infrastructure and sea lines of communication.

Incidents like those in Sweden, Finland, and the United Kingdom are, at minimum, provocative and are rightly perceived by NATO allies and partners as evidence of increasing Russian

aggression. It would not be fair, however, to ascribe *all* Russian military activities as having directed intentions. A great deal of Russia's reported undersea aggression more accurately reflects a return to standard operating practices—exercises, sea trials, readiness drills, and transit between Kaliningrad and St. Petersburg—for submarine fleets. Certain legitimate actions may *feel* aggressive because Russia is resuming more constant activities from a very low, post–Cold War operating tempo as it begins to rebuild its Submarine Force after years of atrophy. Such misperceptions may be further exacerbated by the lack of muscle memory among allies and partners in dealing with the Russian undersea threat and the atrophy of their own response capabilities.

RUSSIAN NAVAL OBJECTIVES

The Russian Navy's strategy, doctrine, and structure have not radically changed since the days of the Soviet Navy. It mostly conducts the same missions with the same platforms as its Soviet predecessor, only on a dramatically reduced scale. The last major shift in Russian naval thinking took place under the direction of Admiral of the Fleet Sergei Gorshkov in the 1970s and 1980s. At this time, the Soviet Navy transformed into a global force and began to develop capabilities reminiscent of Western naval forces. In general, the Russian Navy's role can be understood as operating across three key lines of effort.

Sea-Based Deterrence

First, the navy is charged with maintaining a credible sea-based deterrent force on active patrol, with a high state of readiness, and protecting the ability of the sea-based deterrent force to carry out this mission. These tasks reflect the importance of Russia's nuclear arsenal to overall national power.

The provision and protection of Russia's nuclear fleet for strategic deterrence and denying an adversary's freedom of movement will remain the guideposts for the Russian Navy. In support of this, Russia is already in the process of modernizing its ballistic missile Submarine Force and replacing, albeit slowly, its oldest Soviet-era attack submarine fleet. Targeted investments in

overhauling older submarines leverage the technical excellence of the late Soviet submarine designs while offsetting their deficiencies in combat weapon systems through more modern upgrades. During the Second World War, both Germany and the United States used submarines to impose outsized costs on their adversaries. It was then that the Soviet Navy recognized how potent submarine warfare could be in the face of an adversary with superior surface capabilities.

Sea Denial

Second is the defense of maritime areas of geostrategic importance to include the Arctic, Barents, Baltic, and Black Seas, which represent the *aeromarine* approaches to Russia. To achieve this end, grand naval strategy offers two competing concepts: sea control and sea denial. A navy that embarks on the strategy of sea control seeks to achieve dominance of the seas in order to achieve national aims. Historically, sea control translates into blockades, amphibious operations, or carrier strikes against inland targets. During the Cold War, NATO's maritime strategy was one of sea control. This would allow the successful resupply of forces in Europe and strikes against the Soviet flank should the Cold War turn hot.

The Soviet Navy recognized NATO's sea control strategy and surface fleet superiority. It chose to respond not through direct competition but rather through a strategy of sea denial. This strategy has often been embraced by continental, land-centric powers facing maritime powers. At its core, it aims to prevent an adversary from using the sea to its advantage. For the Soviet Union, this meant preventing the United States and NATO from conducting sea-based strikes on Soviet territory. This would be achieved by *killing the archer*, or destroying U.S. and NATO vessels before they could carry out their missions. The sea denial goals of the Russian Navy are the same as their Soviet predecessors and include protection of vital military installations and assets—notably, the large complex of bases on the Kola Peninsula that house the Northern Fleet, the largest of Russia's four naval fleets.

Russia has begun to reestablish a sea denial strategy using a layered defense approach through increased operations of surface ships and submarines in the North Atlantic and moving steadily closer to Russia's territorial waters through the Barents, Arctic, and Baltic Seas. This is reflected in the estimate that Russia has increased its submarine patrols by 50 percent in the past year alone.[16] Submarine warfare has long been a key element to Russia's sea denial strategy, embodied most evidently by Russia's emphasis on the guided missile submarine (SSGN). Unlike their U.S. equivalents, the Russian variants are designed to attack surface naval group formations with long-range, anti-ship cruise missiles. By contrast, the U.S. equivalent, the *Ohio*-class SSGN, is exclusively used for land attack missions and does not have a substantial anti-ship capability. The increased activity of Russian submarines has led to renewed U.S. and NATO interest in monitoring the Greenland-Iceland-UK (GIUK) gap, a strategic choke point that represents the Russian Northern Fleet's gateway to the Atlantic Ocean.[17]

Strategic Signaling

Third, and as previously mentioned, Russia's naval power is also used to signal other nations of Russia's intent and help to achieve overarching political goals. This buttresses Russia's attempts to maintain and, where necessary, reclaim what it believes to be its traditional sphere of influence. A submarine's stealthy veil can be lifted at an opportune moment as a *tacit revelation* of both presence and capability. Such reveals of capability (and adversary weakness) can impose significant psychological and financial costs on the signaled party; recall the massive and expensive search embarked on by the Swedish Navy as a result of a simple surfacing maneuver.[18] A key attribute of Russia operations is the idea of reflexive control, or forcing your adversaries into a predictable course of action by manipulating how they perceive your intent.[19] This manipulation takes many forms and is part of Russia's overarching information campaign. Due to the relative efficiency of such tactics, the low number of platforms required, and the opportunity for plausible deniability

that is far greater than surface maritime or airspace violations can provide, the Russian Navy has seemingly embraced the use of submarines and *tacit revelations* as a reliable method of fear and coercion.

When applying these overarching objectives in the Baltic Sea, Russia's naval activities have included efforts to monitor NATO naval activity; conduct targeted provocations and intimidation; complicate allied contingency planning to preserve Russia's perceived sphere of influence, including by acting as a component of Russia's anti-access/area denial (A2/AD) network; deter NATO military activity on or near its border; disrupt the sea lines of communications of NATO allies and partners; and ensure Russia's territorial integrity. In the North Atlantic, Russia's Navy is additionally focused on maintaining its sea-based nuclear deterrent by ensuring access through the GIUK gap; holding at risk key NATO assets; and protecting the naval approaches to its interior in order to protect its ballistic missile submarines (SSBNs). The activities of the Russian Navy in the Baltic Sea and North Atlantic demonstrate how important naval forces can be to broader coercion campaigns.

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CHAPTER 2
RUSSIA'S UNDERSEA CAPABILITIES:

Today and Tomorrow

Russian naval capability development has been informed by the requirements of its sea denial strategy. Rather than investing heavily in carrier battle groups, Russia has emphasized submarine capabilities, certain surface warfare capabilities, and long-range anti-ship missiles. Over and above the requirements for sea denial, Russian has also demonstrated an unwavering commitment to the development and maintenance of its submarine-based strategic deterrent. In fact, many of the sea denial capabilities Russia has developed are meant to protect its SSBNs. While a detailed discussion of the relationship between the Russian Navy and the Russian nuclear deterrent is beyond the scope of this study, it is important to remember that the relationship exists and the protection of these weapon systems is a major factor informing Russian naval planning.

Russia's Current Capabilities

The active Russian submarine fleet is considerably smaller than it was in the late 1980s and early 1990s. Today's Russian Navy is believed to operate approximately 56 submarines in comparison to the 240 that the Russian Navy inherited from its Soviet predecessor. Russia has been slowly overhauling and modernizing the core of its undersea fleet while retiring the vast majority of its inherited vessels.

Russian submarines are generally believed to be very capable vessels when properly maintained. While the design and layout of many Russian submarine classes may seem unorthodox or even needlessly complicated to Western designers, the end result has been quite impressive. At the end of the Cold War, Russian designers and some Western analysts believed that the Soviet Union was on the cusp of overtaking the United States in terms of acoustic quieting, which would have represented a complete reversal of the Cold War's *regular order* regarding submarine technology. Present day U.S. admirals have publicly acknowl-

edged the prowess of Russia's forthcoming *Severodvinsk*- class nuclear-powered attack submarines.[1] Russian submarines still trail U.S. and Western vessels, however, in sonar performance; that is, they carry fewer towed arrays and, until very recently, an inferior sonar array design.

Russia maintains a host of anti-submarine warfare (ASW) capabilities ranging from dedicated surface warships to long-range, fixed wing aircraft, almost all of which were inherited from the Soviet Navy. These capabilities are not discussed at length given this study's focus on Russian undersea activities. Nevertheless, it is important to acknowledge that any nation operating submarines near Russian territory will have to consider Russian ASW capabilities into their risk calculus. The U.S. and European ASW capabilities needed to counter Russian undersea activities, however, will be discussed in Chapter 3. The following section explores the current state of the Russian submarine fleet and the maintenance and shipbuilding challenges faced by the Russian Navy.

Submarines

The Russian Navy is emerging from its post–Cold War malaise. During the 1990s, its naval leadership, grappling with severe cost constraints, made hard trade-offs in order to triage and save some of the most advanced Soviet submarines. These efforts prioritized the Russian SSBN fleet. These SSBNs, in addition to a relatively small number of modernized diesel (SSK) and nuclear-powered attack submarines (SSNs), make up the core offensive capability of the Russian Navy.

The Russian Navy operates one class of SSK (the *Kilo*-class), four classes of SSNs (the *Victor III*-class, the *Sierra II*-class, the *Akula*-class, and the *Severodvinsk*-class), and one class of guided missile or SSGN submarines (the *Oscar II*-class). As with a large majority of Soviet and Russian naval systems that must typically contend with long development and production timelines, there is a high degree of variation even between single classes.[2] Table 2.1 below offers an overview of Russia's Submarine Force. However, it does not include several classes of submarines in advanced

stages of development or Russia's fleet of auxiliary submarines used for special missions and systems development.

From an organizational perspective, the Russian Navy is divided into four fleets: Northern, Pacific, Black Sea, and Baltic. There is also one flotilla in the Caspian Sea. We focus here exclusively on the Northern and Baltic Fleets. The Northern Fleet is Russia's largest and most formidable. The fleet is homeported at a collection of installations in the Kola Peninsula in Murmansk Oblast. In terms of its submarine order of battle, Russia claims its Northern Fleet includes 42 submarines. Open source analysis, however, suggests that the number of operational submarines is much lower, at approximately 22 to 31.[3] The Northern Fleet also includes a number of special mission and auxiliary submarines, which will be discussed in more detail later in this section. Table 2.2 represents the study team's best estimate of the Northern Fleet's current laydown based on open source material.[4]

Table 2.1. Current Russian SSKs, SSBNs, SSGNs, and SSNs

Class	Type	Basic Characteristics
Kilo (Project 877 and 636)	*SSK*	Successful diesel submarine design produced in large numbers for both the domestic and export market. It is unclear to what extent the older Project 877 boats have been modernized.
Delta IV (Project 667BDRM)	*SSBN*	The final evolution of the Delta design and the backbone of the Russian at-sea nuclear deterrent. When the Deltas were first introduced, they were a step change in terms of acoustic performance. All remaining vessels will be retired as the *Dolgorukiy*-class are commissioned.
Typhoon (Project 941UM)	*SSBN*	The largest submarine ever designed. A truly massive platform for ballistic missiles. One vessel remains in service and is used as a test platform for a new generation of submarine-launched ballistic missiles (SLBMs).

Dolgorukiy (Project 955)	*SSBN*	The latest Russian SSBN that is supposed to replace the entire existing fleet. This class has faced delays in construction and in the development of the primary weapon system, the *Bulava* SLBM; three are currently in service.
Oscar II (Project 949A)	*SSGN*	One of the largest submarines ever built. Created to sink U.S. carriers and their escorts with an extremely long anti-ship cruise missile armament.
Victor III (Project 671RTM)	*SSN*	Most advanced of the second generation of Russian/Soviet SSNs. First submarines used heavily to track U.S. ballistic missile submarines.
Sierra II (Project 945A)	*SSN*	First of the 3rd generation of Russian/Soviet SSNs and first to feature a single reactor. Titanium hull.
Akula (Project 917 and 971M)	*SSN*	Follow-on to the *Sierra II* but with a steel hull, increased displacement, and an improved combat weapon system.
Severodvinsk (Project 885)	*SSN/ SSGN*	A multirole submarine designed to replace both Russia's SSN and SSGN fleets. Tremendously expensive but exceptionally quiet with a large missile armament.

Table 2.2. Estimated Northern Fleet Order of Battle

Type	Northern Fleet	
	Believed Active	Claimed by Russia
SSK	5	6
SSBN	6	8
SSGN	2	3
SSN	7–9	14
SSAN[1]	2–9[2]	9
SSA[3]	0	1[4]
Total	22–31	42

[1] Auxiliary submarine, nuclear powered (SSAN).

[2] Reporting on the status and operations of Russia's fleet of auxiliary submarines is tremendously difficult due to the secrecy that surrounds their existence. The team is relatively confident that a small handful of these vessels conduct regular operations. The exact number is unable to be discerned.

[3] Auxiliary submarine, diesel powered (SSA).

[4] The one SSA is not an operational submarine; it is a test platform for new submarine technologies. This makes it difficult to characterize in this quantitative assessment.

The Baltic Fleet, in contrast, contains no nuclear- powered submarines and boasts only two diesel-electric *Kilo*-class SSK attack submarines that entered service in the 1980s. One of these submarines is currently down for repairs, with no clear date defined for return to service. The fleet's one active *Kilo* was used in 2015 to exercise Russia's anti-submarine warfare capabilities in the Baltic Sea and may have been responsible for the reported territorial violations discussed in Chapter 1.[5] The size of the Baltic Fleet is restricted largely due to the extremely complex operating environment of the Baltic Sea itself. The Baltic Sea is very shallow with an average depth of 200 feet, requires navigation through an intricate archipelago and heavy sea surface traffic, is littered with what is likely the world's highest concentration of unexploded mines and ordnance (UXOs) from the two world wars, and features unforgiving acoustic conditions due to its low salinity and large seasonal temperature variations.[6] For these reasons, most submariners agree that if you can operate in the Baltic Sea, you can operate anywhere. The Baltic Fleet's Submarine Force is ostensibly homeported at the Russian naval base on Kotlin Island in St. Petersburg, but often operates out of Russian naval facilities in Kaliningrad.

Russia maintains a fleet of smaller auxiliary submarines (SSA/SSAN) for special missions and deep sea research. The most advanced of these auxiliary submarines can be paired with converted SSBN *motherships* to help offset the key weakness of these small submarines: a lack of range and self-deployment capability beyond Russia's near seas.[7] The SSAN AS-12 Losharik, for example, is believed to be carried by a converted *Delta III* SSBN, the Orenburg, and possess an exceptionally deep diving capability greater than 8,200 feet (2,500 meters). For comparison, modern SSNs are believed to have a maximum depth of approximately 1,600 feet (500 meters). The Losharik achieves this remarkable depth through a series of spherical pressure hulls.[8] A second repurposed SSBN, the Podmoskovye, a converted *Delta IV* SSBN, is thought to also be able to serve as a mothership for auxiliary submarines.[9]

Russia's auxiliary submarines, also referred to as deep sea underwater stations, are operated by the secretive Directorate for Deep Sea Research (GUGI). The personnel that man these submarines are some of the most highly compensated in the entire Russian military, speaking to the dangerous and covert nature of their mission.[10] It is likely that Russian auxiliary vessels, including tele-operated or autonomous undersea craft, are equipped to be able to manipulate objects on the seafloor and may also carry sensitive communications intercept equipment in order to tap undersea cables or otherwise destroy or exploit seafloor infrastructure. In theory, this capability could enable collection of sensitive traffic carried on transatlantic cables and/or cyber attacks against secure computer systems, among other things. These vessels may also permit the Russian Navy to covertly place sensitive acoustic recording equipment near U.S. and European submarine installations.

The Northern Fleet is believed to have as many as nine nuclear-powered special mission submarines (SSANs) in total, but it is unclear how many of these are actually operational.[11] It also has one special purpose diesel-electric submarine (SSA), the Sarov, which is being used to test new submarine technologies, including acting as a mothership for unmanned underwater vehicles (UUVs).[12] While the Sarov is shrouded in secrecy, what we do know is that it is highly unusual, as it has a nuclear reactor that is not mechanically connected to the vessel's propulsion system.[13]

SHIPBUILDING AND MAINTENANCE

Russia has improved its submarine maintenance and repair capabilities since the low point of the 1990s, but it remains to be seen whether it will be able to keep up with the maintenance needs of a more active Submarine Force. Russia's poor shipyard infrastructure and its large variety of classes and subclasses do not inspire great confidence in this regard. Reports suggest that up to 70 percent of Russia's total shipyard equipment is in disrepair.[14] The inability to maintain and service submarines became the Achilles' heel of the Soviet Navy. Russia must do better if it hopes to maintain its enhanced operational tempo.

There are also persistent questions about the supply chain feeding Russia's shipbuilding and ship maintenance facilities. For example, the first two *Dolgorukiy*-class SSBNs incorporate hull sections from incomplete *Akula*-class and *Oscar II* submarines and steam turbines from a retiring *Oscar II* submarine.[15] The cannibalization of all available resources to build *Frankenstein* submarines demonstrates supply issues with the Russian industrial base and calls into question the acoustic performance of these initial submarines, which slips with every mistake or imperfection. New investments in existing shipyards may help offset these issues, but long build times and extended sea trials suggest that issues of quality control persist in the Russian shipbuilding industry.

Separate from the shipyards used for submarine maintenance, Russia has two primary centers used for submarine production that are in much better shape: Severodvinsk on the White Sea and St. Petersburg on the Baltic Sea. Sevmash, the primary shipyard in Severodvinsk, is the largest shipyard in Russia and presently the only one building nuclear-powered vessels. The yard took extraordinary efforts to avoid mass layoffs during the economic downturn and has managed to maintain a capable core of shipbuilders for the time being.[16]

Russia's main production line for *Kilo*-class and other diesel-powered submarines is the Admiralty Shipyard in St. Petersburg. In a crisis situation, the Russian Navy could presumably add an additional submarine to its Baltic Sea Fleet by pulling a submarine in sea trials that is meant for export into the Russian Navy. St. Petersburg is linked to the White Sea and the shipyards in Severodvinsk and elsewhere by the White Sea Baltic Canal. This linkage may also permit Russia to quickly redistribute a small number of *Kilo*-class submarines from the Northern Fleet to the Baltic Fleet should the situation warrant.

RUSSIA'S FUTURE CAPABILITIES

Over the next five to 10 years, Russia is likely to continue its plans to develop several new ship classes—though, if history is

any indication, it will struggle to realize its full undersea agenda on time and on budget. The most ambitious of its development programs are likely to be curtailed or delayed by Russia's current economic and geopolitical situation, which is dramatically limiting its access to key foreign technologies and equipment. The depth and targets of these cuts, however, remain an open question. The following section explores Russia's undersea development plans in greater detail and discusses the prospects for key Russian shipbuilding and maintenance facilities in the near-to mid-term.

Submarines and Undersea Capabilities

The Russian Navy aims to improve on its capabilities in the undersea domain. This includes the development of new submarines, new propulsion technologies, advanced sensors, and unmanned underwater vehicles. Current submarine procurement plans call for eight to 10 *Dolgorukiy*-class SSBNs, eight to 10 *Severodvinsk*-class SSNs, and a mix of diesel-powered SSK submarines.[17]

As mentioned, the Northern Fleet currently operates one *Dolgorukiy*-class SSBN submarine. This vessel is likely slightly quieter than the late *Akula*-class SSNs and is comparable in terms of mission to the U.S. *Ohio*-class SSBNs. After very public setbacks due to issues with its main weapon system, the Bulava submarine-launched ballistic missile (SLBM), the production line for this class seems to have turned a corner. Russia is looking to introduce a mid-production design change with either the third or fourth boat, which may carry additional SLBMs and feature a redesigned hull for improved acoustic performance.[18] Unlike the earlier boats in the class, this mid-production design change is likely to include the production of true *new build* SSBNs rather than vessels that rely on cannibalized components.

The Northern Fleet also operates a single *Severodvinsk*-class SSN, with the second boat currently under construction. The lead boat has been in sea trials since launching in 2013, and its future may be in doubt.[19] This vessel was under construction for almost 20 years, having been laid down in 1993.[20] Cost is an additional concern. The lead boat's cost was frozen at 47 billion rubles and

the second boat was reportedly going to cost 112 billion rubles.[21] This converts into about $1.4 billion (pre-ruble crash) / $700 million (post-ruble crash) for the first boat and a staggering $3.3 billion / $1.68 billion for the second boat. To put this in perspective, the current U.S. SSN *Virginia*-class is $2.6 billion per unit, which constitutes a much smaller percent of investment from the U.S. defense budget than a *Severodvinsk*-class SSN requires of Russia. (The United States spent $595 billion on defense in 2015 while Russian spent $91 billion on defense in the same year.[22]) It is unlikely that Russia's shipbuilding budget can support SSNs costing upwards of $2 billion, given its other priorities and fiscal constraints.

Despite these issues, and as previously mentioned, the end product appears to be a technically excellent submarine that has made Western naval leaders sit up and take notice. The *Severodvinsk*-class vessels are full of firsts. They are the first Russian submarines to be equipped with superior spherical bow sonars; previous Russian and Soviet systems had used an inferior cylinder design. They are the first Russian submarines to use Western- style vertical launch tubes for cruise missiles. They are also the first to be equipped with a *life of the boat* reactor; that is, a reactor that will not require a costly and disruptive midlife refueling. Taken together, the Russians appear to have a vessel that approaches and in some cases surpasses the most recent U.S. SSNs.

Russia is already considering a more affordable follow-on to the *Severodvinsk*-class SSN. The follow-on may include two separate designs: one to protect (or *screen*) surface strike groups from adversary submarines and the other to serve as a cruise missile submarine.[23] Given past trends in Russian submarine development, one or two of these vessels may serve as an advanced technology testbed. The Soviet Union was engaged in a number of research and development (R&D) projects at the end of the Cold War that had the potential to transform undersea warfare. One such research stream was the use of composites and polymers to build a submarine hull with substantially reduced hydrodynamic drag that would have dramatically increased the maximum speed

of submerged vessels. Such technologies may appear on a future Russian submarine, although the likelihood of costly R&D projects may be impacted by the current Russian economic situation.

Russia's SSK ambitions are the most uncertain due to the development issues facing the *Lada*-class, the replacement for the *Kilo*-class. Problems with the initial prototype, the *St. Petersburg*, led to the suspension of the construction of the two additional *Lada*-class submarines.[24] The *St. Petersburg* has been in development since 1997 but was not commissioned until 2010. Its trials are set to continue through the end of 2016. During its development, the project has met resistance from Russian naval officials due to "shortcomings" revealed during the Northern Fleet's operation of the Project 677 lead ship, *St. Petersburg*."[25] Further delays seem all but guaranteed despite a top-to-bottom overhaul of the design over the course of its 19-year development and production timeline.[26]

It appears that Russia may be moving on from the failed *Lada*-class altogether with a new design, the *Kalina*-class. These vessels may be equipped with the Russian air independent propulsion (AIP) system currently under development.[27] (Diesel submarines with AIP systems are often referred to as SSPs.) The exact timeline for these vessels is unclear and likely dependent on the completion of the new propulsion system. The introduction of AIP technology has been described as a near-term goal for the past decade with little to show in terms of end product. Current reporting suggests that Russia is investing in a hydrogen-oxygen fuel cell AIP system similar to that currently used on German submarines.[28] This system has completed shore- based testing, and Russia claims it will be ready for operation in the next five to six years.[29]

Other Russian technological developments that, at minimum, should be acknowledged are non-acoustic methods of detecting and tracking submarines. The Soviet Union was very interested in ship-based and space-based technologies that could enable adversary submarine detection and subsequent tracking without a traditional sonar. These technologies would be transformative with

regards to the ASW mission and submarine activities more broadly. Non-acoustic detection may degrade or outright remove a submarine's defining characteristic, stealth. Shortly after the end of the Cold War, there was considerable debate regarding the maturity of the Soviet R&D activities and claims of operational efficacy. Any new claims regarding this technology should be met with a healthy dose of skepticism but cannot be dismissed out of hand.

Table 2.3. Future Russian SSKs, SSNs, SSBNs, SSGNs, and SSPs

Class	Type	Basic Characteristics
Dolgorukiy II (Project 955A)	*SSBN*	Reported to include major structural revisions to the prior design. Increases the SLBM payload by 4 to 20 missiles.
Severodvinsk (Project 885M)	*SSGN/SSN*	Improved design for serial production with the goal to reduce the extraordinary costs of the initial submarines.
Severodvinsk Follow- On	*SSGN/SSN*	Reports have suggested that Russia is in the design stages of either a more affordable SSN or an exceptionally advanced SSN with game-changing technologies.*
Lada (Project 677)	*SSK/SSP*	Planned successor to the *Kilo*-class submarines that was supposed to be equipped with AIP technology. This class has faced extensive delays related to design and production. Unclear if Russia will move forward with this class.
Kalina	*SSP*	Potential replacement for the *Lada*- class design. May incorporate AIP technology, although the development of Russian AIP systems has been fraught with setbacks.

* Given Russia's relatively bleak economic outlook, many will scoff at the suggestion that Russia is working on any revolutionary/transformative undersea capability. However, such advances should not be so quickly discounted. During the Cold War, the Soviet Navy invested in audacious and technically risky submarine development programs. The legendary *Alfa*-class with a titanium hull, liquid metal cooled reactor, and extreme submerged speed is the prime example.

Russia's development of unmanned underwater vehicles is yet another advancement shrouded in mystery. UUVs may eventually revolutionize all facets of undersea warfare should the technology mature, as many predict it will. Russia has cleverly signaled the possible existence of a long-range UUV to be used as a nuclear delivery tool by *accidently* showing a classified slide describing the system in the background of a televised briefing for President Vladimir Putin. However, many Western experts have doubts about the ability of Russia to indigenously develop this technology. Western experts have doubts about the ability of Russia to indigenously develop this technology. Unmanned systems require a mastery of technologies that Russia has never demonstrated a competency in developing or producing. Russia's inability to build successful, large unmanned aerial systems reflects this fact. To offset its own technological weaknesses, Russia has purchased tactical UAS from Israel, and it is possible that Russia has reverse-engineered some Israeli designs. Russia may be able to purchase some systems or subsystems on the international market but will likely be unable to match future Western-style UUVs in terms of either numbers or capabilities.

The development of Russia's future submarine fleet is likely to suffer due to a number of factors. International sanctions imposed on Russia as a result of the Ukraine crisis, coupled with the severing of all access to vital Ukrainian industries, hurt Russian shipbuilding and modernization efforts. Russia (and the Soviet Union before it) struggled to develop an indigenous microelectronics industry. Much of this technology was imported from European sources. Russia also suffers from a shortage of machine tooling, a vital component for the manufacture of heavy industrial and military equipment. This shortage is directly tied to ongoing sanctions following Russia's annexation of Crimea.

While Russia is attempting to find workarounds to this challenge, it is unclear how successful it will be, and the timelines associated with finding viable substitutions are long. In September 2014, the Sevmash shipyard announced that it would no longer be importing foreign parts for submarine construction.[31] Reports of cannibalization of certain parts from retiring submarines suggests

that Russia has yet to bridge the gaps in its supply chains. While submarine construction has been prioritized, the Russian Navy's set targets have not been met and delivery timetables for new equipment have consistently slipped right.[32] This will likely only become more exaggerated should Russia's economic downturn persist.

The future of Russian submarine design, construction, and maintenance may also suffer due to a looming precipitous drop-off in knowledgeable workers. The massive downsizing of the Russian Navy after the end of the Cold War included deep cuts to design houses and shipyards, which had a significant impact on human capital of the Russian shipbuilding industry. As a result of these deep cuts, there is a generational gap in many if not all Russian technical fields. Those with experience designing and building new submarines—most from the Soviet-era—are retiring without having trained qualified replacements. Consequently, while a core of highly capable submariner engineers, builders, and maintainers exist, it is unclear for how long and if it will be sufficient for the fleet expansion envisioned by the Russian Navy. These are skills that Russia has not historically imported from abroad, either through legitimate or illegitimate means, and doing so would prove challenging even if Russia chose to do so.

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MEETING THE RUSSIAN CHALLENGE
CHAPTER 3

As discussed in Chapter 1, Russia's renewed activities in the undersea domain have raised concerns among defense experts in Washington and European capitals who recognize that the West's collective capabilities to meet this challenge have decreased significantly. The following sections consider the priorities of NATO and partner nations in the undersea domain; their available capabilities; and the ability of NATO and partner nations to work together to address key capability gaps.

NATO AND PARTNERS' STRATEGIC PRIORITIES

The priorities for U.S. allies and partners in the North Atlantic and Baltic Sea, while complementary, reflect some degree of unique national interest based on the particular geographic characteristics of each nation and the specific nature of the Russian challenge in each area. Broadly speaking, however, NATO and partner maritime priorities can be defined along three lines of effort: (1) Maintain the capacity to defeat adversaries and respond to aggression, as necessary; (2) ensure that sea lines of communication remain open, allowing for the free flow of goods and security of critical undersea infrastructure; and (3) ensure military access and monitor Russian naval activity, which are foundational to all. NATO allies have the additional task of safeguarding the alliance's sea- based strategic nuclear deterrent.

In the North Atlantic, these priorities are largely achieved by monitoring and subsequently tracking Russian submarines and other naval assets. This is a mission that has remained constant since the late 1940s. During the first several decades of the Cold War, monitoring activities were driven by the need to keep an eye on Soviet ballistic missiles submarines. As ranges of SLBMs increased, monitoring activities shifted to tracking Russian attack and guided missile submarines. This task increased in complexity

as Russia produced progressively quieter submarines. This increase in quieting dramatically blunted the NATO advantage in undersea sensing beginning roughly in the 1980s. Today, the need to monitor the strategic GIUK choke point is once again growing given an increased Russian operational tempo and the use of submarines as strategic signaling tools. This task remains difficult for modern-day allied and partner navies as the latest Russian submarines have reached near parity with some of their Western counter parts.

In the Baltic Sea, each nation prioritizes defense of its own territory, including several hard to defend strategic islands in the middle of the Baltic Sea. In support of ensuring their territorial integrity, Baltic Sea nations monitor Russian activities in an attempt to lessen their coercive effects and mitigate the advantage Russia gains from ambiguity. Undersea monitoring in the Baltic Sea must include key undersea infrastructure such as data and power cables that crisscross the region, as well as vital port facilities. In the Bay of Gdansk, adjacent to Kaliningrad, the main Russian threat is from submersibles and, however delivered, special operations forces. Here, guarding against *little green frogmen* will be especially challenging given the shallow depths and locations of assets on the seafloor.

NATO AND PARTNERS' CAPABILITIES

In decades past, the NATO alliance built and maintained a strong proficiency in ASW, conducting regular ASW operations in the North Atlantic and undertaking robust scientific collaboration that could be leveraged for operational advantages. Once the Cold War ended and the Russia threat diminished, the focus on capability development shifted to conflict management and stability operations mostly beyond the European continent. At the same time, defense bud gets and force structure took deep and significant cuts, which led to divestment in ASW capabilities. Overall, today's platforms are undeniably more capable than those they replaced but European nations (and the United States) are able to afford far fewer than they once did. While the picture remains mixed, the ability of many Western nations to reliably

detect, track, deter, and counter Russian undersea activities has atrophied given lack of investments in readiness and matériel over the past decade and a half. Of course, state-of-the-art capabilities are insufficient without the human know-how required to operate them. Successful ASW is ultimately the result of skills honed over the course of regular, repeated exercises.

Broadly speaking, the capabilities needed for undersea warfare include submarines, surface vessels, fixed wing aircraft, helicopters, and in-place sensors. In most cases, it takes all of these platforms and systems working in concert to achieve an effective ASW mission capability. This integrated capability needs to be undergirded by a coherent and cohesive doctrine and regularly exercised to build a true capability at both a national and alliance level. Table 3.1 provides an overview of regional undersea- related capabilities by nation.[1]

In general, there have been real and worrying decreases in national capability and capacity for ASW operations by the nations most needed for credible undersea deterrence and defense in the North Atlantic and Baltic Sea. Many of the platforms that are currently in inventory are aging and have questionable operational utility in certain maritime areas of operations.[2] These decreases are made starker by the increasing sophistication of Russian submarines. The reality of these reinforcing trends is that barring some revolutionary breakthrough in undersea sensing technology, it will take more assets than in the current inventory to locate and then track suspected Russian activity. Table 3.2 provides a brief snapshot of how NATO and partner submarine fleets have decreased since 2000. In addition to showing a nominal downward trajectory, the figures all reveal an increasing burden on the United States. In 2000, the United States accounted for about half of submarine capabilities of the nations considered in this study; by 2016, that number has risen to 65 percent.

Table 3.1. Relevant ASW Assets Based in the North Atlantic and Baltic Sea

	Submarines	Fixed Wing Aircraft	ASW Helicopters	ASW-Capable Surface Vessels
Denmark	0	0	7	3 FFGs, 4 FFs, 2 AGs
Finland	0	0	0	4 PCs, 2 MLs
France	6 SSNs	12	35	1 CVN, 22 FFGs
Germany	5 SSPs	8	22	7 FFGs
Netherlands	4 SSKs	0	18	6 FFGs
Norway	6 SSKs	6	3	5 FFGs
Poland	5 SSKs	0	11	2 FFGs
Sweden	5 SSPs	0	0	5 FSs, 4 PCs
UK	6 SSNs	0	75	6 DDGs, 13 FFGs
U.S.	23 SSNs	44	95	5 CVNs, 10 CGs, 24 DDGs

Note: Auxiliary, miscellaneous (AG); aircraft carrier, nuclear-powered (CVN); destroyer, guided missile (DDG); frigate (FF); frigate, guided missile (FFG); corvette (FS); minelayer (ML); patrol craft (PC); submarine, diesel-powered (SSK); submarine, nuclear-powered (SSN); and submarine, air independent propulsion (SSP).

Denmark

The Royal Danish Navy is responsible for the defense of the Danish mainland and its considerable overseas territory, namely Greenland. It is the fifth largest exclusive economic zone (EEZ) in NATO trailing France, the United States, Canada, and the United Kingdom.[3] These factors contribute greatly to the force structure of the Danish Navy, which operates a comparatively large number of ocean patrol vessels, as well as one class of frigate specifically optimized for Arctic operations.

Table 3.2. Submarine Fleets (2000 and 2016)

	2000	2016
Denmark	3	0
France	7	6
Germany	14	5
Netherlands	4	4
Norway	10	6
Poland	3	5
Sweden	9	5
UK	12	7
United States	74	71
Total	136 (62)	109 (38)

Source: International Institute for Strategic Studies (IISS), *The Military Balance 2000–2001* (London: IISS, 2000); IISS, *The Military Balance 2016* (London: IISS, 2016).

Note: The numbers in parenthesis are the total European fleet without the United States.

All of the major Danish surface combatants are equipped with a unique system known as Stanflex, a modular mission payload system that allows vessels to be rapidly configured for certain missions.[4] Denmark operates three classes of frigates capable of carrying out the ASW mission for a total of nine vessels. It should be noted that these ships do not possess a towed array sonar system, instead relying on embarked helicopters to augment their hull-mounted sonar systems. One of these frigate classes is a unique hybrid vessel combining the missions of a frigate, troop transport, command ship, and minelayer into one platform. The

modular nature of these vessels is what allows them to be reconfigured to meet the requirements for each of these different missions.

Denmark previously operated a relatively robust Submarine Force but divested this capability completely in the middle of the 2000s. There are no announced plans to rebuild any form of submarine force. Denmark is in the process of replacing its ASW helicopters with new MH-60Rs purchased from the United States. The Royal Danish Navy took delivery of the first of these aircraft early in 2016.[5]

France

France is an interesting case due to the history of its relationship with NATO and the Mediterranean focus of most of its naval forces. The French Navy operates the only non- U.S. nuclear-powered aircraft carrier, maintains a fairly substantial surface fleet, has recently recapitalized its maritime patrol aircraft (MPA), and is in the early stages of procuring a new class of small SSNs. Despite France's considerable ASW capabilities and capacity, it is unclear whether the French government would be willing to employ them in the GIUK gap or in support of operations in the Baltic Sea.

The majority of the French naval fleet, which includes the SSN force, is based in Toulon on the Mediterranean coast. At 20 knots, it would take a French naval vessel approximately six days to travel from Toulon to either the GIUK gap or the Baltic Sea. Given France's core security concerns, its naval orientation toward the Mediterranean is understandable. The reality is that France is far more likely to contribute to any NATO maritime missions in the Mediterranean and broader Middle East than in the waters of the North Atlantic.

Regarding hardware, the European multi-mission frigate (FREMM), a joint development and acquisition effort between Italy and France, will form the backbone of the French surface ASW force. This vessel comes in several variants specific to each nation. The majority of the FREMM frigates that have been purchased by France are the ASW variant.[6] A previous frigate

class is also being retrofitted with a towed sonar array as a stopgap method until a new class can be procured in the mid-2020s.

Additionally, the French Navy has begun the construction of a new class of SSNs, the *Barracuda*- class, which are expected to enter service in late 2017. These vessels are noteworthy for their small size when compared with their U.S. or UK counter parts and will represent a substantial upgrade for the French Navy. These submarines will have the ability to launch a long-ranged land attack cruise missile, the *Missile de Croisière Naval* (MdCN), which is comparable to the U.S. Tomahawk.[7]

France is one of the few nations in Europe that still maintains an MPA fleet, in the form of 12 Atlantique 2 aircraft. While these aircraft are quite old, their avionics and sensor suites received an upgrade earlier this de cade.[8] Despite this, they will likely need to be replaced at some point in the coming de cades.

Finland

Finland takes an interesting approach to its military. The Finnish Defense Forces total just slightly over 8,000 professional soldiers, sailors, and airmen. Finland does have compulsory military service with over 20,000 active conscripts and nearly 1 million reserve personnel who could be called up.[9] Accordingly, the Finnish Navy is quite small and does not operate any submarines. It does operate a small number of corvettes equipped for the ASW mission to include sonar systems. Finland is planning to comprehensively overhaul its surface fleet by acquiring a new class of corvettes that appear to be more capable across a wider range of missions than the previous designs. This new procurement program, called Squadron 2020, may include embarking a multirole helicopter.

Finland's surface vessels are augmented by a system of sensors that monitor the maritime approaches to the country. A unique element of the Finnish Navy is its steadfast commitment to mine warfare. The Finns maintain a robust fleet of minelayers and a stockpile of advanced sea mines. This strategy is very much in keeping with their overall defense doctrine of absolute territorial

defense. In a crisis scenario, the Finnish Navy could mine the approaches to key facilities and deny access to adversary vessels.

Germany

The German Navy is representative of the ASW capabilities resident in several relevant European nations. For the past fifteen years, NATO has emphasized its operations in Afghanistan. In response, the German Navy moved away from investing in capabilities needed for territorial defense. Therefore, the latest class of German surface combatant, the F125 *Baden-Wurttenberg*-class, has little to no ASW capabilities.

This surface fleet shortfall is partially offset by the excellence of the German submarine fleet. The Type 212 submarines, the product of a joint development program with Italy, are some of the most advanced air in de pen dent propulsion (AIP) submarines in the world. Their exceptional stealth, long submerged endurance, and small size makes them ideal for shallow water and littoral operations. While they would seemingly excel in Baltic Sea operations, it is unclear to what extent the German Submarine Force operates in these waters.

Notably, however, these vessels have no land attack capability. In fact, the German Navy does not possess any form of long-range land attack weapon for either surface or subsurface vessels. There are understandable political sensitivities around the acquisition of such capabilities by the German Navy. However, given the current security environment in Europe and beyond, a limited investment into these systems may to be prudent.

Germany operates eight P-3C ASW patrol aircraft acquired from the Netherlands in 2006.[10] These second hand aircraft are quite old, but the German Navy is funding a major overhaul of the airframes, which will hopefully extend their service life considerably. However, this service life extension program will take eight years to complete and, given past experiences with such activities, may prove costlier than originally projected. These aircraft are based near the Jutland Peninsula and could be relevant for operations both in the North Atlantic and Baltic Sea.

The Netherlands

During the Cold War, the Netherlands previously maintained a robust ASW capability to include surface vessels, submarines, and aircraft. While it still has a somewhat robust surface ASW capability that includes ship- based helicopters, the other legs of its ASW triad (submarines and aircraft) have atrophied.[11]

The Royal Netherlands Navy operates four *Walrus*-class, diesel-powered SSKs. These vessels entered the force starting in 1992 and had a midlife upgrade in 2007, but they are not equipped with AIP systems.[12] The *Walrus*-class vessels are unlikely to be effective in the deep waters of the North Atlantic against modern SSNs. They may have greater utility in the North Sea or potentially the Baltic Sea. The Dutch government understands that these vessels are getting old and announced that they will be replaced in the 2025 time frame. Reports indicate that the Netherlands may be partnering with Sweden on submarine development and production.[13]

The Netherlands previously operated a fleet of 13 P-3C MPA aircraft and was an active participant in NATO ASW missions during the Cold War.[14] During the early 2000s, all of these aircraft w ere divested and sold to Portugal and Germany. There are no announced plans to replace this capability.

Norway

Norway has long been a key partner in NATO ASW efforts. This is unsurprising given its proximity to both the GIUK gap and then- Soviet naval facilities in the Kola Peninsula. For these reasons, Norway's ASW competencies, especially as they relate to personnel and organization, have not atrophied as greatly as other nations. However, the Norwegian Navy still has to contend with decreasing defense spending and a shrinking pool of assets.

Norway's navy operates six *Ula*-class SSK submarines that, while relatively capable, are scheduled to reach the end of their already-expanded lifetimes in the early 2020s.[15] While these small diesel submarines can operate effectively in the Baltic Sea, they most likely operate in the North Atlantic close to Norwegian shores. Norway's geographic advantage means that its Submarine

Force does not face a long transit time to patrol areas. It is unlikely that these diesel submarines, or a new generation of AIP vessels for that matter, would be effective at open ocean ASW missions against the new generation of exceptionally quiet nuclear submarines. This is due to their low tactical speed, smaller sonars, and decreased ability to operate towed arrays when compared with nuclear-powered vessels. Off board sensors and multiplatform integration could help offset this shortcoming, but the balance of power in undersea warfare tilts toward SSNs in the open ocean.

In addition to its submarine fleet, the Norwegian Navy operates five large multipurpose frigates with ASW capabilities, including embarking an ASW helicopter.[16] Norway is one of the few NATO nations that has maintained an MPA capability throughout the post–Cold War period in the form of four P-3C aircraft. While this is a small number of airframes, Norway again benefits from its geography as the P-3Cs are based on the eastern edge of the GIUK gap. Given the age of its fleet and an inability to fund a full replacement program, Norway is considering leasing P-8s from the United States to meet its ongoing operational need for MPAs.[17]

Poland

The Polish Navy operates a mixture of old Western and former Soviet equipment, including two frigates, formerly U.S. *Oliver Hazard Perry*–class vessels, and five aging submarines. The submarines include four very small vessels (less than 1,000 tons) acquired from the Norwegians in the early 2000s and a singular *Kilo*-class SSK submarine inherited from the former Soviet Union.[18] While this SSK is generally well suited for the Baltic environment, its overall readiness is unknown and the other four small submarines are likely not combat relevant. Reports suggest that Poland is interested in acquiring a new class of submarines with long-range land attack missiles and may be looking at a Swedish-designed vessel. This interest in new, advanced submarines suggests that the Polish armed forces may appropriately be pursuing a strategy of sea denial (vice sea

control) that complements with the land-centric nature of their military.

Poland also maintains a small number of aging rotary wing ASW aircraft. These were supposed to be replaced with a new Airbus- produced helicopter; however, this deal was opposed by the now-ruling party and may be reconsidered.[19] Regardless, it will be some time before any new ASW capabilities enter the Polish armed forces. At one point, Poland operated a network of undersea sensors in the Bay of Gdansk. If this network is still operational, it likely does not possess significant operational efficacy due to its age and mostly silent Russian SSKs.

Sweden

Like others, the Swedish Navy is less capable across the full spectrum of ASW mission requirements than it once was, despite operating several excellent platforms that could be used in this mission. This suggests that the force has not maintained its proficiency in ASW from previous highs and that Sweden may lack some capacity to cover its large and intricate coastline. In this regard, Sweden is confronted by a geographic problem. Not only is its coastline challenging to monitor, but Swedish officials must also concern themselves with the defense of Gotland, a strategic island in the middle of the Baltic Sea.

Sweden operates one of the most capable AIP submarine classes in the world, the *Gotland*-class. These three vessels are highly capable and designed for the Baltic Sea environment. The *Gotlands* are so advanced that the United States leased one from Sweden in 2005 to test U.S. ASW capabilities.[20] The Swedish Navy also operates two older *Sodermanland*-class submarines that have subsequently been updated with AIP technology. These older boats will be replaced in the near-to mid-term by two new, highly advanced AIP submarines. The new A26 vessels will be a step change in terms of multi-mission capability—a major advancement for small AIP submarines. The A26s will also use Stirling engines vice fuel cells, eliminate the days- long fueling process, and boast a flexible payload capacity with the ability to deploy everything from torpedoes to divers.

The Swedish Navy's primary surface vessel, the *Visby*-class stealth corvette, has a robust sonar suite but lacks the ability to track submarines at range, as it lacks a dedicated aviation capability. Sweden is currently acquiring a dedicated airborne ASW platform in the form of the popular NH90 helicopter.[21]

United Kingdom

The Royal Navy may be at its lowest ebb in terms of overall force capacity. The coming years should see the fleet try to reverse some of its losses and regain key capabilities. From an ASW perspective, the Royal Navy is looking to complete the acquisition of the last four of the *Astute*-class SSNs, take delivery of the first *Queen Elizabeth*–class aircraft carriers (CVs), begin construction of a new frigate class, and purchase a fleet of maritime patrol aircraft.

The *Astute*-class SSNs, the successor to the *Trafalgar*-class, are technically excellent, with press reports suggesting that these vessels are roughly comparable to the U.S. *Virginia*-class.[22] The fleet will total seven nuclear attack submarines (a one-for-one replacement of the previous class), with three boats currently in service. While a seven-ship fleet is small, the excellence of the vessels and their crews, and their basing location in Faslane, Scotland, makes them an ideal partner for ASW operations in the GIUK gap. Additionally, the exceptionally close defense relationship between the United States and the United Kingdom means that the two navies have an unrivaled operational partnership in the undersea domain.

The flagship naval acquisition program for the Royal Navy is the two-ship carrier class, the *Queen Elizabeth*. The Royal Navy expects to take delivery of the first of two CVs in 2017. It is difficult to overstate, from both a cultural and operational perspective, the importance of the Royal Navy regaining carrier capabilities. These CVs may be used in support of some ASW operations; however, they are most likely to be used as a highly visible signal of national intent and an offensive strike platform when required. The surface vessels that play a much more direct role in the United Kingdom's ASW operations are its 13 Type 23

frigates. These vessels will begin to come out of service in the early 2020s and will be replaced by some combination of two new classes: Type 26 Global Combat Ship and Type 31 General Purpose Frigate. The initial Type 26 program was a one-to-one replacement for the Type 23s, but the program was altered in the 2015 Strategic Defence and Security Review (SDSR) to include eight Type 26 ASW frigates and at least five of a lighter class, the Type 31.[23]

The United Kingdom's biggest shortcoming in the undersea domain is the lack of any MPA capability since the Nimrod platform was retired in 2010. As discussed in Chapter 1, this shortcoming was dramatically underscored in 2015 when the United Kingdom had to request assistance from NATO allies during a suspected Russian submarine incursion near Faslane. The 2015 SDSR committed the United Kingdom to rebuilding this capability by purchasing nine U.S. P-8 aircraft, but these will not enter service for several years.[24]

United States

The U.S. Navy is the world's largest and most powerful naval force with 10 nuclear-powered carriers (CVNs), 22 cruisers (CGs), 63 destroyers (DDGs), and 53 SSNs in its total force.[25] This doesn't count numerous support vessels, amphibious warfare ships, or ballistic missile submarines. While the U.S. Navy has maintained unquestioned primacy since the end of the Cold War and is arguably the most capable it has ever been, other actors are gaining in both size and capability.

China's Navy is asserting itself in the Pacific and the Russian Navy is finding its sea legs once more.

Under the *Asia-Pacific Rebalance* policy of the United States, the U.S. Navy plans to have 60 percent of its fleet homeported in the Pacific by 2020.[26] Assuming a 53 boat fleet, the number of SSNs homeported on the U.S. East Coast would need to decrease from 23 to 21 to meet stated goals. However, the total size of the U.S. SSN force is on the decline and is set to bottom out at 41 in 2029.[27] The U.S. Navy's reliance on allies and partners to respond to the Russia challenge will, therefore, only increase given other

challenges to U.S. national security in the Asia Pacific and Middle East.

There are also practical issues impacting the ability of the United States to fully engage in the Baltic Sea region. Given its size, a U.S. SSN would have an extremely difficult time navigating the shallow and uneven undersea environment of the Baltic Sea. The U.S. *Virginia*-class is 377 feet long and draws approximately 30 feet of water.[28] By contrast, the Swedish *Gotland*-class has been optimized for this environment and is roughly 200 feet long and draws approximately 18 feet of water.[29] The United States can contribute aerial and possibly some surface assets in this region, but is not best placed to lead an undersea response here.

In the broader North Atlantic, the United States no longer has all of the tools it once possessed to monitor subsurface activity. The efficacy of permanent undersea acoustic sensors against modern Russian SSBNs and SSNs is questionable. To increase its collection ability in this region, the U.S.

Navy has recently announced that it will operate maritime patrol aircraft from the former Keflavik Naval Air Station in Iceland on a rotational basis.[30] It will also be undertaking efforts to recoup some of the navy's lost institutional knowledge regarding ASW and build greater officer proficiencies in integrated ASW operations.

WORKING TOGETHER

NATO and partner nations do not currently possess the ability to quickly counter the Russia undersea challenge in much of the North Atlantic and Baltic Sea. Declining capabilities are not only to blame for this shortcoming; equally problematic is the lack of integration among relevant allies and partners. An effective ASW capability is built on different platforms, sensors, and personnel being able to combine forces in a coordinated manner. Unfortunately, NATO allies, including the United States, and partner nations have lost the ability to work together against a peer adversary in the ASW domain. The organizations, relationships, intelligence, and capabilities that once supported a robust ASW

network in the North Atlantic and Baltic Sea have not been seriously called upon since the early 1990s.

The most obvious way to approach developing an integrated, multinational ASW campaign is to leverage existing structures and multinational organizations. In this case, NATO is perhaps an obvious choice, though any format would need to be adjusted to include non-NATO partners Sweden or Finland. Sweden and Finland are, of course, key contributors to advancing joint priorities in the North Atlantic and Baltic Sea. Given that anti-submarine warfare is extremely complex and highly classified—to the point that integrating undersea maritime forces is difficult even among NATO allies—conducting unified responses with partner forces adds an extra layer of complication.

Within the NATO context, the domestic political and national security concerns of Sweden and Finland must be carefully navigated, given Russia's strong aversion to the idea of these nations moving closer to NATO. So far, they have taken care to walk a fine line between ensuring their own territorial integrity and avoiding unnecessary provocation. Respecting these nations' positions outside of the NATO structure while ensuring a unified approach to common security challenges is vital.

The European Union (EU) may be an alternative structure, though European collective defense through an EU body has faced major challenges and, of course, the EU does not include the United States. The Nordic Defense Cooperation (NORDEFCO) could also potentially play a role in catalyzing enhanced cooperation and integrating ASW capabilities. This body aims to achieve defense cooperation among its member states and includes both NATO and non-NATO nations, but excludes relevant players such as Poland, Germany, the United Kingdom, and the United States. Both the EU and NORDEFCO would also be limited in how far they could take cooperative efforts as they lack a standing command and control structure akin to NATO. Regardless, they may yet prove to be useful launching points for knitting together a more unified response to Russian activity in the Baltic Sea region.

These imperfect options highlight the seam in the European defense community between full NATO members and the vital

partner countries of Sweden and Finland. There are, however, promising signs of increased integration between Sweden, Finland, and key security actors. At the 2014 NATO Summit in Wales, allied leaders established a forum called the Enhanced Opportunity Partnership to ensure Sweden and Finland remain closely integrated with the alliance.[31] Both Sweden and Finland also signed a host- nation support agreement with NATO in 2014 that allows both states to request NATO forces in times of crises.[32] These are steps in the right direction, but achieving a foundational level of jointness while respecting the sovereignty of both nations will require novel solutions and dedicated U.S. leadership.

Augmenting the multilateral approach with strong bilateral relationships can help bridge the lack of alignment between existing international structures and the current threat environment. Close bilateral relationships will also be required to undergird current structures and augment these arrangements where necessary. The United States is well placed to play a key bridging role in the integration of ASW capabilities across the region and enable partnerships with key allies on very sensitive systems. The U.S. Navy and Finnish Defence Forces already enjoy a close and deepening working relationship and are partnering on some science and technology projects with real relevance to anti-submarine and undersea warfare. Likewise, the United States and Sweden recently signed an agreement that deepens their bilateral relationship and specifically calls out undersea warfare capabilities and training as a focus area. Similarly, the budding relationship between Poland and Sweden may help to bridge the gap in the Baltic Sea region. Increased cooperation between these nations could open the door for creating a host of synergies with regards to operations and acquisitions.

The United States will also need to leverage its bilateral relationships with close allies like the United Kingdom and Norway to develop and deploy a new generation of undersea sensing capabilities. In both cases, the United States has been willing to cooperate on very sensitive issues. The U.S. Navy and Royal Navy conduct tactical submarine combat exercises, for example, and the United States has helped outfit Norwegian

survey ships with sophisticated electronic intelligence collection equipment. Leveraging strong bilateral relationships and NATO's enhanced partnership initiative may be the best path forward to simultaneously respect Swedish and Finnish neutrality and build a collective security system in the Baltic Sea and North Atlantic.

ENDNOTES

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UNDERSEA WARFARE TRAINING: KNOWLEDGE FOR ALL OFFICERS

By Ens. Jim Catina, USN

Ensign Jim Catina, USN, a native of Stroudsburg, PA, is a 2016 graduate of the U.S. Naval Academy. He is currently a student in the Undersea Warfare Academic Group at the Naval Postgraduate School in Monterey, CA, obtaining a master's degree in Mechanical Engineering. Upon his graduation in June of 2017, Ensign Catina will report to the Naval Nuclear Power Training Command in Charleston, SC to begin his training as a submarine officer.

Over the last 100 years, the U.S. Navy has been the epicenter of innovation for fighting and winning the wars of tomorrow. From the Revolutionary War through Operation Iraqi/Enduring Freedom, the U.S. Navy has constantly prepared for the conflicts of the future and ensured that its officer corps attain the highest levels of competency in those critical warfighting domains prior to these conflicts. This force-wide knowledge base has allowed the Navy to achieve the monumental asymmetric advantage of unsurpassed preparation. But with new warfare domains quickly entering the picture and the conflict of tomorrow shaping into a war unlike any seen before, the Navy has apparently lost its educational advantage.

It is no secret that the conflict of tomorrow will be waged from the undersea and cyberspace domains, two areas of great intrigue both from war-planning and research perspectives. Great strides have been made in order to strengthen the war-fighting capabilities in these areas within the United States military, and the Navy is filling a critical role in both domains. With the establishment of the 10th Fleet, the Cyber Warfare Centers at both the Naval Postgraduate School (NPS) and the U.S. Naval Academy (USNA), the new Virginia-class submarine, and the development and integration of unmanned underwater vehicles

(UUVs), the Navy certainly seems on its way to winning the conflict of tomorrow in a similar fashion as the conflicts of the past.

But, upon closer inspection, it is very clear that the Navy has been derelict in its duty to educate young officers on the threats of the undersea domain, seeming to neglect its importance for the more *hot-button* topic of cyber warfare. Though this is not to insinuate that the Navy should eliminate the education of cyber warfare for junior officers (JOs), a significantly greater effort must be made to prepare JOs, and ultimately all officers, regardless of their warfare community, for the threats the undersea domain poses and what can be done to mitigate our adversaries' capabilities. This paper will show that education for JOs in the undersea domain is a critical necessity and that the current situation does not provide our JOs the knowledge they need to be successful in this warfare domain. Furthermore, it will present a plan to increase our officer corps' capability to both understand and act in the undersea domain.

Warfighting and Training in the Past

Before an in-depth discussion of future conflicts can commence, it is important to understand the conflicts of the past and what role training and preparation played in the U.S. Navy's successes and failures. Understanding these conflicts is critical to understanding the current state of the U.S. Navy and its path towards future conflicts.

One of the most prominent failures of the U.S. Navy in modern history is the disaster at Wonsan Bay during the Korean War in 1950. The North Koreans, supported by the Soviet Union, set up a blockade of mines in Wonsan Bay in an effort to prevent U.S. forces from attempting amphibious landings. When these mines were discovered by U.S. forces prior to an attempted landing, mine countermeasures ships were deployed with the intent of sweeping the mines quickly in order to proceed with the amphibious landings. However, because of what can only be described as a general mine countermeasure ineptitude, the U.S. Navy took over five days to clear the mines, preventing the

amphibious landings at Wonsan from occurring in a strategically advantageous manner, causing great embarrassment for the U.S. Navy (McElroy 1). In his report on the incident, the Commander-in-Chief of the U.S. Pacific Fleet, Admiral Arthur Radford, was very blunt in his assessment of the situation, stating "Mine warfare has long been a low priority training subject for general consumption in the U.S. Navy…The sweeping of mines by most naval officers is remembered only as a tactical problem which any line officer should be able to do" 1. In other words, a lack of emphasis on the required training and education in the undersea domain, in this case mine warfare, cost the U.S. Navy control of the seas, its main tenet.

Another example of the role that training plays in the effectiveness of U.S. Navy operations occurred in Operation Desert Shield/Storm. During this operation, the U.S. Navy was able to maintain unmatched dominance of the seas by leveraging many of its developing technologies in strike and mine warfare. These efforts complemented revitalized multinational cooperation to deliver an unrecoverable blow to Iraqi forces. In his report on Operation Desert Shield/Storm in 1991, the Chief of Naval Operations, Admiral Frank Kelso II, stated that "The most significant contributor to our decisive victory was our motivated, dedicated, and well-trained volunteers." Because of the many months that the U.S. Navy had to prepare for the conflict, and the years prior to acquire the appropriate assets, the U.S. Navy was able to train and educate its sailors for the assumed conflict of the future, and this strategy showed its benefits through its results.

From discussion of these two major conflicts, one important and rather obvious trend stands out: a well-trained force will greatly outperform an untrained force. To go even further, having a force that is untrained for a future conflict could result in mission failure and cause great embarrassment to the Department of the Navy, Department of Defense, and the United States at large.

The Conflict of Tomorrow: The Necessary Preparation

To many civilian and military experts, the domains of the conflict of tomorrow are clear: cyberspace and undersea. In many

respects we have already seen what a cyber conflict could look like from acts in recent history. In June of 2010, a cyberattack known as *Stuxnet*, was unleashed on Iranian nuclear refinement facilities. Without any kinetic action or boots on the ground, 954 centrifuges were broken in over 15 different facilities across the country, equating to roughly one-fifth of all of the centrifuges operated by Iran (Kelley 1). This ability to produce kinetic effects without a kinetic means is unquestionably powerful.

At the same time, the United States has been vulnerable to cyberattacks itself. U.S. officials have testified to Congress regarding a number of major cyber-espionage operations conducted by the Chinese in recent years and have stated the breaches are significant. These breaches have included the compromise of design information for major programs to include the F-35C, the P8-A, and both the F/A and E/A-18 aircraft (Dewey 2). If such sensitive data can be obtained in peacetime, there is no telling just how potent the cyber threat can be during war time.

However, an even larger opportunity and potential vulnerability may exist in the undersea domain. Unbeknown to many individuals, the undersea realm is directly responsible for many of the luxuries of the modern age. For example, 99% of the world's international data travels via undersea cables (Brown 1). Much of the world's oil reserves are sent from drill platforms in the ocean to home nations via undersea piping and, of course, a vast majority of the world's international trade arrives at its destination via shipping over water, which can be greatly compromised by enemy undersea activity (Wethe 1). Thus, it is very clear that maintaining control of the undersea domain is critical to maintaining the way of life to which many people across the globe have become accustomed.

From a military perspective, the undersea domain also contains great strategic promise. With the technological advances in aircraft-tracking RADAR, the undersea domain has become the only warfare area in which assets are truly "stealthy" (Mujumdar 1). This gives the United States, and any country with an undersea capability, the ability to launch strikes from undersea platforms against targets on land or at sea without notice. Additionally, due

to advances in weapons technology, an undersea asset like a submarine could be hundreds or thousands of miles away from its target, undetected by the intended target, before launching its offensive weapon. The undersea domain also provides a trove of intelligence gathering opportunities, due to its stealth nature, and remains the United States' only survivable nuclear launch platform. (Huessy 2).

With the many risks and opportunities of both the cyber and undersea warfare domains, it is clear they will form the basis for the conflict of tomorrow. This determination then leads to an important question: What must the United States do in order to prepare for this conflict? Besides the traditional preparatory stalwarts of manning and equipping the United States military, a deep commitment to training and education of its officer corps must be instilled. When U.S. forces have veered away from this commitment to training and education, the results in combat have been poor. For example, during the Civil War, the Union Navy was decimated by the undersea domain, particularly mines, because of a lack of knowledge within its officer corps on the potency and capabilities of mines (Melia 16). The same lack of training and education was also a major contributing factor to the decimation of the British fleet and merchant shipping during the First World War and again for the Americans at Wonsan. This education and training must not only take place, but it must be instilled early and upgraded regularly, regardless of the communities in which officers are a part. If this is done, officers will have a strong base knowledge of these key warfare areas so that when the time comes to engage in such a conflict, they will be prepared to make decisions involving these realms as it applies to their particular warfare specialty.

Warfare Education Today

There are two main pipelines through which JO education is accomplished: the Reserve Officer Training Corps (ROTC) and the USNA. Both programs have their unique education requirements, but the focus of this discussion will center on how both

programs educate their midshipmen in both cyber and undersea warfare.

To begin, USNA has been a national leader in undergraduate cyber warfare education. All midshipmen are required to take two cyber-related courses. These courses cover basic cyber-attacks, defenses, computer architecture, and threats in the cyber and electronic domains (USNA). This education succeeds in providing midshipmen a base knowledge of the threats associated with the cyber domain.

However, there is a major lack in the education of midshipmen in the undersea domain. The only time that the undersea domain is mentioned, with a lenient definition of *mentioned*, is during a senior-level course entitled *Naval Weapons Systems* in which students briefly learn about some of the technical nuances of SONAR and how torpedoes sink ships (USNA). This certainly does not amount to a base knowledge of undersea warfare, and does not rival the amount of education provided to midshipmen in the cyber domain.

ROTC midshipmen are in an even worse position than their USNA brethren. After an analysis of many of the nation's top ROTC units, none of them require midshipmen to take a class in either undersea or cyber warfare. This formula for education is most certainly not conducive to producing officers who are capable and educated leaders in both the cyber and undersea domains.

Fixing the Problem: Undersea Education

With such a major gap in the education of JOs with regard to the undersea domain, action must be taken as soon as reasonably possible to remediate this deficiency. To fix this problem, learning from a model that currently provides education on the undersea domain would be extremely beneficial. The Naval Postgraduate School (NPS) in Monterey, CA provides such a model. At NPS, the Undersea Warfare Academic Group educates naval officers from various communities and nations on the importance and nuances of undersea warfare at the graduate-level. Students enrolled in this curriculum receive a wide variety of education in

"modeling and simulation for undersea warfare, non-acoustic sensor systems, and sonar systems engineering" (Stein 1). The curriculum begins with a broad overview of the current issues facing undersea warfare through two separate courses, "Undersea Warfare: Yesterday, Today, and Tomorrow" (taught by RADM Jerry Ellis, a former COMSUBPAC) and "The History of Mine Warfare," (taught by RDML Rick Williams, a former PEO Mine Warfare). Although the NPS program only reaches a small percentage of the students at the institution, NPS provides the most diverse and in-depth knowledge bases for undersea warfare in the Department of Defense today.

Using the NPS curriculum as a model, particularly the introductory courses, the most logical place to begin this educational transition is the USNA. As it currently stands, midshipmen must take three semesters of basic navigation, with the curriculums greatly overlapping (U.S. Naval Academy). This current system is seen as unnecessary by many midshipmen and does not greatly improve their knowledge of navigation by requiring three courses in navigation. The requirement for second class navigation should be replaced with a course in undersea warfare, discussing the history, basic tactics, and threats in this critical warfighting domain, in the model of the introductory undersea warfare courses at NPS. There are many individuals stationed at USNA who have experience in the undersea domain, to include submariners, surface warfare officers and aviators, who all bring their unique perspective to undersea warfare. Also, by offering this class during second class year, the timing aligns directly with a midshipman's first Top Secret brief from the submarine community, allowing them to see the knowledge they are learning in class applied to current real-world situations. In addition, undersea warfare should be directly integrated into every midshipman's community-specific practicum class to understand the importance of their community in supporting the undersea mission. This more tailored approach will allow midshipmen to commission as officers in their specific warfighting community with an understanding of how their job influences the particular requirements of the undersea domain.

ROTC units must take a similar approach to integrating undersea warfare into their coursework, as well as including cyber warfare. ROTC units have a different challenge in that they have a much smaller contingent of officers able to teach classes. Amongst the ROTC units analyzed, each curriculum required second class midshipmen to complete a two-course series over both semesters of their junior year in *Naval Ship Systems*, covering a wide range of topics to include propulsion plants for different naval assets and weapons systems, similar to USNA's *Naval Weapons Systems* (Virginia Military Institute). Both Naval Ship Systems classes should be replaced with one class in cyber warfare taught by that institution's computer science department and one class in undersea warfare taught by the unit officers. Both of these courses should align to the USNA course curriculum as much as possible. This strategy allows for the greatest amount of continuity in background knowledge between the two commissioning sources and also ensures that the curriculum is relevant to the Navy at-large.

Conclusion

It is evident that there is a significant need for JOs to have a base knowledge of the warfighting domains of tomorrow to maintain U.S. military dominance. There is no doubt that the conflict of tomorrow will largely be waged in the undersea and cyber domains and the military must prepare their officers accordingly to make decisions to win in these critical areas. If officers are not prepared, the possibility of history repeating in the form of a Wonsan Bay-type scenario could be well within reason. By implementing a curriculum at both the Naval Academy and at Reserve Officer Training Corps units across the country that emphasizes the unique requirements of these critical warfighting domains, the U.S. Navy can increase the overall knowledge base of its officer corps and prepares the military for sustained short and long-term success.

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SUBMARINE NEWS FROM AROUND THE WORLD

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From the July 2016 Issue

TAIWAN – 2018-2040 Naval Plan Announced

In mid-June 2016, the Republic of China Navy (ROCN) announced its new shipbuilding and force modernization plan that will run from 2017 through 2040. The ROCN is projecting a budget of US$14.7B for the 23 year period. The sea service also envisions indigenous development, construction and manufacturing for the majority of the programs.

AMI believes that this shipbuilding and modernization plan must be considered overly aggressive and underfunded when considering the development costs and numbers of hulls being planned. One must also consider the 23 year span in which several elections will be held and several whitepapers will be issued, undoubtedly changing the modernization effort before completion. Technology assistance from abroad will also be needed when considering the ROCN is considering the full development of its own submarine and AEGIS equipped surface combatants.

The programs that fall under the 23 year plan are as follows:

Diesel Electric Submarines: Mentioned in the 2017-2040 shipbuilding and modernization plan, 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 2001 although no progress has been made.

In regards to the indigenous approach, the research and development (R&D) center Ship and Ocean Industries apparently is developing the design and the China Shipbuilding Corporation (CSBC) will be awarded the construction contract. In late August 2015, the MND submitted a US$90M budgetary proposal (probably approved) to continue the design phase. Chung Shan Institute of Science and Technology (CSIST) is tasked with the development of the combat system. Other than early development funding through 2015, this program remains unfunded and will be the most costly of all future programs. A funding flow will be required through the late 2040s if the ROCN intends to realize its dream of an indigenous submarine.

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 a 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.

NORWAY

Ula Diesel-Electric Submarine (SSK) Replacement: The RNoN currently operates a six-unit Submarine Force that was commissioned in the early 1990s and has been receiving incremental upgrades since entering service. These upgrades are intended to

keep the submarines active until beyond 2020 when a new class of SSK can be procured.

The 2016 whitepaper specifically states that the current six unit Submarine Force will be replaced with a modern four unit force; reducing the subsurface element by two boats.

While no specific design has been selected, the RNoN had considered the Swedish A26, DCNS Scorpene, and TKMS 212/214. In April 2016, the RNoN shortlisted the suppliers to the new front runners for the program, Scorpene and Type 212/214, eliminating the A26 from the competition.

AMI anticipates that a design could be decided upon by the end of 2016 and followed by a Request for Proposals (RfP) in late 2016 or early 2017, resulting in a construction contract by the end of 2017.

It is possible that some of the modules of the new submarines could be built in Norway with final assembly at the foreign partner's yard.

If the time line mentioned above is adhered to, the first unit for the class could commission as early as 2021, with the fourth and final submarine entering service in 2023. With the desire to reduce the Submarine Force by two, it is likely that the first four Ulas will be removed from service on a one for one ratio, decommissioning the final three when the last new submarine is commissioned.

ASIA – Regional Update

INDIA: Kalvari (Scorpene) (Project 75) Class Submarine: In late May 2016, the Indian Navy (IN) cancelled the deal to procure Whitehead Alenia Sistemi Subacquei (WASS) Black Shark torpedoes from Leonardo-Finmeccanica. The torpedoes were to be deployed in the Kalvari class submarines in addition to India's ballistic missile submarines.

The sea service has yet to make a decision on a replacement torpedo.

DID YOU KNOW?

RUSSIA: On 27 May 2016, the Russian Navy (VMFR) announced that the sea service's 5th and 6th Improved Kilo III (Project 636.3) class submarines, RFS VELIKY NOVGOROD and RFS KOLPINO, would be commissioned by the end of 2016.

UNITED STATES: On 15 June 2016, he USN named its 27th Virginia class nuclear powered attack submarine (SSN), USS ARKANSAS (SSN 800). It will be commissioned in 2024.

GREECE: On 15 June 2016, the Hellenic Navy (HN) formally commissioned its third and fourth Papnikolis (Type 214) class submarines, HS MATROZOS and HS KATSONIS, into the Greek sea service.

From August 2016 Issue

INDIA – Shishumar (Type 209/1500) Class Submarine: On 06 July 2016, AMI received information that ThyssenKrupp Marine Systems (TKMS) received a US$38.4M contract from the Indian navy (IN) to integrate the Boeing Harpoon (UGM-84) anti-ship missile (ASM) system into two of the four Shishumar (Type 209/1599) class submarines for the sea service. The work will be done in India at Mazagon Dock Ltd (MDL) with technical assistance from TKMS' Howaldtswerke-Deutsche Werft (HDW).

The Harpoon integration work will only be carried on the two MDL-built submarines, SHALKI (S46) and SHANKUL (S47) and will probably be completed by the end of 2017.

The Indian Government submitted a request through US foreign military sales for the addition of UGM-84 Harpoon anti-ship missiles (ASMs) for its submarine fleet in 2015. This request was approved by the US State Department for the sale of 22 Harpoon ASMs for US$200M which comprises 12 UGM-84L Harpoon Block II encapsulated missiles and 10 UTM-84L Harpoon encapsulated training missiles.

SPAIN – Galerna Class Submarine TRAMONTANA: On 06 July 2016, the Spanish Navy's Galerna class submarine, SPS TRAMONTANA (S74), completed its two-year service life extension that will extend its life through the mid-2020s.

The 2014 US$58.1M contract with Navantia called for the following work package:

- Hull maintenance, repair and preservation.
- Overhaul of main engines, alternators and shafting.
- Replace main batteries.
- Software upgrades weapon control system.
- Software upgrades to surface search radar and ESM sensors.
- Software updates to sonar suite.

In 2014, the SN made the decision to extend the service life of the second of three 80s-vintage Galerna class submarines due to the S80 (Isaac Perol Class) submarine program's delay.

The three Galerna class boats are based on the French Agosta 70 design and were commissioned into service in 1983, '85 and '86. SPS MISTRAL (S73) completed an 18-month service life extension program in 2013. The MISTRAL's refit will ensure the vessel will remain operational until the 2022 timeframe and now the TRAMONTANA through around 2025.

CANADA – Victoria Class Submarines Sustainment: In early July 2016, the Government of Canada awarded Lockheed Martin Canada (LMC) an US$11M contract to provide long term support for the Submarine Fire Control System (SFCS) on all four Victoria class submarines and land based team trainers.

The contract covers all in service and field service support, obsolescence management, and technical investigations as requested by the Canadian Department of Defence (DoD). Under the new contract, LMC will incorporate additional system integrations including modernized layer-based displays support of advanced sonar processing upgrades, remote control and image display of the search and attack periscopes as well as precision

electronic navigation and integration of the electronic supports measures (ESM) systems.

RUSSIA – Delta IV Class SSBN BS 64: On 28 July 2016, AMI received information that the Russian Navy's (VMFR) Delta IV class nuclear powered ballistic missile submarine (SSBN) VLADIMIR (KS 64) will complete its conversion to a deep sea rescue vehicle (DSRV) carrier by the end of 2016.

VLADIMIR will be renamed RFS PODMOSKOVYE (BS 64). The conversion includes inserting a 43 meter (141ft) section from the decommissioned Yankee Stretch auxiliary submarine to replace the missile tube section that was removed during decommissioning. The insertion will bring the PODMOSKOVYE to around 170 meters (557.7ft). The conversion is being done at Severodvinsk (Zvezdochka Shipyard).

From the August 2016 Issue

UNITED KINGDOM

Naval Update – Four SSBNs Okayed

Successor Nuclear-Powered Ballistic Missile submarine (SSBN): On 18 July 2016, the United Kingdom's Parliament (House of Commons) voted overwhelmingly (472 yes, 117 no) to replace the Vanguard class nuclear powered ballistic missile submarine (SSBN) force with four new construction submarines of the successor SSBN class. The four replacement hulls will give the United Kingdom a Continuous-At-Sea-Deterrence (CASD) as envisioned under the *National Security Strategy and Strategic Defense and Security Review (SDSR)* that was released in November 2015.

On 01 August 2016, the British Ministry of Defense (MoD) announced that it was planning to release more than US$1.32B in funding for the SSBN program. The total cost for the Successor is estimated at US$54.1B over a twenty year period, which includes research and development, construction, missiles, operations and through life support from 2016 through 2035. The US$1.32B will

fund continued design work, the ordering of long lead time components in addition to securing the supply chain.

Main Gate approval (to start construction) is expected by the end of 2016 with the first hull starting by the end of 2017 in order to replace the first retiring Vanguard class in 2028.

Unlike other procurement programs, the MoD will release funds in stages in an attempt to keep costs under control. Essentially, before each stage begins, the MoD and main contractors (BAE and Rolls Royce) will negotiate and agree on the conditions for performance and delivery prior to the release of funds.

All four of these submarines will be built at BAE System with the entire class in service by 2033. Rolls Royce will provide the engineering system including the nuclear reactors.

THAILAND

Approval for Chinese Submarines, Again

On 01 July 2016, Thailand's Defense Minister (and Deputy Premier), Prawit Wongsuwan, confirmed (again) that Thailand will purchase three Chinese-built submarines for an estimated US$1B. This follows the Defense Minister's announcement on 15 July 2015 that the submarine procurement program would be put on hold until a thorough study could be completed.

With the defense ministers approval, the Royal Thai Navy (RTN) will use up to US$333M from the 2017 defense budget for the first unit, identified as the Yuan class S26T. The two remaining hulls are expected to be purchased over the next several years and financed over a ten-year period.

The decision to procure a Chinese design came in a June 2015 announcement that a 17-member Submarine Procurement Committee appointed by the RTN voted in favor of the Chinese solution for the sea service's submarine program. Although the Chinese solution got the most votes (breakdown not released), sources indicate that the remaining votes were split between Germany and South Korea. Sources indicated at the time that the Submarine Procurement Committee decision was based on the

best value for the money, which included the three submarines, submarine technology transfer agreements in addition to a training package.

Although no timeline has been given by the Defense Minister for the actual procurement, the 2017 funding of the first unit indicates that negotiations with the Chinese will begin shortly if not already underway. A deal could be struck as early as 2017 with the first unit beginning construction in 2018. Units two and three could follow in 2019 assuming a Chinese-backed financing package is in place.

The export model of the Yuan class, the S26T is diesel electric with a Chinese Air Independent Propulsion (AIP) system using a Sterling-cycle engine developed by the Number 717 Institute of the China Shipbuilding Industry Corporation (CSIC). The three hulls will more than likely have a complete Chinese combat systems package and very similar to those sold to Pakistan.

Although it seems that the RTN is once again on the cusp of getting new submarines, one must ask as to what will either stall or cancel the procurement before it gets off the ground. The stall scenario has become a very familiar as the RTN continues its quest for submarines, a quest that started in the 1990s. The theme for Thai submarines seems to be, better luck next year. Only time will tell if the scenario plays out once again.

UNITED STATES

Future SSBN-X (District of Columbia Class) Design Contract by October 2016

In mid-May 2016 and again in July 2016, the United States Navy (USN) announced that the design contract for the sea service's Ohio Class Nuclear Powered Ballistic Missile Submarine (SSBN) Replacement Program (ORP Program) (District of Columbia Class) would be in place by the fourth quarter of 2016, more specifically October 2016. In the event of sequestration (in that the FY 2017 defense budget is not approved in time), the USN still expects approval of a design contract.

General Dynamic – Electric Boat (GD-EB) has already been selected as the prime contractor for the program and submitted its bid to the US Naval Sea Systems Command (USNAVSEA) on 20 May 2016. Negotiations are underway in order to get the detailed design phase underway by October.

The ORP is expected to proceed through a Milestone B review in August 2016 in order to begin the engineering, manufacturing and development phase. The first unit will begin construction in Fiscal Year (FY) 2021. A work-share agreement for the construction phase of the twelve hulls has already been submitted to the Navy with Huntington Ingalls Industries (HII) Newport News Shipbuilding being the other builder. Both yards are also share construction in the Virginia Class Nuclear Powered Attack Submarines (SSNs) as GD-EB and HII Newport News are the only two submarine builders left in the United States.

The first unit will cost over US$11B with the eleven follow on units at around US$6B although the Navy is attempting to push the price per unit to as low as US$5.5B for the follow on hulls.

For the first hull (USS COLUMBIA) that will begin in FY 2021, US$883M was already committed in FY2015 and US$971M in FY2016. The 30 year shipbuilding budget (FY2017-FY2021) calls for US$773M in FY2017 (plus US$1.091B in R&D), US$787M in FY2018, US$2.7B in FY2019, US$1.3B in FY2020 and US$3.6B in FY2021 when the construction phase begins.

The second unit will begin construction in FY2024 and the third unit in FY2030. The 12th hull is expected to begin in 2035 and commission in 2041*. With the ORP in full swing by 2024, all shipbuilding programs will be under budget stress as the projected Shipbuilding and Conversion (SCN) funding is not expected to support the ORP in addition to all other projected naval shipbuilding programs. With the anticipated blow out in the budget estimates some members of the US Congress are now attempting to shift some of the ORP funding outside of the SCN budget.

**Editor's Note: According to the Congressional Research Service report of October 25, 2016, by Ronald O'Rourke, the third unit will be procured in 2026.*

Further because of the significant amount of workload GD-EB is faced with, the USN has released its "Submarine Unified Build Strategy" (SUBS) that has HII – Newport News Shipbuilding taking on additional responsibilities with the Virginia class SSNs.

UNITED STATES SOCOM Dry Combat Submersible (DCS) Program Underway

In July 2016, the United States Special Operations Command (USSOCOM) signed a contract with Lockheed Martin (LM), in partnership with Submergence Group LLC (SG) to build, integrate, test and deliver up to three dry combat submersibles (DCS).

Under the US$166M contract, LM/SG will build up to three DCS vehicles over the next five years. The new DCS will allow USSOCOM forces to operate at greater depths and travel longer distances than with the previous *wet* submersibles that have been used in the past.

The significance of the *dry* combat submersible is that, instead of sitting in the open in scuba gear and wet suits, exposed to the ocean, the passengers will be in a dry environment until arriving in the target location. This will allow for more rested and fresh force to conduct operations.

Although no specific design has been released by LM, they have stated that the new DCS will weigh just over 30 tons and will be launched from surface ships. This size is nearly twice as big as the S302 design that has been released by LM. The S302 carries a crew of two pilots and six Special Forces personnel, meaning the new DCS will likely carry up to twelve divers plus the two crew members. They will be sized to be able to be transported by C-5 or C-17 transport aircraft.

They will likely be 11.6 meters (38ft) in length with a depth rating of 100 meters (328ft) and a lock-out depth of 30 meters (98ft). They will have a top speed of 5 knots and a range of up to 70 nautical miles. They will be powered by silver oxide batteries powering one electric motor and four positioning thrusters. They are to be equipped with an inertial navigation system (INS),

Doppler velocity log (DVL), underwater telephone (UWT), UHF communications radio, obstacle avoidance sonar, and fathometer.

Construction is anticipated to begin immediately with the first unit entering service in 2019, unit two in 2020, and unit three in 2021.

ASIA SOUTH KOREA

Jangbogo III Class Submarine (KSS-3): On 17 May 2016, the keel was laid for the Republic of Korea Navy's (ROKN) first Jangbogo III class submarine JANGBOGO, at Daewoo shipbuilding and Marine Engineering's (DSME) Okpo Shipyard.

On 16 July 2016, first steel was cut for the second unit of the class at DSME. Unit one will be commissioned in 2020, unit two in 2022 and the remaining seven units through 2029.

AFRICA

Regional Update

As of mid-August 2016, the following are highlights of the Africa Region:

EGYPT S-41 (Type 209) Class Submarine: In early July 2016, the Egyptian Navy's (EN) first of four Type 209 class submarines, S-41, began initial sea trials in the Baltic Sea. The submarines are being built at Germany's ThyssenKrupp Industrial Solutions (TKIS) HDW Shipyard.

S-41 is expected to be delivered to the EN by early 2017. All four units will be delivered to the sea service by 2020.

INTERNATIONAL

Combat, Sensor, and Integration System Developments

Rubin Central Design Bureau Air-Independent Propulsion (AIP) System: On 29 June 2016, Russia's Rubin announced that they had developed an AIP unit (named Kristall-27E) for diesel-electric submarines (SSK) in 2015, finally acknowledging what had been speculated about for years.

The Rubin Central Design Bureau for Marine Engineering is a subsidiary of Russia's United Ship-Building Corporation and has recently stated in their annual report that they continue to equip SSKs with AIP systems able to burn reformed diesel fuel. This type of AIP system also has electrochemical generators.

Rubin is currently building a special floating facility that is designed to test ship-borne versions of their AIP unit that was developed in 2015 as part of the Russian Navy's Kalina research program.

Indian Varunastra Heavyweight Torpedo: On 29 June 2016, as part of a test and evaluation launching and handover ceremony, the Indian Defense Research and Development Organization (DRDO) test-fired a Varunastra heavyweight torpedo from an Indian Navy (IN) destroyer.

After the successful demonstration, Defense Minister Shri Manohar Parrikar officially handed over the torpedo to the IN in a befitting ceremony. DRDO has stated that local participation in the program is at 95 percent, in keeping with the desire to build and develop systems indigenously.

The Varunastra is a 533mm (21in) wire-guided, active-passive acoustic homing torpedo built by Bharat Dynamics Ltd that is around 8 meters (26ft) in length and weighs 1500kg (3300lbs), has a top speed of 40 knots using an electric propulsion system and carries a 250kg (550lb) warhead.

Full-rate production is not anticipated to begin with the first order of 73 weapons being produced and delivered in the next three years. Each torpedo is stated to cost around US$1.8M

DID YOU KNOW?

ITALY: On 16 July 2016, the Italian Navy's third Todaro (Type 212A) class submarine, ITS PIETRO VENUTI (S528), was delivered to the sea service. It will become operational in 2017.

From the September 2016

UNITED KINGDOM: Trafalgar Class Nuclear Powered Attack Submarine (SSN):

In August 2016, HMS TRENCHANT (S 91) has returned to the fleet following a 24 month revalidation and assisted maintenance period (RAMP) at Babcock's Devonport Royal Dockyard. The maintenance period will now allow the submarine to operate until its scheduled decommissioning in 2019.

The refit cost US $471.3M.

The 24-month overhaul included:

- HM&E maintenance and repair, and preservations.
- Installation of new rudder system.
- Inspection of the tail shaft.
- Overhaul of port and starboard circulating water systems.
- Upgrade of nuclear steam rising plant (NSRP).
- Communications and information technology systems upgrades under the Defense Information Infrastructure, Future (DII(F)) project.
- Received the common combat system (CCS) upgrade.
- Upgrade of the communication electronic support measures (CESM) equipment under the Eddystone program.
- Survey and repair of Type 2076 sonar flank arrays.
- Galley upgrades.

UNITED STATES – Los Angeles Class Nuclear Powered Attack Submarine (SSN): On 26 August 2016, the USN's Los Angeles class SSN, USS HOUSTON (SSN 713), was decommissioned at the Kitsap-Bangor Naval Base in Washington State.

The submarine will not be resold on the used ship market as no US nuclear powered vessels are released to other countries.

From the October 2016 Issue

MODERNIZATION PROGRAMS

PERU – Angamos (Type 209/1200) Class Submarines: In June and September 2016, AMI received information that Servicios de la Marina (SIMA) Peru signed contracts with ThyssenKrupp Marine Systems (TKMS) and Elbit Systems to upgrade the Peruvian Navy's (Marina de Guerra del Perú [MGP]) four Angamos (Type 209/1200) class submarines.

TKMS received a US$44.8M contract on 16 September 2016 and Elbit Systems received a contract (undetermined amount) on 02 June 2016. The entire modernization effort will cost US$312M. The units that will receive the modernization effort include the ANGAMOS (S31), ANTOFAGASTA (S32), PISAGUA (S33) and CHIPANA (S34). All were commissioned between 1980 and 1984.

The two units known as the Islay class, ISLAY S35 and ARICA S36, will not be covered under this contract. The TKMS and Elbit contracts follow the 2015 international tender for the modernization of four of the six Angamos/Islay class submarines. The MGP has been planning this upgrade since early 2013.

In 2013, AMI received information that the four units scheduled to undergo the mid-life modernization effort to extend their service lives approximately 15 years with the following refit activities expected:

- Repair and preservation of the hull, shafts and propellers.
- Crew habitability improvements.
- Replacement of batteries.
- Overhaul of the four MTU 12V 483 AZ80 GA31L diesel engines, four Siemens alternators and one Siemens motor.
- Upgrade of the SEPA Mk 3 weapon control system.
- Upgrades or replacement of the sonar, navigation and communication suites (all Atlas Elektronik systems).
- Replacement of masts and periscopes.

- Replacement of SST4 torpedoes with the AEG 264 heavyweight torpedoes.
- Addition of anti-ship missiles, probably the Boeing UGM-84 Sub Harpoon.
- Replacement of current ESM system with the Elbit Timnex II ESM suite.

TKMS, as prime contractor, will cover technical advice and assistance in separating the hull in two parts, enabling Peru to conduct the modernization or replacement of all the systems listed above. The first submarine will commence by the end of 2016 and will run through 2018. The three follow on units will follow at two year intervals with the entire class being modernized by 2024.

PORTUGAL – Tridente (Type 209PN) Class Submarine: In mid-September 2016, AMI received information that the Portuguese Navy (PN) would be replacing the batteries in its two Trident (Type 209PN) class submarines, TRIDENT (S 160) and ARPAO (S 161).

The estimated US$11.2M budget for the program was approved in May 2015 with the first payment in 2016 and the remaining in 2018. The deal covers the batteries and associated accessories. The first two Sunlight 324 cell lead acid batteries will probably be installed on the first unit in 2017 and the second in 2019.

TAIWAN – Sea Dragon Class Submarines: On 01 April 2016, AMI received information that the Republic of China Navy (ROCN) was moving ahead with a Life Extension program (LEP) for its two Sea Dragon (Zwaardvis) class submarines. The two submarines have been in service since 1988. It appears that the overhaul will be conducted at China Shipbuilding Corporation (CSBC) with the assistance of a foreign yard.

In mid-March 2016, a contract for the LEP design work was awarded to two European marine engineering companies. Taiwan's Ship and Ocean Industries Research and Development Center (SOIC) will be the local subcontractor for this phase which

is expected to be completed in 2018. The modification phase will run from 2018 through 2020 and will address obsolescence issues. The work package is expected to include:

- Hull, mechanical and electrical (H,M&E).
- Non-propulsion electronic system modifications.
- Upgrades to the TIMNEX 4CH(V2) electronic support measures (ESM). Several firms are now competing for the estimated US$9M ESM upgrades.
- Replacement of the Thales Naval Nederland (TNN) SIMBADS-M CMS system and SIASS-Z integrated sonar system with the Lockheed Martin Submarine Integrated Combat Systems (SUBICS).
- Replacement of the SUT torpedoes with the Raytheon Mk 48 Advanced Capability (ADCAP) torpedoes (approved by the US Government by the end of 2016, also funded in 2016).
- Replacement of the UGM-84L Harpoon anti-ship missiles (ASM) with the Harpoon Block II ASM including integration into the CMS. US$200M deal concluded for 32 UGM-84L Sub-Launched Harpoon Block II ASMS.

The Chungshan Institute of Science and Technology (CSIST) will play a minor role in the LEP with foreign companies such as Lockheed Martin and Raytheon playing major roles. The LEP combat system work was expected to be under contract by 20 May 2016.

UNITED STATES – BAE Systems Mk 45 127mm Naval Guns: In late August 2015, BAE Systems was awarded a contract from the US Navy (USN) worth up to US$130M to overhaul and upgrade the Mk 45 127mm guns on the sea services destroyer force. The initial contract of US$80M is for the upgrade of six guns to the Mod 4 configuration in 2015 with an option for four additional Mod 4 configurations in 2016.

The option for the four additional guns was exercised on 27 September 2016 at a cost of US$50M (total contract for ten is US$130M). The 10 Mod 4 configured 127mm guns will be installed on Arleigh Burke class destroyers with the first occurring in 2017 and the tenth in 2020.

The fully digital Mod 4 configuration includes upgrades including a 62 caliber barrel, strengthened gun and mount systems, enhanced control systems, a reduced signature and a low maintenance gun shield. Operational and performance improvements are designed to support potential increased ranges for naval surface fire support that will come with future extended range guided munitions.

UNITED STATES – Attack and Guided Missile Submarines: In late May 2016, AeroVironment announced that the United States Navy (USN) would begin deploying its Blackwing Unmanned Aircraft System (UAS) aboard the sea service's nuclear attack submarines and nuclear guided missile submarines providing an advanced reconnaissance system. The guided missile submarines include the four Ohio class SSGNs and the attack submarines of the Virginia, Seawolf and Los Angeles Classes.

The Blackwing UAS is a small, tube launched system that can deploy from under the surface of the sea, on manned submarines and Unmanned Underwater Vehicles (UUVs). The Blackwing is a low cost system optimized for anti-access and aerial denial (A2/AD). The system employs an advanced, miniature electro-optical and infrared (EO/IR) payload, Selective Availability Anti-Spoofing Module (SASSM) GPS and secure Digital Datalink (DDL). The Blackwing UAS can be fully integrated into the submarine fleet using existing, standard command and control systems.

In early 16 August 2016, the USN successfully demonstrated the use of the Blackwing UAS to link with a swarm of UUVs and communicate with the submarine's combat control system. The UAS can also provide a relay for command and control (C2)

between geographically separated vessels such as unmanned submarines, UUVs and surface ships.

USED SHIP TRANSFERS/RECEIPTS/ DECOMMISSIONING

India – Nuclear-Powered Attack Submarine (SSN) Lease: On 12 December 2014, Russia's Trade Minister announced that it was ready to lease an additional used nuclear submarine to the Indian Navy (IN). The statement was believed to have referred to the Akula class, of which one is already under a US$970M ten-year lease to the Indian sea service through 2021. In late March 2015, AMI received information that the Indian Government had made the formal request for a second Akula.

Sources in late-2015 reported that the IN was also considering one of the Yasen (Project 885) class SSNs as an alternative. In September 2016, AMI received information that India would send a delegation to Russia before the end of 2016 in an attempt to attain a lease a Yasen, probably the SEVERODVINSK (K-329), for ten years. The Indian rational is that the Yasen class is much newer than the 1980s/90s vintage Akula class SSNs. The only two units of the Yasen class built to date are the RFS SEVERODVINSK (K-560) and the RFS KAZAN, both commissioned since 2013. The IN began considering the lease of a second unit in early 2013.

In the event that the IN remains with the Akula, it may be either the Akula II hull IRIBIS, which is 60% complete and remains at Russia's Amur Shipyard or the completed Akula I KASHALOT (K-322).

The procurement of the second SSN has become a much higher priority in recent months as the first Indian-built Nuclear Powered Ballistic Missile Submarine (SSBN) INS ARIHANT began sea trials in mid-December 2014. Negotiations will probably be completed by 2017 with the lease costing around US$1B over the ten year period.

ITALY – Decommissioning Schedule for Navy, Coast Guard and Finance Vessels:

Prospective Decommissionings: Sauro III Class Submarines: PRIMO LONGOBARDO (S528) in 2018 and GIANFRANCO GAZZANA PRIAROGGIA (S525) in 2019.

FRANCE: Rubis Amethyste Class Nuclear-Powered Attack Submarine (SSN): In late September 2016, AMI received information that the French Navy (FN) would decommission its first Rubis Amethyste class nuclear powered attack submarine (SSN), FS RUBIS (S 601), in January 2017. The SSN will be replaced by the first unit of the Suffren (Barracuda) class, SUFFREN, when it commissions in 2017.

The RUBIS will probably be held in reserve prior to being scrapped. The five remaining units for the Rubis Amethyste, SAPHIR (S 602), CASABLANCA (S 603), EMERAUDE (S 604), AMETHYSTE (S 605) and PERLE (S 606), will probably decommission in 2020, 2022, 2025, 2027 and 2029 as the five follow on Suffren class SSNs enter service.

From the November 2016 Issue

ISRAEL More Dolphin Submarines Being Considered

In late October 2016, AMI received information that the Israeli Defense Force (IDF) Navy (Heil Hayam Ha Yisraeli – HHHY) was interested in the procurement of three additional Dolphin II submarines in order to replace the original three Dolphin I class that were commissioned in 1999 and 2000. Source indicates that a Memorandum of Understanding (MoU) has been signed and the Israeli Government has already entered into negotiations for the three hulls.

The HHHYs three Dolphin I and three Dolphin II (3rd unit to be delivered in 2017) submarines were built at Howaldtswerke Deutsche Werft AG (HDW) (ThyssenKrupp Industrial Solutions – TKIS). The majority of the subsystems are also derived in Germany with the Dolphin IIs using an Israeli surface search radar and ESM system. The US Harpoon is also integrated into all six hulls.

The original three Dolphin Is and three Dolphin IIs were heavily discounted as the German Government paid for 33 percent of the total cost of the submarines. Israel will probably also seek to

receive a similar discount if and when the additional submarines are procured. Whether Germany will help fund the additional submarines is questionable as federal elections (Federal Parliament – Bundestag) will occur in October 2017. On the positive side, TKIS will need to keep its submarine orders stable in order to maintain its industrial base as the last German Navy Type 212A will be delivered in 2017 followed by the third Israeli Dolphin II in 2018.

Assuming that a deal is concluded, the Israeli Government could move forward with the additional submarines as early as 2018 in order start construction on the first Batch II hull (unit 4) in 2019 and delivery in 2025. The oldest Dolphin I will be 26 years old in 2025. All three units could be in service by 2029.

SPAIN – S-80 Submarine Construction Resumes

On 23 October 2016, AMI received information that Navantia is finally continuing with the fitting out phase of the S-80 class submarine following a lengthening of the hull.

Originally, the lead boat, ISAAC PERAL, was to be delivered by 2011, but budget shortfalls and contention regarding who would supply the combat management system (CMS) created delays, pushing the fist of class to 2015.

The S-80 class diesel electric submarines (SSK) were further delayed for over three years while a redesign of the submarines' stability and performance problems were corrected. In 2013, Navantia announced that there were serious weight imbalances in the design that would result in delaying ISAAC PERAL until 2017 while a fix was found. General Dynamics Electric Boat determined that the submarine had an overweight problem and the hull was lengthened by 7 meters (23 ft) in order to correct the issue. Additionally, it was found that the Air Independent Propulsion (AIP) system was under-powered but the addition of the added buoyancy from the lengthened hull would correct the problem.

With the hull and mechanical work now complete, the submarine can now move on to the fitting out of weapon systems and the interior furnishings. With work recommencing, ISAAC PERAL is

anticipated to be launched in 2020, and delivered to the Spanish Navy in 2021, a total of 10 years beyond the original schedule.

When complete, the S-80 class SSKs will be 79.05 meters (269.4ft) in length and will displace 2,426 tons submerged. They will be powered by three bio-ethanol diesel engines, one AIP fuel cell and one electric motor for a top speed of 19 knots submerged.

They will be manned by a crew of 32 and armed with six 533 mm torpedo tubes capable of firing the Atlas Elektronik DM2A4 heavyweight torpedoes as well as Boeing Harpoon anti-ship missiles (ASM).

The remaining three submarines will, barring any additional delays, be delivered by 2026.

ASIA Regional Update

As of mid-November 2016, the following are highlights of the Asia Region:

INDIA Arihant Class Nuclear Powered Technology Demonstrator (SSBNX) (Advanced Technology Vessel – ATV Program): On 18 October 2016, AMI received information that the Indian Navy (IN) commissioned the Arihant class SSBNX ARIHANT in August 2016. The 6,000-ton SSBNX will be the only unit of the class and will be followed by the 8,000-ton Aridhaman class SSBN.

INDONESIA:

Improved Chang Bogo (Type 209) Class Submarine: On 25 March 2016, the first Indonesian Navy (TNI-AL) Improved Chang Bogo (Type 209) class submarine (KRI NAGABANDA) was launched from Daewoo Shipbuilding and Marine Engineering's (DSME) Okpo yard in South Korea. It will be delivered to the TNI-AL in late 2017.

The second unit was launched on 24 October 2016 from DSME and will be commissioned in 2018. The third unit will be built at Indonesia's PAL Shipbuilding (with assistance) and will begin construction in 2017 and commission in 2020.

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 October and November 2016:

ASC to Split into Three Companies: On 11 October 2016, the Australian Government announced that it wants to split Adelaide-based ASC into three separate companies in an effort to streamline ASC's corporate structure. The three companies have been identified as Shipbuilding, Submarine Maintenance and Support, and Infrastructure.

The Shipbuilding company will be responsible for employing the shipbuilding workforce and completing the Air Warfare Destroyer (AWD) program as well as building the new SEA 1000 submarines.

The Submarine Maintenance and Support Company will employ the submarine sustainment workforce and will sustain the Collins class submarines.

The Infrastructure company will hold and upgrade all shipbuilding and infrastructure assets used to support future shipbuilding and submarine programs.

ASC currently operates separate submarine and shipbuilding businesses and has five subsidiaries that look after construction of the AWD, Collins class maintenance, employment, asset management, and infrastructure. The split into three companies will allow each to focus on their core function without having an effect on employees' terms or conditions.

This action will bring to Australia defense giant DCNS and will create Osborne South, the most modern and one of the busiest shipyards in the world when completed in mid-2017.

INTERNATIONAL
Naval Ship Design Developments

AMI is currently tracking naval ship design developments. The following are the highlights for the months of October and November 2016:

DCNS SMX 3.0 Submarine: At EURONAVAL 2016 held at Le Bourget, France from 17-21 October 2016, DCNS unveiled its new submarine concept, SMX 3.0, touted as being tailored for Generation Z.

The SMX 3.0 is to have a displacement of 3,000 tons and will be tailored to be a strengthened submarine, specifically designed to offer exceptional crew comfort for the men and women onboard.

Data systems are to be completely interconnected, robust, secure, fast, and upgradeable. The combat and platform operations systems have been designed around more efficient, intuitive and fluid man-machine interfaces (MMI).

Equipped with a vertical launch system capable of launching both drones and missiles, the SMX 3.0 extends the scope of a submarine's traditional warfare roles. The more hydrodynamic shape and anechoic coating increases the submarine's acoustic suppression, making it more difficult to be located passively.

The submarine will be equipped with a second-generation air-independent propulsion (AIP) system (AIP FC2G) that is currently being tested at a shore facility. It will be capable of long, underwater patrols without the need to surface or snorkel.

Drass DG85 Midget Submarine: Drass of Italy showcased its latest midget submarine design, the DG85, at EURONAVAL 2016. Based on traditional Italian midget submarines, the new submarine will bring more modern technologies to the market.

The new DG85 is 21.06 meters (69.1ft) in length, had a beam of 3.82 meters (12.5ft), displaces 94 tons, and has a submerged speed of 13.9 knots. It is armed with two 400mm wire-guided torpedoes capable of attacking surface ships in harbors or in littoral waters. Additionally, they can be used to deploy mines, gather intelligence and patrol coastal littoral waters. It is equipped with active and passive sonars, TV periscopes, navigation and platform management systems, and echo sounders.

Its small size and rather inexpensive cost will allow for navies that have a desire for a submarine capability to enter the market

for much less than a traditional diesel-electric submarine. Additionally, navies with shallow coastal waters can use their larger submarines for longer-range patrols while using a midget submarine for coastal and harbor patrols.

Another feature of the DG85 is that its bolted together allowing for easier maintenance as well as disassembly for transport over land or for storage in an on-shore hangar when not needed, increasing its life-span.

DID YOU KNOW?

RUSSIA: On 26 October 2016, the Russian Navy (VMFR) announced that the sea service's 5th and 6th Improved Kilo III (Project 636.3) class submarines, RFS VELIKY NOVGOROD and RFS KOLPINO, would be commissioned by the end of 2016. The RFS VELIKY NOVGOROD was commissioned in early October and the RFS KOLPINO was handed over to the VMFR for commissioning by December.

UNITED STATES: On 29 October 2016, the USN's 11th Virginia class nuclear powered attack submarine (SSN), USS ILLINOIS (SSN 786) was commissioned at the submarine base in Groton, Connecticut.

UNITED KINGDOM: On 01 October 2016, the Royal Navy (RN) announced it will begin construction on the first Successor Class Nuclear Powered Ballistic Missile Submarine (SSBN). Under "Delivery Phase 1", manufacturing will begin on the structural steel work for the auxiliary machine space. In late October, the RN named the first unit, HMS DREADNOUGHT.

SUBMARINE COMMUNITY

COMMANDER SUBMARINE FORCE,
U.S. PACIFIC FLEET

DECEMBER 7TH, 1941:
A SUBMARINE FORCE PERSPECTIVE

"When I assumed command of the Pacific Fleet on 31 December 1941, our submarines were already operating against the enemy, the only units of the fleet that could come to grips with the Japanese for months to come. It was to the Submarine Force that I looked to carry the load. It is to the everlasting honor and glory of our submarine personnel that they never failed us in our days of great peril." -- Admiral Chester Nimitz, Commander in Chief, U.S. Pacific Fleet (and also a submarine officer)

This week America remembers the 75th anniversary of the attack on Pearl Harbor. This remembrance is particularly meaningful to the U.S. Navy, and even more to Sailors serving at Pearl Harbor. But it should have the greatest significance to the Submarine Force, because it was our contributions to the Second World War that suggest that December 7th, 1941was actually the day that Imperial Japan won a battle, but lost the war.

Submariners are well-aware that World War II provided some of our greatest challenges, our greatest successes, our greatest heroes, and also our greatest sacrifices. And here in Pearl Harbor, we can stand atop the Dive Tower on the Submarine Base and actually see the most visceral reminders of the complete cycle of the war: its opening salvo, the seeds of our eventual victory, and even the war's conclusion. That makes Pearl Harbor unique—where else in the world is there such a singular vantage point for the breadth of such a major conflict?

The Opening Salvo:

Visual reminders of the start of the war are obvious, and infamous. In the harbor lies the USS ARIZONA Memorial, which honors the nearly 1200 Sailors and Marines who lost their lives onboard that fateful day. Seaward of ARIZONA sat the battleships that comprised Battleship Row, remembered now by a line of white caissons. These caissons remind us not only of the Sailors of those battleships, but of the sheer number of casualties: the nearly 2,400 men, women, and children, both service members and civilians, who lost their lives on that "day that shall live in infamy."

The War's Conclusion:

Sweeping to the left of the Arizona from the Dive Tower, those caissons now bracket the most powerful symbol of the war's conclusion: the battleship USS MISSOURI. Today we can visit the very place on board that ship where in September 1945 the peace treaty was signed that ended the war. That signing ceremony marked both a beginning and an end. As an end, it meant that the war had been won. But it also marked the beginning of the equally important challenge of how to win the peace. And as a result of having won the peace, the United States of America and our former adversary of Japan are now close friends, partners, and allies – committed to each other's success, to each other's defense, and to promoting freedom and democracy throughout the Pacific.

The Seeds of Victory:

So the USS ARIZONA reminds us of the start of the war, and USS MISSOURI reminds us of the end of the war; but the reminders of how the war was won are also visible from the Dive Tower. Although the results of December 7th were horrific, they did not prevent us from prevailing. There were three significant targets that were not struck, and the omission of the fuel farm, the shipyard, and the submarine base had strategic consequence.

From the Dive Tower we can see some of the many fuel tanks that supplied the fleet. Admiral Nimitz observed that had these tanks been struck, and their four million barrels of fuel lost, it would have taken two years to replenish our supply such that the fleet could prosecute the war across the vast, vast reaches of the Pacific Ocean.

From here we can also see the dry docks and the incredible industrial capacity of the Navy's "No Ka Oi" shipyard, the Pearl Harbor Naval Shipyard. After the attack, 12 ships including five battleships had been sunk or beached and nine ships including three more battleships had been damaged. Yet within only three months, most of the smaller ships and all three of the damaged battleships were returned to service or refloated, and all of them eventually returned to the fight in the Pacific.

Lastly, Pearl Harbor submarines and the Submarine Base weren't struck. Within hours of the attack, Chief of Naval Operations Admiral Harold Stark ordered, "EXECUTE AGAINST JAPAN UNRESTRICTED AIR AND SUBMARINE WARFARE;" our submarines were the only forces able to immediately begin war patrols. They carried the battle across the Pacific and into Japanese home waters while the fleet was repaired.

Our submariners did their deadly business very well. Although submarines made up only two per cent of our entire Navy, they sank 30% of all Japanese warships, and 55% of all Japanese merchant ships sunk during the war. But submariners also paid the heavy price of the heaviest casualty rate of any American branch of service in the war: fifty-two submarines were lost, and 3,628 submariners (22% of the force) remain on eternal patrol.

The Pearl Harbor horizon has many memorials containing much history, but this important story of Submarine Force success and sacrifice is hard to find within the Pearl Harbor narrative already on display. Until now. Today, we begin to share that story—honoring our heroes and educating the public—with a new display located in front of the USS Bowfin Memorial, free and accessible to anyone visiting Pearl Harbor's iconic landmarks.

It's important to remember though that the history of our Submarine Force didn't begin on December 7th, 1941; and the Submarine Force's significant contributions to our nation's security didn't end in September 1945. Throughout the hostile peace of the Cold War, our strategic forces proved undetectable and invulnerable to threats, while our attack submarines demonstrated the ability to hold at risk what other nations' hold most dear. And strategic deterrence and undersea superiority are just as important to our national security today as they have been in the past.

That makes this an incredibly exciting time to be a submariner, and an incredibly important time for our Submarine Force to maintain its undersea superiority. Our Navy and our Nation should expect no less. So although the history of our Submarine Force is impressive and is to be celebrated, that history is not complete. Our history is being made today, and every day, by every one of today's submariners. Because throughout the 116-year history of the U.S. Submarine Force, the most important factor in all of our many successes and in all of our nation's conflicts has been the submarine Sailor. It is our submarine Sailors, supported by our families, then as now, that are our greatest asset; our secret sauce; our competitive advantage. They are the envy of every would-be competitor on the high seas—or below them.

So on this Pearl Harbor Day, let us remember the debt we owe to the veterans who preceded us—veterans who have won our nation's wars and who have also won the peace. But perhaps their greatest legacy is their example of honor, courage, and commitment that is now proudly carried forward and embodied in today's generation of submarine veterans. This is another greatest generation; one that continues to preserve that hard-won peace. It is their service that should now give us all great confidence that General MacArthur's words delivered on board USS MISSOURI in 1945 should prove to be prophetic: "Let us pray that peace be now restored to the world, and that God will preserve it always."

COMSUBPAC Press Release
Dec. 6, 2016

Commander Submarine Force, U.S. Pacific Fleet and USS Bowfin Submarine Museum and Park Unveil New Submarine Exhibit

By Lt. Tia Nichole McMillen,
Submarine Force Pacific Public Affairs

USS BOWFIN SUBMARINE MUSEUM AND PARK—Commander, Submarine Force, U.S. Pacific Fleet, Rear Adm. Frederick "Fritz" J. Roegge, in partnership with Mr. Chuck Merkel, executive director of the USS Bowfin Submarine Museum and Park, unveiled a new submarine exhibit in honor of the 75th commemoration of the attack on Pearl Harbor on Tuesday, December 6, 2016, at 9:40 a.m. at the USS Bowfin Submarine Museum and Park.

Roegge spoke to nearly 150 guests, military and civilian, about the importance of the Submarine Force during World War II.

"Within hours of the attack, Chief of Naval Operations Admiral Harold Stark ordered, 'Execute against Japan unrestricted air and submarine warfare.' Our submarines were the only forces able to immediately begin war patrols. They carried the battle across the Pacific and into Imperial Japanese home waters while the fleet was repaired."

He explained that while the Submarine Forces made up only two percent of our entire Navy, they sank 30% of all Japanese warships, and 55% of all Japanese merchant ships sunk during the war.

"Submariners also paid the heavy price of the greatest casualty rate of any American branch of service in the war. Submariners are well-aware that the challenges of World War II produced some of our greatest successes, our greatest heroes, and our greatest sacrifices," Roegge said.

Roegge explained the intention behind the exhibit by noting that, "It's hard to find that important story within the existing narrative on display across the many museums and memorials that fill the horizon, and failing to highlight those details reflects a missed opportunity——not only to honor our heroes, but to share our story here at Hawaii's most popular tourist and historical destination until today."

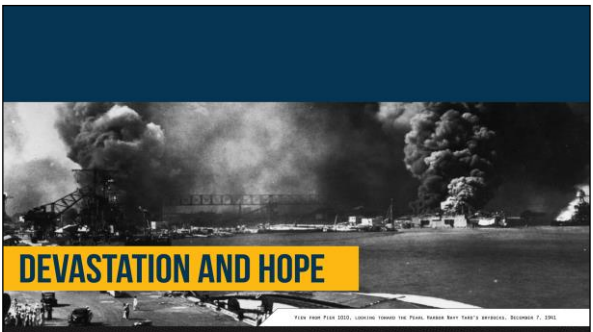
Today, we begin to share that story—honoring our heroes-with a new display located in front of the USS Bowfin Submarine Museum and Park, free and accessible to anyone visiting Pearl Harbor's iconic landmarks.

PEARL HARBOR (Dec. 6, 2016) Rear Adm. Fredrick "Fritz" Roegge, commander, Submarine Force, U.S. Pacific Fleet, greets a Pearl Harbor survivor during the unveiling of a new submarine exhibit at the USS Bowfin Submarine Museum and Park. Dec. 7, 2016, marks the 75th anniversary of the attacks on Pearl Harbor and Oahu. The U.S. military and the State of Hawaii are hosting a series of remembrance events throughout the week to honor the courage and sacrifices of those who served Dec. 7, 1941, and throughout the Pacific theater. As a Pacific nation, the U.S. is committed to continue its responsibility of protecting the Pacific sea-lanes, advancing international ideals and relationships, well as delivering security, influence and responsiveness in the region. (Navy Photo by Petty Officer 2nd Class Michael H. Lee/Released)

PEARL HARBOR (Dec. 6, 2016) Chuck Merkel, executive director of the USS Bowfin Submarine Museum and Park, middle, and Rear Adm. Fredrick "Fritz" Roegge, commander, Submarine Force, U.S. Pacific Fleet, right, unveil the new submarine exhibit at the USS Bowfin Submarine Museum and Park. Dec. 7, 2016, marks the 75th anniversary of the attacks on Pearl Harbor and Oahu. The U.S. military and the State of Hawaii are hosting a series of remembrance events throughout the week to honor the courage and sacrifices of those who served Dec. 7, 1941, and throughout the Pacific theater. As a Pacific nation, the U.S. is committed to continue its responsibility of protecting the Pacific sea-lanes, advancing international ideals and relationships, well as delivering security, influence and responsiveness in the region. (Navy Photo by Petty Officer 2nd Class Michael H. Lee/Released)

PEARL HARBOR (Dec. 6, 2016) Rear Adm. Fredrick "Fritz" Roegge, commander, Submarine Force, U.S. Pacific Fleet, addresses guests during an unveiling of a new submarine exhibit at the USS Bowfin Submarine Museum and Park. Dec. 7, 2016, marks the 75th anniversary of the attacks on Pearl Harbor and Oahu. The U.S. military and the State of Hawaii are hosting a series of remembrance events throughout the week to honor the courage and sacrifices of those who served Dec. 7, 1941, and throughout the Pacific theater. As a Pacific nation, the U.S. is committed to continue its responsibility of protecting the Pacific sea-lanes, advancing international ideals and relationships, well as delivering security, influence and responsiveness in the region. (Navy Photo by Petty Officer 2nd Class Michael H. Lee/Released)

Photos of the USS Bowfin Submarine Museum and Park
New Submarine Exhibit



DEVASTATION AND HOPE

View from Pier 1010, looking toward the Pearl Harbor Navy Yard's drydocks. December 7, 1941

DECEMBER 7, 1941:
IMPERIAL JAPAN WON THE BATTLE, BUT LOST THE WAR

During the attack, the submarines moored in Pearl Harbor manned their guns and fired against the attacking airplanes.

TAUTOG and NARWHAL shared partial credit for downing one torpedo bomber.

TAUTOG was credited with downing a second torpedo bomber.

USS NARWHAL overlooks the Navy Yard during the attack. December 7, 1941

USS TAUTOG, ca. 1945

USS NARWHAL, ca. 1933

IMPERIAL JAPAN'S STRATEGIC OVERSIGHT
... LEADING TO OUR VICTORY IN THE PACIFIC

Despite the massive destruction in Pearl Harbor, the December 7th attack could have inflicted even more damage:

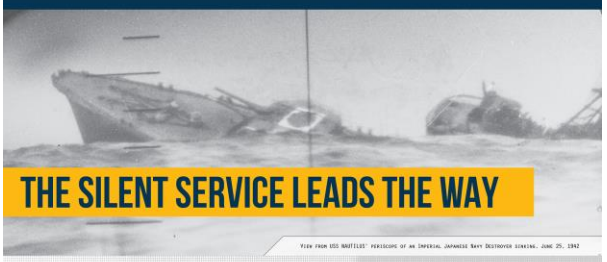
The fuel storage tanks were not attacked, saving the Navy a two year supply of fuel desperately needed to sustain the fleet.

The Pearl Harbor Naval Shipyard dry docks survived the attack.

Six of the eight Battleships struck were returned to the fight by Naval Shipyards.

The Submarine Base and the submarines moored there were undamaged, allowing the submarine force to immediately strike back.

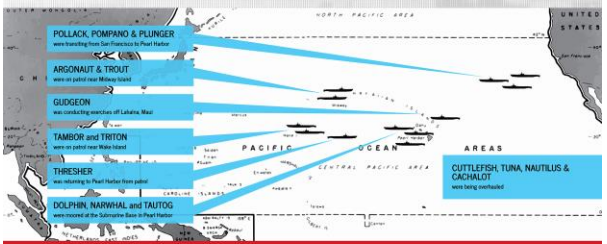
SUBMARINES TAKE THE FIGHT TO THE ENEMY



THE SILENT SERVICE LEADS THE WAY

View from USS Nautilus' periscope of an Imperial Japanese Navy Destroyer sinking. June 25, 1942

DISPOSITION OF PACIFIC FLEET SUBMARINES
ON DECEMBER 7, 1941



Within hours of the Japanese attack, the following message was sent by Chief of Naval Operations, Admiral Harold Stark:

EXECUTE AGAINST JAPAN
UNRESTRICTED AIR
AND SUBMARINE WARFARE.

INITIAL RESPONDERS

The Submarines of the Pacific Fleet were unharmed during the attack, so they were immediately mobilized and were among the first ships to bring the fight to the enemy.

On January 27, 1942, USS Gudgeon was the first U.S. submarine to sink an Imperial Japanese Navy submarine – the I-173.

Admiral Nimitz, a submarine officer, assumed the duties as Commander-in-Chief, U.S. Pacific Fleet 24 days after the Pearl Harbor attack.

CINCPACFLT change of command ceremony onboard USS Grayling, December 31, 1941

"When I assumed command of the Pacific Fleet on 31 December 1941 our submarines were already operating against the enemy, the only units of the fleet that could come to grips with the Japanese for months to come. It was to the Submarine Force that I looked to carry the load until our great industrial activity could produce the weapons we so sorely needed to carry the war to the enemy. It is to the everlasting honor and glory of our submarine personnel that they never failed us in our days of great peril."

- Fleet Admiral Chester W. Nimitz


VICTORY – AT A COST
SUBMARINES DOCKED AT PEARL HARBOR AFTER THE COMPLETION OF THEIR WAR PATROLS, CIRCA 1945
SUBMARINE FORCE SUCCESSES
The submarine community made up only 2% of the entire U.S. Navy during WWII.
Nonetheless, WWII saw the Submarine Force's greatest achievements, greatest heroes, and greatest sacrifices.
SUBMARINES IN THE PACIFIC CONDUCTED 1,474 WAR PATROLS
1,474
SUBMARINES ARE CREDITED WITH SINKING 30% OF ALL JAPANESE WARSHIPS
SUBMARINES ARE CREDITED WITH SINKING 55% OF JAPANESE MERCHANT SHIPS
7 SUBMARINERS WERE AWARDED THE MEDAL OF HONOR
49 PRESIDENTIAL UNIT CITATIONS WERE AWARDED TO 34 SUBMARINES
53 NAVY UNIT COMMENDATIONS WERE AWARDED TO 37 SUBMARINES
1,229 BATTLE STARS WERE AWARDED TO 233 SUBMARINES
THE ULTIMATE SACRIFICE
At 22%, the submarine community had one of the highest casualty rates of any American branch of service during World War II.
52 Submarines
lost during World War II
3,628 Officer and Enlisted Submariners
remain on Eternal Patrol
USS SEALION SCUTTLED AT CAVITE NAVY YARD, PHILIPPINES, DECEMBER 25, 1941, AFTER SUFFERING FATAL DAMAGE DURING A JAPANESE AIR ATTACK ON DECEMBER 10.
USS DARTER RAN AGROUND ON BOMBAY SHOAL NEAR PALAWAN ISLAND WHILE PURSUING A JAPANESE CRUISER ON OCTOBER 25, 1944.
SIDE VIEW OF THE SAIL OF THE USS LAGARTO. LAGARTO WAS SUNK IN MAY 1945 BY A JAPANESE MINELAYER.

LESSONS IN INNOVATION: THE SSBN TACTICAL CONTROL SYSTEM UPGRADE

by Capt John Zimmerman, USN

First appeared in the October 7th issue of U.S. Undersea Warfare News

In late 2013, the Submarine Force decided to modernize the 1990's combat systems on OHIO-Class submarines. In early 2014, as the Submarine Combat and Weapon Control Systems (PMS 425) Program Manager, I realized that due to the process we use for developing software and hardware, it would take until 2022 to modernize all SSBN combat systems. Based on this lengthy timeline, I challenged my team - "How might we bring as much submarine combat system capability to the entire SSBN Fleet, for as little money as possible, in one year's time?" With no program dollars set aside for this initiative, any resources required would have to come from other organizations or from savings within our program. The one-year target meant we would have to bring capability faster than had ever been done before. However, the most important part of the question was the first three words – "How might we…"

Innovation is about learning what works. "How might we…" put this initiative on a problem solving and learning course that influenced the entire effort.

If It Ain't Broke…
Make It Fifty Times Better

The Submarine Force has an excellent tradition of bringing modern commercial hardware and combat system software to the fleet. The Rapid COTS (Commercial Off-The-Shelf) Insertion (RCI) process is the means by which new commercial hardware

and combat system software are developed for SSNs and SSGNs. RCI is composed of the Technology Insertion (TI) process, which provides new computer hardware, and the Advanced Processing Build (APB) process, which develops new combat system software. These processes run on a two-year development cycle, that are offset by a year so that engineers can develop software on hardware that is in the final stages of production and vice versa.

The PMS425 program office vision is "Any Submarine Combat System Capability on Any Hardware at a Reasonable Cost". This vision sought to improve upon the standard of excellence established by the TI/APB process. The key to this improvement was developing software that could run on many hardware baselines, not just the most current computer hardware. If we achieved this goal, then as soon as new software was developed it could be installed via fast and inexpensive software upgrades instead of the slower and significantly more expensive hardware modernizations. It was this vision, plus the challenge from Admiral Greenert, the Chief of Naval Operations, to "Get Faster," that inspired the development of this initiative.

Innovation requires challenging the way you do business. Even when things are going well, innovation can still achieve dramatic improvements in cost, schedule, and performance.

Find Value and Eliminate Costs

The Submarine Combat System is comprised of two subsystems: The Tactical Control System (TCS) and the Weapon Control System (WCS). The TCS generates an operational picture using ship sensors (SONAR, radar, etc.). Operators use the WCS to place ordnance (either torpedoes or tactical missiles) on target. Because WCS changes require extensive testing, we decided this effort would focus only on upgrading the TCS.

To keep costs down and reduce development and installation timelines, our team concentrated on how to reuse current TCS software and the SSBN legacy combat system hardware. Over the

years, more than one hundred million dollars have been spent developing TCS capabilities. Besides the current TCS software, our team identified a new mission planning application being developed by the Office of Naval Research (ONR) in advance of the submarine modernization process fielding this on SSN platforms.

The team planned to utilize as much of the legacy combat system hardware as possible. Initially, laptops were considered since they were inexpensive and easy to install. However, Fleet feedback was not positive. The laptops had limited processing power, and they crowded the limited space in the SSBN control room. Based on this feedback, the team converged on the idea of integrating one new computer server with the legacy SSBN combat system to run the latest TCS software on the installed SSBN workstations. This solution provided a tremendous increase in processing power, while eliminating the need for new combat system workstations. What remained was to determine if the new server could be integrated into the legacy combat system and provide enough computing power for all the new software applications.

Achieve innovation by finding value in previously-developed products and by eliminating processes that drive cost and schedule.

Simple Prototypes –
Provide Speed and Savings

With little money and little time, the team used simple prototypes to determine what might be achieved. Within one month of the project start, the interface was developed to prove the concept was viable. Based on this progress, the team held a Concept of Operations Experiment (COOPEX) for Fleet representatives at the Naval Undersea Warfare Center (NUWC) in Newport RI. The COOPEX demonstrated the software being run by the new server integrated into the SSBN combat system. In this early configuration, not all capabilities could be supported, and of greater

concern, there were still many technical issues that needed to be resolved. In fact, at the time of the demonstration the latency of the integrated system was so bad that there was a five to ten second delay between the time an operator initiated an action and the action actually occurring. Regardless, Fleet participants made it clear that if the latency issue could be resolved, the initiative would be a tremendous improvement over current SSBN TCS capabilities.

Simple prototypes help to determine quickly what innovative approaches work.

Only Promise To Do Your Best

At the end of the COOPEX, participants provided feedback. Overall, they were pleased but as the list of priorities was developed, some participants started identifying certain priorities as *deal breakers*. "If this can't be done, then we won't use the system." It was tempting in the moment to make promises and guarantees about what would be achieved. Part of what made this an innovative effort was that we were moving so fast we could not be certain what would or would not be achieved. In that moment, we promised only to do our best to achieve what the Fleet felt was important. We also asked the Fleet participants to help us think about how this system could best serve the Fleet, instead of focusing on what the system could not do. Everyone was reminded that the Fleet would make the final decision whether to install the system onboard SSBNs.

Innovation means accepting the final outcome is unknown.

For Bold Innovation –
Risk Taking is a Team Sport

With Fleet buy-in established, but still numerous technical, operational, and schedule hurdles to overcome, the PMS425 team quickly implemented the contract modifications required to purchase the necessary hardware and to begin integrating the new

server into the SSBN combat system. PMS425 purchased the hardware without any assurance that the system would ever be installed. Our team accepted this risk based on initial Fleet support for the initiative and the engineering assessment that the technical issues that remained could be solved.

While there was significant support, many Fleet representatives still were concerned by the risks required to bring this concept to fruition. Submarine Development Squadron Twelve would have to develop employment guidance. The Submarine Learning Center would need to develop new training curricula. The Trident Training Facilities would need to schedule the required training in facilities that were already fully booked. Most importantly, the Submarine Squadrons and submarine crews would have to accept the risk of committing to, and training on, a system that had not yet been fully certified or tested at sea, in order to ensure their crews were ready to employ it once final testing and certifications were complete.

Our team solved many technical and performance problems, and within twelve months of concept initiation, the system was successfully installed in three training facilities in Bangor, Washington and Kings Bay, Georgia. Due to Fleet willingness to take risks, the required employment guidance and training products were also ready.

Innovation across many organizations requires everyone to assume risk.

Expect Setbacks and Respond Accordingly

The installation of the TCS Upgrade in the training facilities offered a number of opportunities: to get the system into the hands of the Fleet operators, to demonstrate the system could be quickly installed, and also to prove the reliability of the system through many hours of Fleet use. With these opportunities also came risks.

While the system had been tested extensively, there were still technical issues that needed to be fixed. The system was deemed *good enough* for installation into the trainers. Our goal was to deliver these capabilities to the Fleet as soon as possible, without

providing a product with so many issues that it could result in a loss of Fleet support.

Unfortunately, setbacks occurred. The initial installation did affect the performance of the legacy combat system. With the TCS upgrade system in operation, operators had to enter a solution twice before the system fully accepted a solution. While this may seem minor, and the SSBN crews quickly adjusted to this annoyance, the real issue was that the TCS upgrade was having an impact on the legacy combat system at all. Additionally, due to another technical issue, at certain times all the contacts in the system would *clump* to the same default solution. For a system whose primary purpose is to paint an accurate operational picture, this was a very significant problem.

Innovation is also about learning what doesn't work. Setbacks help to understand what isn't working. They're part of the innovation process.

Many Small Risks Can Achieve Big Rewards

Fortunately, the submarine crews continued to train with the system while technical issues were being worked. CDR Ken Curtin, captain of USS WYOMING (SSBN742) (Gold), was an excellent example of this willingness to accept risk. After seeing the system in operation, CDR Curtin eliminated all planned legacy combat system training and fully committed to training his officers and crew on the TCS Upgrade system.

CDR Curtin's instincts turned out to be correct. Our team eventually resolved both technical issues, completed all testing and certifications, and on 24 July the Tactical Control System upgrade was successfully installed on USS WYOMING (SSBN742) (Gold), the first US Navy Fleet Ballistic Missile submarine to receive the Tactical Control System Upgrade.

The fact that many organizations were willing to take small risks enabled this success, and achieved very significant rewards for the Fleet. In less than two years this effort journeyed from concept to reality. Each new server brings with it more than fifty times the computer processing power than the legacy SSBN

Combat System, the latest tactical control system capabilities, and the most modern mission planning capabilities available in the Submarine Force today. Just one operator can now perform the functions previously performed by three operators on the legacy system. Previously, officers and fire control technicians on SSBNs had a significant training burden when they transferred to a SSN or SSGN. This upgrade put them on par or ahead of all the SSNs and SSGNs in the Submarine Force, providing operators that are better trained, and more easily transferred to different submarines throughout the Submarine Force. Due to the extremely small size and ease of installation and testing, the upgrade has already been installed in three Fleet trainers and eleven SSBNs. This effort represents the fastest, least expensive, and most significant improvement in tactical control system capabilities in the history of the US Navy Submarine Force.

He who is willing to risk and innovate can win big.

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**.

A stipend of up to $200.00 will be paid for each major article published. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League**. The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League.

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

Articles should be submitted to the Editor, SUBMARINE REVIEW, 5025D Backlick Road, Annandale, VA 22003-6044.

ADIOS, SURE SHOOTER!

by Mr. Dick Brown

Dick Brown is a member of USSVI's Holland Club, a life member of the Navy League (New Mexico Council) and a long-time supporter of USS Albuquerque. He is also a member of the Naval Submarine League and a frequent contributor to The Submarine Review.

USS ALBUQUERQUE (SSN-706) has "gone out of business." At a special Inactivation Ceremony on 16 October 2015 at Naval Station Point Loma, the combat veteran was taken out of service and is being defueled and scheduled for official decommissioning in early 2017.

There has been a long-standing relationship between the submarine and her namesake. It started at commissioning when then Mayor Harry Kinney offered the keys of a Phantom series Rolls-Royce to the first skipper who brought the boat up the Rio Grande for a port call in Albuquerque. By tradition, the keys have been passed along to each skipper at 13 Change of Command ceremonies; however, the fabled Rolls, elusive as a phantom, has gone unclaimed. Our submarines are quite stealthy, so one former skipper, retired CAPT Leonard Zingarelli (CO 1995-1997), posed the question, "How do you know we haven't already done it?" It's doubtful—the river is at most only two feet deep and has several dams so this was an impossible task and a very safe bet for the Mayor. The boat's final CO, CDR Donald Tenney, plans to return the keys for posterity, albeit begrudgingly, to Albuquerque's current mayor, Richard Berry.

USS ALBUQUERQUE was commissioned on 21 May 1983 as the 19th Los Angeles-class attack submarine. Initially she was home-ported in Groton, CT and was deployed many times in the Atlantic and the Mediterranean. During the 1999 Kosovo conflict, her Tomahawk land-attack missiles hit 100 percent of their targets and ALBUQUERQUE became known as Sure Shooter of the Submarine Force—which explains the 10 TLAMs on her battle

flag. She received a new lease on life during the period 2001-2003 when her reactor core was refueled. In 2009, ALBUQUERQUE shifted her homeport to San Diego, CA, concluding the Navy's 60/40 Pacific/Atlantic split of our Submarine Force assets. The aging battle-tested boat was deployed many times in the Pacific, doing her part in the Global War on Terrorism. All told, she built a record of superior performance, earning three Navy Unit Commendations, four Meritorious Unit Commendations and four Battle Efficiency "E" Awards.

In 1984, ALBUQUERQUE earned the Gold Dolphin Flag as all of her officers had qualified in submarines. The following year she earned the Silver Dolphin Flag for enlisted men as well as the Atlantic Fleet Golden Anchor Award for retention.

ALBUQUERQUE's reach, as documented in the ship's annual command histories, has been global. On her maiden deployment in 1984 she crossed the Arctic Circle, making every member of the crew a Blue Nose. In 2011, the crew became Golden Shellbacks when the boat simultaneously crossed the Equator and the International Dateline. The boat has also hosted a number of Distinguished Visitors, including SECDEF Richard Cheney in 1989. Ten years later, former President George HW Bush visited the boat. Submarines were not new to the President. In September 1944, downed pilot LTjg Bush spent four weeks aboard USS FINBACK (SS-230), having been rescued after being shot down over the Pacific. The fearless WWII skipper of USS BARB (SS-220), Rear Admiral Gene Fluckey, also visited ALBUQUERQUE. Fluckey received the Congressional Medal of Honor and four Navy Crosses for his phenomenal combat performance during BARB's last five war patrols in the Pacific. On ALBUQUERQUE's last patrol in the Pacific, she steamed over 50,000 miles—enough for two global circumnavigations, a traverse across the equator, and another opportunity to turn slimy Pollywogs into noble Shellbacks.

Rear Admiral Stuart Munsch (CO 2002-2005) served as the honored guest speaker at the Inactivation Ceremony. His inspiring talk was directed to members of ship's company and their obligation to continue ALBUQUERQUE's legacy as they disperse

to other submarines and shore commands after *decom*. Munsch also paid tribute to his old boat, stating he believed it to be in better shape than the Rolls-Royce which has been waiting for 33 years.

In addition to Munsch and Zingarelli, the ceremony was attended by the commissioning CO, retired CAPT Richard Hartman, retired Rear Admiral Jerry Burroughs (CO 1999-2002), CAPT Chris Cavanaugh (CO 2010-2013) and Barbara Sears representing her late husband Rear Admiral Scott Sears (CO 1983-1986). Also in attendance were 41 plank-owners, 35 post-commissioning crewmembers, about 200 ALBUQUERQUE fans and Ship's Sponsor Nancy Domenici, accompanied by her husband, retired 6-term US Senator Pete Domenici. Nancy simulated breaking the christening bottle by swinging a bouquet of flowers against the sail.

The day after the Inactivation Ceremony, CDR Tenney, Chief of the Boat STSCS(SS) Neal Bederson and three additional crewmembers attended the Navy League New Mexico Council's Navy Birthday Ball in downtown Albuquerque. The theme of the event was a salute to the officers and crew of the good ship ALBUQUERQUE as she retires at the top of her game. As the honored guest speaker, CDR Tenney expressed sincere gratitude on behalf of all past COs for Albuquerque's strong support over the years.

The Albuquerque hometown support team has requested the ship's sail, rudder and select shipboard mementos for a future USS Albuquerque Memorial. The CO fully expects to discover some additional *keepsakes* as equipment is removed from the boat. Already the culinary specialists have located some old canned goods with shredded labels, obvious leftovers from one of the boat's recent deployments.

Returning to San Diego after the Navy Ball, CDR Tenney and his crew prepared for ALBUQUERQUE's final voyage, a 6-day, 1,385-mile trip up the West Coast to Bremerton. The transit doubled as a Tiger Cruise. It was dive number 1075 on 23 October 2015 when the boat slipped below the horizon for the very last time. She navigated through the Channel Islands off Los Angeles,

cruised past Monterey and San Francisco, and quietly steamed along the coasts of Oregon and Washington, hundreds of feet below daylight.

The cruise provided a rare opportunity for 10 tigers to enjoy shipboard life and stand watches with their sons, including on the bridge. The author was also invited to join the tigers. All spent time interacting with the crew and observing computer-based fire control, navigation and sonar systems. It is interesting to note that in 1994, ALBUQUERQUE was the SUBLANT test platform for submarine LAN applications, demonstrating the efficiency of an interconnected computer network onboard a submarine, eventually leading to sailors sending and receiving E-mail at sea. How technology has changed life aboard a submarine! —from 15-word family-grams to sailor-mail, from clipboards to laptops, from 3-reel movies to DVDs . . .

ALBUQUERQUE's officers and crew exhibited great teamwork and an exuberant sense of duty during the transit along the West Coast. Most crewmembers are younger than their boat, being in their early 20s. But don't let age fool you. These deployment-tested sailors are highly skilled professionals, trained in their specialty and extremely knowledgeable in all shipboard systems. Well, except for one isolation valve in the auxiliary machinery room where an embossed label is followed by two question marks. Hmm—best to *knock on wood* for that one, that is, if you can find wood onboard a submarine. That age-old expression is often used to ensure that good things will continue. ALBUQUERQUE kept a 6x6-inch block of hardwood in the wardroom for just such knock-on-wood occasions.

A critical time for any submarine is when it comes up to periscope depth to snag message traffic or gulp fresh air through the snorkel mast. In an effort to minimize control room conversation during the boat's approach to PD, the Officer of the Watch, noting the boat is not running silent, not running deep, reminds everyone, "We're a submarine, not a tambourine!"—a possible reference to a song known to the younger set—"Tambourine Submarine" by a Seattle-based male trio.

Off the Olympic Peninsula, P-3 training exercises were provided with a periscope wake—hardly coincidental, but convenient. After all, skills are perishable over time so to ward off complacency and to maintain a sharp edge, P-3 training is vital. One presumes the *mystery* target was detected and tracked before it turned towards the Strait of Juan de Fuca. The periscope wake was a gift from the Silent Service—a visual target for real-time ASW training and maritime surveillance—compliments of ALBUQUERQUE.

Like the periscope, excitement was on the rise. The time for the boat's final three ah-oo-gahs was fast approaching. And per tradition on the night before returning to port, pizza and wings were served in the crews mess—well, just pizza, as the galley, known as the Roadrunner Grill, was out of wings. Still, for this special evening, the galley operated as a nuclear-powered pizza parlor, turning out a variety of great pizzas.

It was a 24-hour surface transit under navy-gray skies as ALBUQUERQUE cruised east through the Strait, then south into Puget Sound, and finally through ever narrowing passages, arriving at her rain-soaked berth at Naval Station Kitsap in Bremerton on 28 October 2015. There she has been awaiting her turn in the scrapping and recycling process when Puget Sound Naval Shipyard workers begin ripping into her hull—an inglorious end for a glorious ship.

To all who have served onboard ALBUQUERQUE, Bravo Zulu. Never in the spotlight, but always operating in one of the most unforgiving environments on the planet, ready for any situation in a world filled with danger and uncertainty, thank you for your service. And thanks to the families who also make sacrifices while their undersea warriors keep America safe and secure.

ALBUQUERQUE lived up to her motto *Silentum Excubitor* meaning *Silent Guardian*. Her sailing list reflects the highest credit upon her officers and crew, a very special submarine brotherhood. These men have signed their names to history. USS ALBUQUERQUE will long be remembered for her incredible service to our Navy and our Nation. Adios, Sure Shooter!

BOOK REVIEW

REVELATIONS AND INSIGHT ABOUT GERMAN SABOTEURS AND COMMERCIAL SUBMARINES

The Baltimore Sabotage Cell—German Agents, American Traitors and the U-Boat Deutschland during World War I
(Naval Institute Press, 2015)
By Jamie Bisher

Baltimore, Maryland played an important role in German war strategy before the United States plunged into WWI in April 1917. Dwight Messimer's fascinating book, The Baltimore Sabotage Cell—German Agents, American Traitors and the U-Boat Deutschland during World War I, illuminates how disparate German war objectives found an unlikely common node in Baltimore. The core stories are familiar to WWI historians: Baltimore saboteurs, anthrax smugglers, spies and the commercial submarine U-Deutschland. But Messimer reveals some amazing new details that will rekindle fascination in these old familiar cases, dispels a few mysteries along the way, and, most of all, shares his unique expertise and analysis of Germany's commercial submarine program.

In spring 1915, Germany launched two innovative projects in Baltimore. One project aimed to disrupt the Allies' transatlantic supply lines, the other aimed to evade the tight Allied blockade. Interestingly, one native-born Baltimorean, Paul Hilken, was given responsibility for both projects by separate intelligence organizations in Berlin. Hilken, a graduate of Lehigh University and MIT, was the operations director of North German Lloyd shipping lines (known by its German acronym NDL), a prominent position in the bustling port until the British blockade brought his operations to an abrupt halt in autumn 1914. Despite his US citizenship, Hilken was probably already involved with the German Navy's secret logistics and intelligence network, the Etappendienst, at the time of the Sarajevo assassination. Within a year, he was the go-to man

in the mid-Atlantic states for at least two overseas German intelligence organizations, responsible for multiple projects while maintaining his image as a upstanding, middle class businessman.

On behalf of the Secret Service of the Army General Staff, Hilken became overseer and paymaster of one of the most dangerous sabotage networks in the Americas. Its tentacles spread through the Midwest and helped spread mayhem and intrigue as far away as Buenos Aires and Tokyo. Messimer relates fascinating and coherent narratives that weave in new details about meetings in Berlin, destructive road-trips through the Midwest, and many other episodes. He describes the people, places and targets that were critical to the network's success in sabotage, and does not ignore their talents in fomenting strikes, setting up phony unions, transferring cash and anthrax to other cities, and other nefarious activities.

However, this book's richest contribution to WWI and submarine history is about the commercial submarine program—Germany's long-shot hope to evade the British blockade. Messimer lays out the program from conception to termination in exquisite detail: financing, construction, manning, and the silent industry partnership with the German Admiralty that makes it clear that *commercial* was a misnomer that applied only to most of the submarine's cargo. Paul Hilken spearheaded United States operations for the project with the zeal and determination expected of an experienced NDL director, Etappendienst operative and German patriot. Messimer dissects Hilken's extensive preparations and aggressive operations security in both Baltimore and New London, Connecticut, as well as Hilken's many public relations failures. He also spotlights Captain Paul Koenig and fleshes out every officer of the U-Deutschland crew and other principal figures.

Messimer's descriptions of the submarine's features and many foibles—including a number of dangerous design flaws—show how successful German disinformation was in shaping US intelligence perceptions. If only US analysts had known of the utter misery and perils that the commercial submarine crews faced on their voyages to become feted celebrities in Baltimore and Kiel

in 1916… The US public and some intelligence officials fell for the Germans' tales of nonchalantly cruising in comfort under the sea, champagne glass in hand.

The Baltimore Sabotage Cell is an easy read that explains complex technical issues in terms that liberal arts majors should find enlightening. It is chronological—18 chapters, 2 appendices and extensive notes and bibliography, and 35 rare photos. The epilogue looks at the lives of the vessels and people involved in the commercial submarine and US sabotage episodes, and adds a fascinating chapter about post-war U-Deutschland souvenirs, artifacts, relics and counterfeits.

Dwight S. Messimer is an engaging storyteller and gifted engineering analyst who brings the story alive whether it is transpiring onboard a submarine, at the docks in Baltimore or Kiel, or in the shadows where conspirators and saboteurs whispered. Ironically Messimer is an Army veteran who lives on the West Coast. But he is also the author of at least ten other books on military and naval history, several about the WWI era and submarines, including Find and Destroy: Antisubmarine Warfare in World War I, and Verschollen: World War I U-Boat Losses. Messimer also had a hand in writing The U.S. Navy in World War I: Combat at Sea and in the Air. The Baltimore Sabotage Cell expands upon Messimer's 1988 book The Merchant U-Boat: Adventures of the Deutschland, 1916-1918.

Messimer's passion for the subject, impressive knowledge of WWI submarine engineering, operations and warfare, and talent for crafting nitty-gritty descriptions mixed with insightful analysis and expert technical breakdowns make The Baltimore Sabotage Cell a rich resource brimming with new details and insight about subjects long considered settled.

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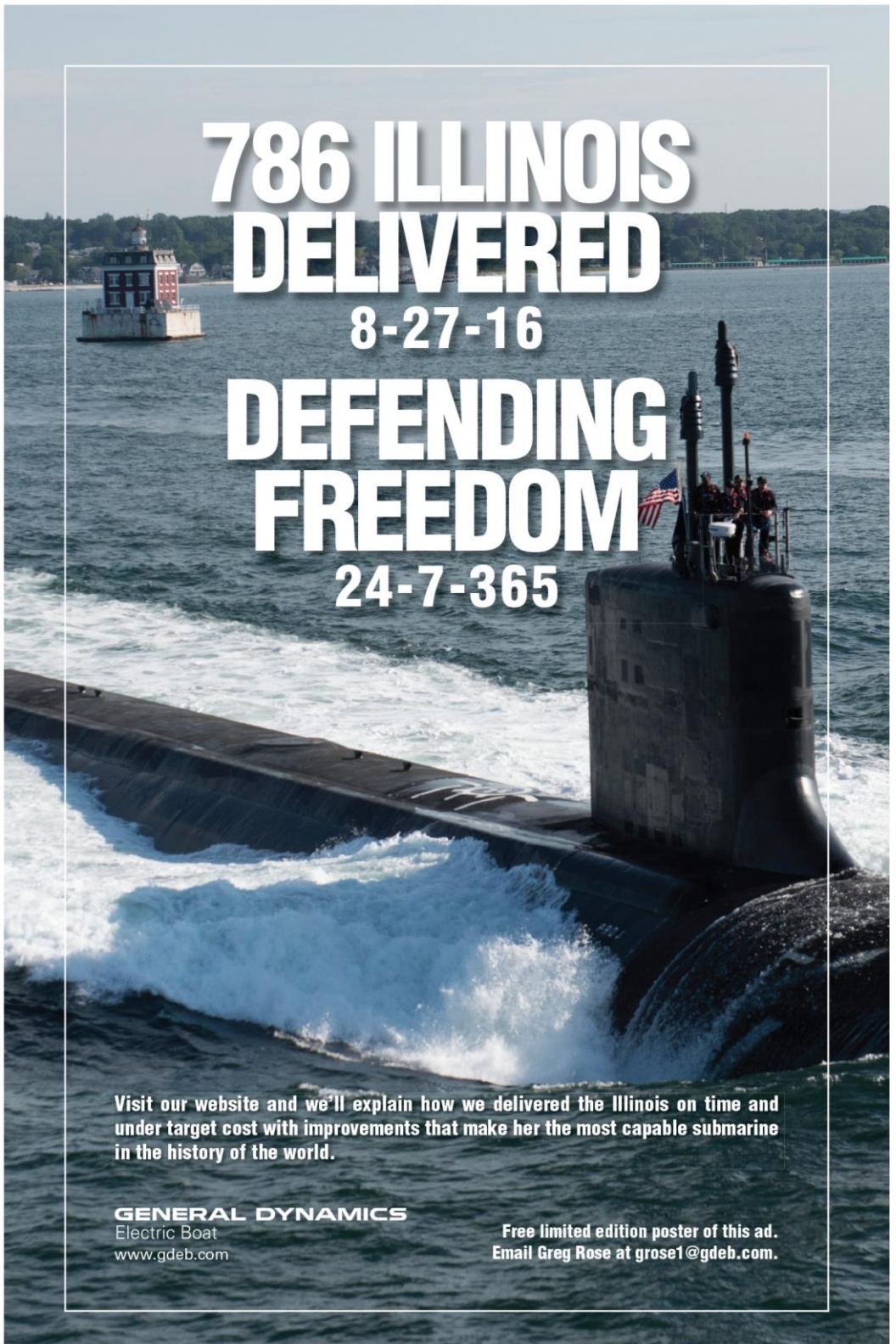

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