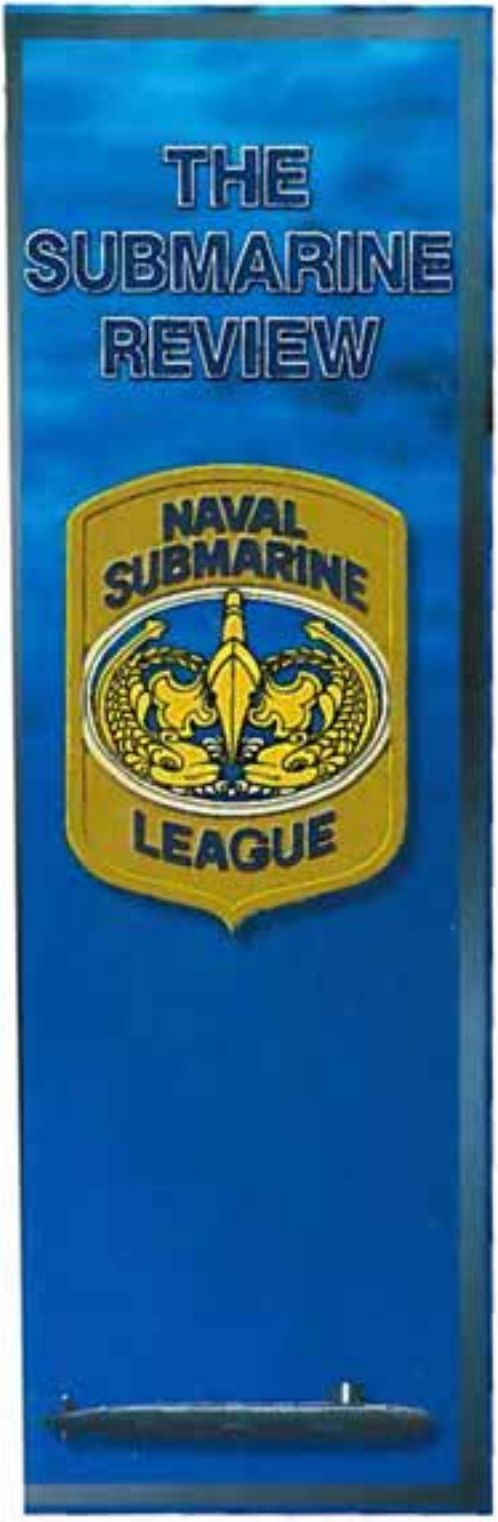
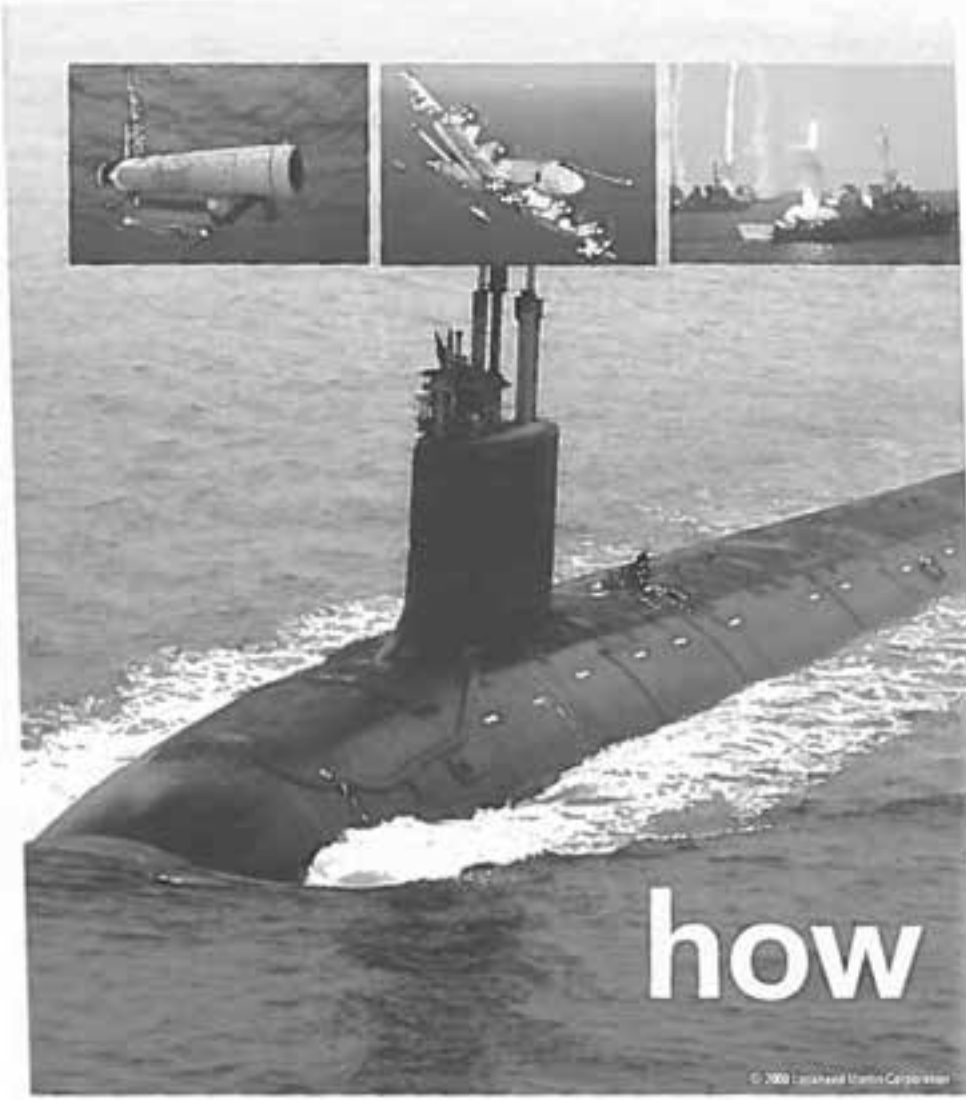


APRIL 2008

PAGE



BETWEEN SMART SHIPS AND COMMAND DECISIONS, THERE IS ONE IMPORTANT WORD: HOW.

Flexible. Affordable. Intelligent. Open. Requirements to support today's naval demands. Words that define our C2 combat systems. Bringing battlespace management to the high seas is all a question of how. And it is the how that makes all the difference.

LOCKHEED MARTIN

We never forget who we're working for®

lockheedmartin.com/how

EDITOR'S COMMENTS

This April 2008 issue of THE SUBMARINE REVIEW has several noteworthy aspects. First, we have in our FEATURES section messages from the two ranking members of the submarine community most directly concerned with the operations and development of the Force we have today and will have in the foreseeable future. Both Admiral Donald and Vice Admiral Donnelly spoke to the League's Corporate Benefactors in early February and reported on the status of the Force and gave their views of what has to be done in the near and mid-term future. In addition, there is a report from USS PASADENA (SSN 752) on their ship's actions in committing the remains of RADM Gene Fluckey to the sea in one of the areas of the Pacific in which he operated with such success. Also included in the FEATURES section is a *one-of-a-kind* graphic which is a first for this magazine. The four color *FOUR ACES* is a celebration of the full SSGN force at sea and ready for duty.

Readers should note also a new initiative in the League's effort to inform about the submarine community's efforts for constant improvement. One section of this issue is devoted to the rather unusual publication of the unclassified Abstracts of representative papers which will be presented in classified form to the 2008 SUBMARINE TECHNOLOGY SYMPOSIUM, co-sponsored, as it has been for years, by the Naval Submarine League and the Applied Physics Laboratory of Johns Hopkins University. The Abstracts are, of course, technical in nature but the possibilities for development and the potential for military effectiveness can be seen. These Abstracts were selected and are introduced by Vice Admiral George Emery, the Co-Chairman of the Technology Symposium, with a brief description of the Symposium, its history and its objectives. These Symposia are directed to the interest of the technologists in industry and the Navy's acquisition establishment. Their efforts necessarily are not in the public venue; therefore, it is the interest of informing the other members of the submarine community of how that phase of the business is being conducted that we are publishing this section.

The first two of the six ARTICLES (I didn't count the Submarine News from Around the World–which is really news) are about one

phase of the business of submarine development which normally does not get very much general community attention. The Basic Research done as part of the Research and Development process really underpins all the technology effort that follows. There has been a lot of discussion over the years about funding Basic Research and one concern has been the support of fundamental research without necessarily being able to identify an end use for whatever technology comes from it. The article about the Navy Research Labs early work on nuclear power and the one about the National Research Council's efforts in ASW both relate basic research done with a clear end in sight, but both efforts had to be done in wartime. Aside from the very interesting stories in both articles perhaps there are *lessons to be learned* about what basic research should be pursued now for undersea warfare needs.

Another somewhat unusual aspect of this April 2008 issue of THE SUBMARINE REVIEW is the number (five) and scope (wide) of the books reviewed in the final section of the magazine. The first is a very personal story by a loving daughter about her submarine skipper father who went down with his boat on a World War II war patrol. The second is a Cold War tale of an unusual mission under the ice told by the skipper who made the trip. The third is not directly related to a submarine action but is included here for its background on a section of the world which probably will be a trouble spot with which we will have to contend for some time. The fourth book is an import from Great Britain by the Naval Institute Press which relates a number of submarine versus submarine encounters. The emphasis is on incidents from the era before the Cold War but the final chapter is a twelve page recounting of several incidents from the Cold War. The fifth book reviewed is one from a different world altogether, and written by one famous then as submarine ace and later to the world as the father of the von Trapp family made famous by the movie Sound of Music. Captain Georg von Trapp performed his undersea feats in a World War I boat of the Austro-Hungarian Navy which was so small and basic it made the German U-boats look luxurious. It's a great book .

Jim Hay
Editor

FROM THE PRESIDENT

The USS GEORGIA (SSGN 729) Return to Service ceremony in late March marked the completion of the conversion of four OHIO Class submarines into a new weapon system. This accomplishment has been celebrated by all of the Department of Defense as an example of a well defined and executed acquisition program. RADM Willy Hilarides described this accomplishment in his article in the January 2008 Review. The League published a special booklet containing his article and sent it to all members of Congress, DoD officials and the state legislators of the key submarine building states. Each SSGN is a Force of One!

The Naval Submarine League completed its fiscal year on 31 March 2008. While the League received generous support from our members and Corporate Benefactors in sponsoring our events, we did not meet expenses and ended this year with a deficit. We have been impacted with the increased costs of our events and supplies. The move to the new hotel was a major expense. The Board of Directors reviewed the proposed budget at their 6 February 2008 meeting and will take measures at their next meeting to address the issues that caused the deficit. I have initiated a program of asking the Life Members to consider making a donation to the League to help meet the budgeted expenses. The Board also approved an increase in the advertising fees for the Submarine Review, the first increase in seven years, to help meet the increasing costs of providing this publication.

The Corporate Benefactors continue to be the life blood of the NSL. This year they underwrote much of the costs associated with the Corporate Benefactor Recognition Days, receptions held during the Annual Symposium, and sponsored large contingents of their employees to attend League events. We added eight new benefactors during this fiscal year. When you see a Corporate Benefactor at one of the League events, please thank them for their continued support of the organization. Individual name tags and a blue ribbon identify Corporate Benefactors.

The Corporate Benefactor Recognition Days held 6-7 February 2008 set a new record in attendance, with 53 of our 76 benefactors represented, and more than 20 principal executives. This event was a success in every measure. The active duty submarine Flag Officers' participation and guest speakers were the highlights of the event. Over 250 members of the League's submarine support

community attended. The opportunity to interact with the active duty Flag Officers at a reception following Admiral Kirk Donald's remarks was appreciated by all. Dr. Vic Reis, Senior Advisor, Office of the Secretary, Department of Energy, spoke to the luncheon attendees on the nuclear energy program and highlighted the significant achievements of this very successful venture of the government. At the Congressional breakfast Congressman Joe Courtney addressed support for obtaining the advanced procurement funding to support going to two Virginia Class submarines per year starting as early as 2011. He is a strong supporter of the Submarine Force.

The Cold War Submarine History Seminar, *"50 Years Under The Ice"*, was well attended and another outstanding event in the NSL history series. The project team is already working on another part of our submarine heritage for the 2008 seminar. This event is important to preserving the legacy of the Submarine Force.

The Submarine Technology Symposium will be held at The Johns Hopkins University Applied Physics Laboratory on 13 to 15 May 2008. VADM George Emery highlights some of the specific papers in this issue and you can see the full agenda on the registration website, http://www.jhuapl.edu/sts/index.html.

The final NSL event for this year will be the Annual Symposium to be held at the Hilton McLean Tysons Corner on 22-23 October 2008. This year the Submarine Force Fall Cocktail Party will be integrated into the program. Please look for the mailing to all members this summer and participate in the election of NSL Board of Directors.

Your Naval Submarine League leadership continues efforts to increase membership. We continue to focus on initiatives to recruit active duty, retired and former members and submarine advocates. The online Membership Directory provides an outstanding resource to find contact information for members of the League. Assistance in updating the address file would be appreciated.

I ask each of you to recruit a new member by asking friends if they are interested in becoming a submarine advocate by joining the Naval Submarine League.

Jan joins me in wishing you a healthy and refreshing spring.

J. Guy Reynolds
President

THE SUBMARINE REVIEW IS A PUBLICATION OF THE NAVAL SUBMARINE LEAGUE

NAVAL SUBMARINE LEAGUE - Box 1146 - Annandale, VA 22003-9146
(703) 256-0891 Fax (703) 642-5813 E-mail: subleague@cox.net
Web Page: www.navalsubleague.com

FEATURES

NAVAL SUBMARINE LEAGUE
CORPORATE BENEFACTOR RECOGNITION DAY

ADMIRAL KIRKLAND H. DONALD, U.S. NAVY
DIRECTOR, NAVAL REACTORS

WEDNESDAY, 06 FEBRUARY 2008

Admiral Mies, thank you for that introduction. Admiral Smith and the Submarine League's Board of Directors—it is a pleasure to see you all here tonight. To the Corporate Benefactors, thank you for your continued support of the Naval Submarine League and the Submarine Force. I am honored to be invited back to speak again this year.

Last year, one of the issues we discussed was the Navy's plan for a 313 ship fleet and how our shipbuilding industry was responding. Since then, we have had a pretty good year in that business.

- USS VIRGINIA (SSN 774) redelivered on 1 March and achieved Initial Operational Capability. She is scheduled to go on her maiden six month deployment during the summer of 2009.

- USS TEXAS (SSN 775) is completing her Post Shakedown Availability and will redeliver to the Fleet next month.

- USS HAWAII (SSN 776) was commissioned on 5 May. She will deploy later this year, and then in the fall of 2009, she will complete a homeport shift to Pearl Harbor, Hawaii.

PCU NORTH CAROLINA (SSN 777) was christened last April by Mrs. Linda Bowman (with Mr. Linda Bowman in attendance)—and I must say, she had a truly impressive swing when she smashed

the bottle of sparkling wine on the ship's bow! The ship subsequently launched on May 5th and successfully completed initial Sea Trials in December. There will be a rousing commissioning ceremony in the Tarheel State in May and another great ship will join the Fleet.

Six more VIRGINIA-class submarines are under construction and progressing on budget, on schedule, and on the glideslope toward the $2B a copy goal we set for ourselves in 2005.

- PCU NEW HAMPSHIRE (SSN 778) is approximately 81% complete. She is scheduled to deliver in August 2008.

- PCU NEW MEXICO (SSN 779), approximately 72% complete, is scheduled to deliver in August 2009.

Construction of SSNs 780 thru 783 continues to progress. The Secretary of the Navy just announced last week the names of the next three submarines. SSN 780 will be USS MISSOURI, SSN 781 will be USS CALIFORNIA, and SSN 782 will be USS MISSISSIPPI.

Four OHIO-class submarines have been converted to SSGNs, and the first three have returned to the Fleet. The last, USS GEORGIA, completed her conversion in December and will formally return to service in March. Initial Operational Capability for the SSGN Program was achieved by USS OHIO on 1 November 2007 – on-time per the original schedule. USS OHIO is on deployment right now in the western Pacific, marking the maiden deployment for the SSGN class. She's completed our first remote site crew turnover for a nuclear-powered submarine. She also completed a maintenance availability in Guam, flexing our forward deployed maintenance capabilities with a detachment of craftsmen from Puget Sound Naval Shipyard.

In addition to the progress in the Submarine Force, there has been great progress in the construction of our aircraft carriers.

PCU GEORGE H. W. BUSH (CVN 77) – the tenth and final NIMITZ-class aircraft carrier is approximately 86% complete, with primary ship structure completed. We have commenced the testing program and compartment turnover is in progress. Current ship

construction and testing progress supports a December 2008 delivery and January 2009 commissioning.

PCU GERALD R. FORD (CVN 78) – the first of the next generation of aircraft carriers. You've all heard the *bumper stickers* on the improved capability and cost effectiveness of this new design. Well, I am here to tell you that in the propulsion plant, the *bumper stickers* are actually real construction drawings and in fact, bent steel, completed reactor plant components, and assembled bulkheads. While the actual construction contract is being negotiated, don't let that fool you—the ship's construction is and has been in progress. The first steel was cut in April 2005, and when the construction contract is awarded later this year, over 25% of the ship's structure will already be built!

And lest we forget our operational arm, our OHIO-class ballistic missile submarines are our Nation's most survivable strategic deterrent. These submarines carry over 50% of our Nation's strategic deterrent, while using only about 2% of our naval personnel. Our attack submarines are in demand on point supporting the Combatant Commanders.

Beyond shipbuilding and fleet operations, it has been a year of transition and achievement in other very important fronts. We are in the final stages of closing a long chapter of our history with the official ending of our presence in La Maddalena that began back in 1973. While I remain concerned over the long term consequences of the continued decline in deployed naval repair capability, the inactivation was handled in a professional manner characterized by technical competence and facilitated by the long history of both environmental and radiological stewardship.

We are continuing a chapter in a 50 year old relationship with our allies in the United Kingdom in matters pertaining to nuclear power. Both of our countries are reaping significant benefits from close collaboration on submarine design, engineering, construction, and operation. We applaud the Royal Navy's achievement in June last year—christening HMS ASTUTE, the first ship in their newest class of attack submarines. We continue to explore opportunities for close collaboration with the Royal Navy in recapitalizing their strategic ballistic missile Submarine Force.

And a new chapter opens this fall when USS GEORGE WASH-

INGTON replaces USS KITTY HAWK as the forward deployed carrier in Japan—marking the first time a nuclear-powered warship has been forward deployed. As you can imagine, a tremendous amount of hard work has gone into making this a reality. The maintenance and repair of the ship will be coordinated between the Ship Repair Facility, Yokosuka and a detachment from Puget Sound Naval Shipyard. Puget Sound will complete all the required maintenance and repair work in the propulsion plant spaces. There will be up to 550 craftsmen from the shipyard deployed to Japan on TAD assignments up to 7 months long to complete the scheduled maintenance availabilities. A smaller permanent detachment of approximately 35 shipyard workers will provide year-round support, coordination, and planning. In addition to the planning efforts, facility improvements are currently underway to prepare for the GW's arrival: upgrading shore power, dredging the Yokosuka harbor —a $65 million Government of Japan project, construction of a high-quality water facility, and other upgrades to the berth and surrounding area. And to ensure everything is done to our standards, I stood up the first forward deployed Naval Reactors Representative Office in July 2007—sending over Joe Gist whom many of you remember was the 08J section head for many years. This would not have been possible without our legacy of safe reactor operations. We have hosted Japanese delegations at Puget Sound Shipyard, San Diego Naval Base, and Norfolk Naval Base. It was a great testament to the reputation of our Program when, during a tour of USS STENNIS in San Diego, the mayors of Coronado and San Diego stood on the ship's bridge and explained to the Japanese officials that it was our great safety record that made them feel safe about the Navy operating nuclear reactors right next to their cities. Additionally, we conducted a coordinated response drill in Yokosuka with the Japanese government officials. We are looking forward to the successful homeport shift—validating all the work and effort by so many people both here and in Japan.

The Congress has duly noted the successes we continue to achieve in our nuclear shipbuilding programs and the importance of submarines to the Navy and the Nation. Congress provided the Navy with an additional $588 million dollars of advanced funding to procure an additional VIRGINIA-class shipset of nuclear and non-

nuclear government furnished components. As a result of this additional funding, we are a step closer to our stated goal of 2 Virginia-class submarines per year.

Indulge me for a moment as I recap how WE got here. WE—the nuclear Navy, the Navy leadership, the shipbuilding industrial base, the nuclear vendor base and certainly all of you in this room. It wasn't that long ago that WE were in *choppy waters* in shipbuilding, and, in fact, in a broader sense, in the perceived value of the Submarine Force. The Cold War ended and the Seawolf program was cancelled. There was significant resistance to a force structure recapitalization plan that included construction of JIMMY CARTER and the design of VIRGINIA. And I've lost track of how many times Naval Submarine Base Groton has been on the BRAC list. The thing I am most proud of through all of that is how our leadership took the long view, even under the tremendous pressure of a climate in this town that demands short term *show* at the expense of long term *go*. Our leaders encouraged the spirited debate inside the Force to develop sound concepts and strategies. They demanded technical rigor in parallel with an innovative, flexible, and responsive approach to problem-solving. And in the end, when the key decisions were made, the community (and I include all in this room in that phrase) rallied under the flag with a single voice and with purpose to carry the vision to reality. Those successes I mentioned above simply would not have happened without the strong leadership that was our blessing and the cohesiveness of the community—You!

Now I suppose some of you are wary at the idea of getting such praise from, of all places, Naval Reactors. Your suspicions are well founded—nothing is free. We have more work to do and we, the community leadership, need your help.

First, we still have work to do before we achieve our goal of reducing the per-ship cost of a Virginia class submarine to 2 billion dollars. And we've got aircraft carriers to build and deliver. Since increasing the acquisition profile to two submarines per year is predicated on meeting the 2 billion dollar goal, we must continue to find innovative ways to drive costs down, while maintaining—or even increasing—capability and not yielding a millimeter in construction quality. Some of you have heard me talk about cost control during my visits to our contractors and vendors, and the

message is simple—high quality and being good stewards of the public trust are not mutually exclusive. We are not interested in *cheap*—we demand *value* for our dollar. Some of our industry partners are further along than others in improving our value/dollar profile, but my sense is everyone *gets it*.

We are, however, not immune, like any other successful organization, to institutional hubris that can lead to a decline in vigilance and lack of wariness as to the stringent technical and operational demands of operating nuclear power plants at sea on submarines and aircraft carriers. Last year I discussed the disturbing string of operational incidents that had cost us dearly in lives of our shipmates, in dollars, and in our professional reputations. I applaud the efforts of our Force, from VADM Donnelly and RADM Walsh as they drive the message from the top down to our deckplate leaders, to refocus the Force and get *heads back in the game*. However, one only has to look at the integrity issue on USS HAMPTON and the welding quality issue that has recently impacted Virginia class construction to realize that none of us have justification for overconfidence. We must always remember to maintain our vigilance and respect for the complex technology that we work with as a part of our daily lives.

With that in mind, let me outline a couple of more challenges for the year ahead: First and foremost—Sea Based Strategic Deterrent (SBSD). The analytical work is well underway to support the construction start date defined in our shipbuilding plan. Both the STRATCOM-directed capabilities based assessment and the Secretary of the Navy's undersea launched missile system study are progressing to support initial acquisition decisions this summer. And we are synchronizing our work with that of the Royal Navy as they bring their VANGUARD successor program requirements to maturity.

Upcoming decisions include:

1. Agreement on key capability attributes (matching the platform and weapons system to the missions) while addressing potential threats through a threat and physics-based assessment.
2. Platform – submarine or surface ship

3. Missile – warhead characteristics
4. Tube size and number
5. Hull size
6. Quieting goals
7. Speed
8. Propulsion

As we narrow our options, the research and development plan and program are starting to take shape with POM 10 being the focus for laying in the funding we need. This is particularly important, not only to the SBSD, but also to support for continued innovation across the spectrum of platforms and warfighting capabilities. We will be including action to shape the design and engineering workforce such that we will have the skills and bench strength we will need as we build this ship over the next 15 plus years. Obviously a lot of work remains to be done; hard work, but I remind you of how we have been successful in the past:

1. Doing the hard work up front.
2. Staying loyal to the truth – analytical rigor and technical discipline.
3. Pressing the bounds of technology and innovation but doing so with a proper dose of technical reality.
4. One message – many voices.
5. Perseverance in the face of adversity.

Next challenge: CG(X). The Navy is still coming through decisions on mission, capabilities, and technology with respect to the radar and missile systems. Until that work is complete, we are on hold for a decision on hull type/size and propulsion. I am satisfied with the rigor that has gone into propulsion aspects of the Analysis of Alternatives. We are ready to support the final decision-making process with a fact based, technically grounded argument. Where I can use your help is in a couple of areas:

1. (1) Keeping the facts straight. As you can imagine, we can tend to attract "antibodies" when we get involved in a project that is outside of our normal line of business. Such is the case here where well-meaning folks with the best

interest of Navy at heart offer opinions that are simply incorrect when it comes to nuclear propulsion. I am not asking nor do I want you on a crusade to set the record straight every time one of these opinions surfaces, but if you do hear these things and feel a response to set the record straight is necessary, let us know.

2. One message – many voices (again). This is going to be a real challenge for the Navy to come through and there will be a lot of attention inside and outside the Navy. Be very careful as you discuss this topic to ensure you have your facts straight and that you aren't getting in front of the Navy leadership. Again, fact based, technically rigorous and disciplined, one message.

One more challenge—and I saved the most important one for last—our people. Let's face it—we have really good people in our business (Sailors, government civilians, and industry partners). It is both our blessing and our curse. Multiple forces are driving us into a more competitive environment—this can be seen from several precursors: declining retention in the Navy, industry dealing with aging demographics, and a rising demand throughout the Nation and internationally for smart, young engineers.

In the Navy, we are taking a multi-pronged approach to this problem. We have come through a period of downsizing, coupled with a period of increased propensity for young people to join the Service in the post 9/11 environment. Times have changed. We are reinvigorating our recruiting efforts to attract the most qualified young people. The Force leadership is renewing its focus on improving retention and limiting attrition of our talented Sailors. We are making adjustments to bonuses and special pays to ensure our compensation remains competitive. We are improving our collaboration with the groups who are drawing from the same talent pool—the NRC, NEI, etc. And, we are redoubling our efforts in collaboration with industry partners to increase interest in technical studies in our high school and college students across the Nation.

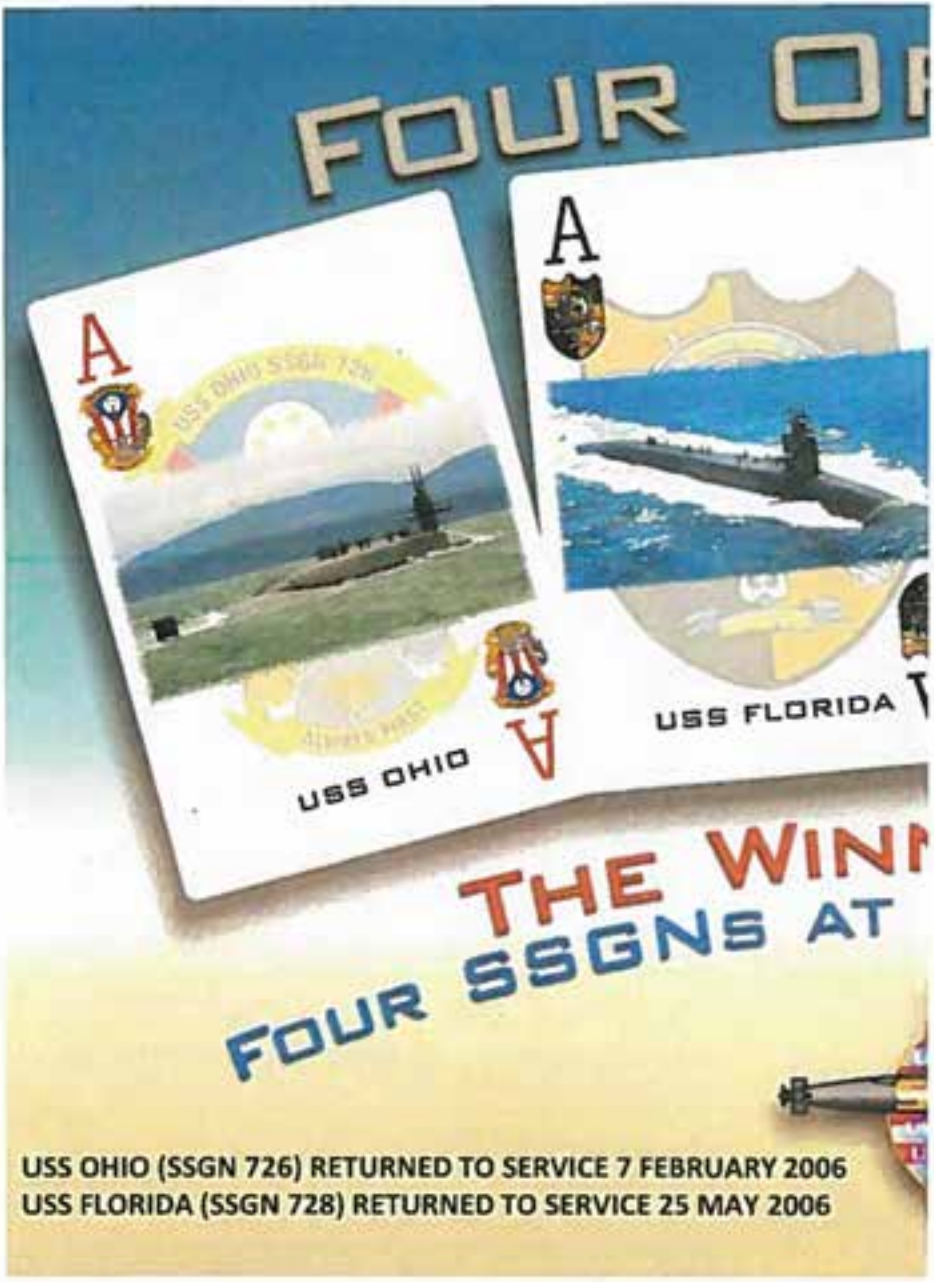
We need similar multi-pronged approaches in the industry if we are to solve this problem. As I visit your facilities and we discuss

people, I see similar demographics throughout industry—a large bow wave of older folks nearing retirement eligibility, a gap in the mid year experience levels, and a good crop of young people recently hired. Accordingly, it is critically important to ensure the older, experienced workers transfer their knowledge and experience to the smart, eager, younger workers.

There have been many successes over the past year. The challenge I lay before you tonight is to seize the momentum offered by our past successes and use it to overcome our present challenges and ready our forces for the future security threats. We must continue to work together as a TEAM, with ONE CONSISTENT MESSAGE, because—as we have seen—when we do, great things happen.

I would like to thank the Naval Submarine League and everyone in this room for their steadfast support of the Submarine Force and the U.S. Navy. Thank you again for allowing me to speak here tonight. I will be happy to take a few of your questions.■


NORTHROP GRUMMAN
DEFINING THE FUTURE
A winning hand ready
to meet any challenge.
MODULARITY. FLEXIBILITY. CAPABILITY.
Defining a new mission for today and the future with Northrop Grumman.


FOUR O
A
USS OHIO
A
USS FLORIDA
THE WIN
FOUR SSGNS AT
USS OHIO (SSGN 726) RETURNED TO SERVICE 7 FEBRUARY 2006
USS FLORIDA (SSGN 728) RETURNED TO SERVICE 25 MAY 2006


SHORE
USS MICHIGAN
USS GEORGIA
NG HAND
A - MARCH 2008
USS MICHIGAN (SSGN 727) RETURNED TO SERVICE 12 JUNE 2007
USS GEORGIA (SSGN 729) RETURNED TO SERVICE 28 MARCH 2008


NORTHROP GRUMMAN
DEFENDING THE FUTURE
Undersea.
Overpowering.
Virginia-class attack submarines are designed to project power by multiple means to meet the challenges of the post-Cold War era. Using advanced technologies, the Virginia-class is vital to our dominance at sea and on land. Northrop Grumman Shipbuilding, part of the team building this class of submarines, recently delivered the North Carolina (SSN 777) to the Navy. It affirms the capacity of an organization that is skilled in process improvement and dedicated to program excellence. The North Carolina powerfully demonstrates that the nation is prepared to meet its commitments, and that we keep ours.

2008 NAVAL SUBMARINE LEAGUE CORPORATE BENEFACTOR RECOGNITION DAY MEETINGS

THE SUBMARINE'S CAPABILITY NEEDS IN THE NEW MARITIME STRATEGY

VADM JAY DONNELLY
COMMANDER, SUBMARINE FORCES

Nearly 60 years ago, in March 1948 on his last day as the Chief of Naval Operations, Admiral Chester Nimitz wrote an article for the Armed Forces Staff College's monthly NEWSLETTER entitled, "Who Commands Sea—Commands Trade".

In that article, he described the maritime strategy of the day and why control of the sea was critical to the United States. He wrote, "It is first, the assurance of our national security, and, second, the creation and perpetuation of balance and stability among nations which will insure to each, the right of self-determination ...."

The naval strategy of World War II and the years that followed relied heavily on a large force. Department of the Navy records from that time period show that at the peak of World War II there were 6,768 active naval ships, 232 of which were submarines. In 1948 when Admiral Nimitz wrote this article, the Navy had experienced a significant downsizing to 737 ships, 74 of which were submarines. Still, a very large force by today's standards.

Control of the seas is as important today as it was then. Since then however, the geopolitical world has transformed many times over and the Navy Strategy has changed to meet new demands.

Perhaps the most significant change was the fall of the Soviet Union in the early 90's. In fact on this very day, the 7th of February, 1991, the Soviet Communist Party gave up a 70-year monopoly on political power.

At the end of three days of extremely stormy meetings dealing with economic and political reforms in the Soviet Union, the Central Committee of the Soviet Communist Party announced that it was endorsing President Mikhail Gorbachev's idea that the Communist Party should make no claim for any particular role in the new

constitution that was being rewritten.

Of course, you will remember that we won the Cold War in no small part by winning an arms race. At the peak of the Cold War, the Navy had a total of 594 active naval ships, 139 of which were submarines.

But today, threats to the United States are not clearly identified super powers. Instead, major world powers, regional adversaries, terrorism, lawlessness and natural disasters—all have the potential to threaten U.S. national security and world prosperity. Therefore, a new strategy was necessary. Today's Maritime Strategy requires a flexible and agile, maritime capability enabling us to meet the emerging challenges of an uncertain world.

While the U.S. still remains the world's leading superpower, we share the rest of the world's dependence on the global system and therefore, have a stake in the health and welfare of the greater global community.

Proliferation of weapons and information technology has increased the capacity of nation-states and transnational actors to challenge maritime access, evade accountability for attacks, and manipulate public perception. The appetite for nuclear weapons and other weapons of mass destruction is growing among nations and non-state antagonists. China's arms buildup bears careful monitoring. Smaller nations, such as Iran, are becoming bolder in their confrontations with U.S. forces.

Just as Admiral Nimitz understood in 1948, world prosperity and security depend on free use of the seas. The Navy will play a critical role in preventing, limiting, and deterring disruptions to our global system. But when necessary, our maritime forces must be ready and able to win wars decisively. This will have to be done with a much smaller force than was used to win conflicts in years past. Today, there are 279 Deployable Battle Force Ships, including 71 submarines. The Navy's 30 year shipbuilding plan calls for a minimum level of 313 ships, 66 of them submarines, to meet the anticipated threat in 2020.

The challenge for the Submarine Force will be to remain dominant in traditional naval capabilities while simultaneously enhancing our ability to conduct the full range of missions articulated in the Maritime Strategy with a low density asset.

Just as in the past, the Submarine Force will need to be flexible, adaptable, versatile and when necessary lethal. The task is large for a relatively smaller force and will require improvements in our current war fighting systems and many new capabilities for our ships. To make a tough job tougher, these improvements and new capabilities will have to come with high reliability and at reduced cost.

The Maritime Strategy requires a thorough and in-depth situational awareness that the Submarine Force uniquely provides. Accurate and timely Intelligence, Surveillance and Reconnaissance is a bread and butter mission of submarines and is needed to thwart our adversaries from gaining the initiative on our forward deployed forces. We play a key role in developing and maintaining this critical Maritime Domain Awareness.

However, despite our traditional stealthy posture, we have to readily communicate with other U.S. and international forces as part of an enhanced maritime information sharing network. This is a challenge for the Submarine Force with the limited bandwidth of our current communications systems and our need for stealth. New capabilities are required.

We need Communications at Speed and Depth. We made some progress this year. USS MONTPELIER is deployed with the HARRY S. TRUMAN Battle Group with a new communications capability called High Frequency Internet Protocol. With it, she is able to chat and exchange e-mail over the floating wire antenna at depths below periscope depth.

While this is a step in the right direction, we need to accelerate our efforts to reach the goal of communications across the full range of submarine depths and speeds. Optical Laser Communications shows some promise and we have engaged DARPA and ONR to invest their resources to move this technology along. We hope to experiment with this capability in 2009.

We plan to demonstrate an enhanced ability to find, fix, and finish threats with reduced targeting timeline utilizing special payloads such as UAVs, UUVs and other remote sensors.

Another initiative is to demonstrate the application of a Digital Radio Frequency Memory (or DRFM) technology from a submarine to provide Information Operation (IO) capabilities. As part of this

demonstration we will modify one of our Multi-function communications masts to provide dual Comms/IO capabilities, so we can communicate what we have found while simultaneously gathering critical intelligence with the same mast.

I am a big believer in the Automatic Identification System, commonly referred to as AIS. The ability to receive AIS data, while submerged below periscope depth, would greatly enhance a submarine crew's understanding of the surface picture. This capability might have prevented the NEWPORT NEWS collision in the Strait of Hormuz.

Next year we plan to test a new buoy that might answer that call. It is as simple as adding an AIS receiver to an existing GPS buoy to provide the submarine with additional situational awareness capability. The buoy will provide added surface situational awareness without requiring the submarine to come to periscope depth.

The Submarine Force has received a strong demand signal to extend our sensor range with Unmanned Aerial Vehicles. Last year we demonstrated the first step toward this capability by launching the Buster UAV from the bridge of USS MONTPELIER. The ship submerged to periscope depth and controlled the aircraft as it fed video back. The demonstration was so successful that we deployed a ship with this first step capability last year.

She demonstrated that capability earlier this week when she used Buster to monitor a transiting merchant ship to ranges of 10 nautical miles over a four hour period.

During the next year we intend to complete the necessary work to be able to launch a UAV from the Trash Disposal Unit while submerged and provide communication links through the BYG-1 Fire Control System. This isn't the be-all-end-all answer, but it is another step forward.

Certainly one day we would like a UAV that has more payload capacity and the longer on station time that fuel cells may provide, but for now launching at Periscope Depth with the ability to be controlled from the submarine and receive video data back may be good enough.

SSNs and SSGNs are the platforms that will be called upon to operate in an anti-access environment. We will operate alone, deploying Special Forces, conducting Information Operations,

collecting intelligence and providing early warning. We will need the payloads and sensors necessary to do the missions and the systems to deploy them. And we will need to be able to provide protection for the Special Forces and ourselves when in shallow water where going deep and fast for evasion is not an option.

In our current fiscal environment, we can't get everything we want today. But we can get some capability now and have a plan to get the rest later.

Unmanned Underwater Vehicles are a good example. There are countless missions that a UUV can be used for, but trying to get all of these technologies now may cost more than we can afford. But, a spiral development approach will get us the mature technologies now at a lower cost with a plan to develop the higher risk technologies in the future.

Technology and new approaches are advancing rapidly. Our acquisition programs will be under increasing pressure to deliver the right systems, on time, and at the best cost. However, Commercial Off the Shelf Technology is not the panacea for cost reduction. We have found that these technologies still require careful planning and good engineering to ensure they provide reliable capability at the right cost. But, leveraging existing technology to develop a new capability is an effective strategy.

We have some good examples to draw from with Tomahawk and SSGN. Currently we are taking this approach with the Submarine Littoral Defense System. It may be possible to launch an AIM 9X, a Sidewinder missile from the vertical launch tube of an SSN or the Multiple All-Up-Round Canister of an SSGN against slow, low flying aircraft or small surface craft. The research and development that can bring organic anti-air capability to the Submarine Force is underway and we started working the Concept of Operations piece this year with a workshop held at the Naval War College.

This past fall SSGN became a reality when the OHIO deployed to PACOM. During the deployment she will participate in an exercise held by U.S. Forces Korea. I am unable to go into detail due to the classification of this forum, but it will be the first real operational test of SSGN and how she will participate in a complex expeditionary strike.

OHIO will soon be followed by FLORIDA, who is conducting

maintenance in preparation for her deployment this spring and MICHIGAN is on schedule to deploy later this year. All four SSGN are now in the fleet. GEORGIA delivered in December and will undergo modernization to prepare for her deployment next year.

Now that they have arrived, we are looking for new ways to take advantage of their flexibility and to leverage the storage capacity of her Large Diameter Tubes. One of those ways may be the Payload Interface Module. Developed by SSP and Electric Boat, it will have the ability to launch numerous SOF payloads including Combat Rubber Raiding Craft, UAVs, UUVs, and Seal Delivery Vehicles. It will also be ready for the large diameter tubes of later flight Virginia Class fast attacks.

We are only limited by our imaginations and dollars. The Undersea Enterprise is heavily engaged right now building the budget that will fund our capability strategy for 2010 through 2015. We plan to invest in new technologies that will transform how we conduct operations and win wars.

As these new capabilities are brought onboard, the Submarine Force will be asked to do more. Balancing our traditional missions with these new expanding capabilities will be a challenge.

We have been working hard to provide ready SSNs to the Combatant Commanders, but with shipyard overruns it has been difficult. In order to meet operational commitments, we compressed the Fleet Readiness Training Plan schedules, referred to as the FRTP. The FRTP is the period of time between deployments that we use to prepare the ships and crews to go out again. Average FRTP length across the force has decreased from greater than 17 months to just over 16 months.

Reducing the FRTP length enabled us to meet the COCOM demand in the short term, but it comes at a cost and is certainly unsustainable over the long term. It decreases the Commanding Officer's time to train his crew and maintain his ship. It compresses the time needed for experimentation, modernization and CNO tasking and is having an impact on our people. We are leaning hard on them and they continue to come through for us, but we can't take them for granted.

Our Fleet Response Plan increases our operational availability and flexibility. But, we must effectively use inport trainers, and the

limited underway training time we have, to maintain our warfighting readiness, certify our crews, and ensure we are an agile, capable, and ready force.

When called upon, the ships must be 100% capable. All too often that has not been the case. The TB-29 is a very capable towed array and, when it works, clearly detects contacts that are invisible to other acoustic sensors. But, with a 19% reliability, my Commanding Officers have an understandably hard time trusting that it will be there when they need it most.

The new Maritime Strategy continues to view deterrence as a strategic imperative. Preventing wars is as important as winning wars. We are pursuing an approach to deterrence that includes a credible and scalable ability to retaliate against aggressors conventionally, unconventionally, and with nuclear forces. OHIO Class ships begin decommissioning in 2027 and the 30-year shipbuilding plan calls for 2019 construction start date for their replacement. The Navy is developing the acquisition strategy and the Research & Development plan now, for the next generation Sea Based Strategic Deterrent.

We are also seeing expansion in some of our core missions. There are many challenges to the Navy's ability to exercise sea control, perhaps none as significant as the growing number of nations operating submarines, both advanced diesel-electric and nuclear propelled.

The Navy recognizes the need for a change in our Anti-Submarine Warfare strategy and Rear Admiral (Ret.) Jerry Ellis was assigned in June of last year to be the Special Assistant for Undersea Strategy Office of the Secretary of the Navy. He has been tasked to influence programs and processes to deliver undersea superiority and is looking for innovation and *out of the box* solutions to consider.

While the Submarine Force is a minority voice in any Big Navy discussion, with RADM Frank Drennan's assignment as Commander of Naval Mine and Anti-Submarine Warfare Command, and ADM Jon Greenert in place as Commander U.S. Fleet Forces Command, the Submarine Force is poised to play a more active role in the Navy's ASW strategy. The Global ASW CONOP is a sound strategy, but is heavily focused on defense of the Strike Group. I believe that a more forward leaning strategy would be more

effective. Navy leadership is looking to take a more balanced offensive/defensive approach and I will be engaging to better define our role and allow us to provide the ASW expertise we are known for.

In summary, we have a significant part to play in the Maritime Strategy today and, though it won't be easy, we will play an even more vital role as the world shapes itself in the future. Since our inception, the Submarine Force has been a leader in the innovation, flexibility, responsiveness and cohesiveness needed to meet the challenges of tomorrow. Our long history of success in difficult situations can be attributed to hard work, good analysis and a single coherent story spoken by all submarine supporters, in and out of uniform.

In the final paragraph of his 1948 article, Admiral Nimitz said, "...in preparing for any contest, it is wisest to exploit—not neglect—the element of strength." We will meet the demands of the future by continuing to leverage what has worked so well for us for many years—the strong relationships we share with you, the members of the corporate community.

Thank you.■

A NAVAL MESSAGE
USS PASADENA
CDR DOUG PERRY, COMMANDING OFFICER
REPORTING THE BURIAL AT SEA
OF RADM FLUCKEY'S REMAINS

R261539Z JAN 08
TO COMSUBGRU SEVEN
INFO COMSUBFOR NORFOLK VA
COMSUBPAC PEARL HARBOR HI
COMSUBRON SEVEN
COMSUBRON FIFTEEN
BT

UNCLAS PERSONAL FOR RADM MCANENY INFO VADM DONNELY,CAPT POWERS AND CAPT SAWYER//N05000//MSGID/ GEN ADMIN/PASADENA/100/JAN//SUBJ/RADM FLUCKEY BURIAL AT SEA
//RMKS/

1. I HELD A CEREMONY ON 21 JANUARY TOPSIDE ON ALAVA PIER IN SUBIC BAY WITH MY CREW ASSEMBLED IN SUMMER WHITES TO HONOR RADM EUGENE B. FLUCKEY. READING AN EXCERPT FROM THUNDER BELOW THAT DESCRIBED BARB'S ACTION IN SEPTEMBER 1944, MY CHIEF OF THE BOAT IMPRINTED ONTO MINDS OF 150 PASADENA CREWMEMBERS THE IMAGES OF A TWO-DAY SOUTH CHINA SEA OPERATION. USS BARB TORPEDOED AND SANK THE TANKER AZURA MARU AND THE AIRCRAFT CARRIER UNYO BY FIRING SIX TORPEDOES IN COMPLETE DARKNESS, THEN SURFACED JUST HOURS LATER TO RESCUE FOURTEEN AUSTRALIAN AND BRITISH POWS FROM THE SOUTH CHINA SEA AS A TYPHOON ROLLED IN TO STIR WINDS ABOVE SIXTY KNOTS AND SEAS TO OVER TWENTY FEET.

2. IN THE TRADITION OF OUR SILENT SERVICE, I PINNED DOLPHINS ON FOUR JUNIOR OFFICERS AND TWO YOUNG SAILORS AS MY COB READ ON. THE PINNING COMMEMORATED HOW OUR SUBMARINE QUALIFICATIONS TODAY CONTINUE THE TRADITIONS OF PERFORMANCE SET BY CDR GENE FLUCKEY AND HIS USS BARB CREW THROUGH THEIR PROFESSIONAL EXPERTISE, PERSONAL DEDICATION, TEAMWORK AND MISSION ACCOMPLISHMENT. SUCH ARE THE TRADITIONS OF THE SUBMARINE FORCE, AND ON THAT DAY SIX MORE JOINED OUR RANKS.

3. THREE DAYS LATER I SURFACED PASADENA AT 20N/115E, THE VERY SAME LOCATION BARB RESCUED THOSE ALLIED POWS OVER SIXTY YEARS AGO. IN A MEMORABLE CEREMONY ON THE BRIDGE I COMMITTED RADM FLUCKEYS REMAINS TO THE DEEP.

4. PASADENA IS HONORED TO HAVE CONDUCTED RADM FLUCKEYS BURIAL AT SEA. SAILING WITH HIM FROM PEARL HARBOR, THROUGHOUT THE SAME WEST PACIFIC WATERS WHICH BARB, WAHOO, PARCHE AND OTHERS PATROLLED, REMINDS ME AND MY CREW OF THE TENETS OF OUR PROFESSION AND THE IMPORTANCE OF OUR DEPLOYMENTS TODAY IN SECURING OUR NATIONAL INTERESTS. NOW WHEN WE READ FROM THUNDER BELOW, MY MEN ARE TRULY INSPIRED TO BE EXPERT SUBMARINERS AND ACHIEVE SUPERIOR WARFIGHTING READINESS. THEY KNOW THAT WHILE WE HAVE DRAMATICALLY MODERNIZED OUR SUBMARINE PLATFORMS SINCE THE 1940S, IT IS OUR CONTINUOUS TRAINING AND CONSTANT VIGILANCE WHICH ENABLES US TO SAFELY NAVIGATE THE SEAS AND MAINTAIN STEALTH TO ACHIEVE MISSION SUCCESS IN AN UNFORGIVING ENVIRONMENT.

5. THE TRADITIONS AND STANDARDS OUR PREDECESSORS ESTABLISHED IN WARTIME CARRY ON TODAY IN OUR NUCLEAR SUBMARINE FORCE AS WE EXECUTE

NATIONAL TASKING, JOINT OPERATIONS AND THEATER SECURITY EXERCISES AROUND THE GLOBE ON A DAILY BASIS. IT IS CLEAR TO ME THAT THE OFFICERS, SAILORS AND CHIEFS ONBOARD PASADENA UNDERSTAND THEIR MISSION TASKING AND WE ARE INSPIRED BY RADM FLUCKEYS LEGACY TO ACHIEVE MISSION SUCCESS. WE ARE READY.

6. MC2 HIRAYAMA FROM NAVAL FLEET ACTIVITIES YOKOSUKA PUBLIC AFFAIRS CAPTURED THE EVENT ON CAMERA AND IS PREPARING NEWS ARTICLES THAT HE WILL SUBMIT UPON RETURN TO YOKOSUKA. MY CREW AND I ARE PREPARING A PACKAGE WITH AN ANNOTATED CHARTLET, PHOTOS AND VIDEO TO SEND TO THE FLUCKEY FAMILY FROM AN UPCOMING PORT VISIT. MC2 HIRAYAMA DISEMBARKED TODAY WITH FOOTAGE OF RADM FLUCKEYS BURIAL, AND HE WILL PASS MATERIAL TO LCDR KUNTZ WHEN HE RETURNS TO YOKOSUKA.

7. ANYTIME, ANYWHERE.■

SUBMARINE TECHNOLOGY SYMPOSIUM

SUBMARINE TECHNOLOGY SYMPOSIUM WELCOME REMARKS BY VADM GEORGE EMERY, USN (Ret.)

Editors Note: The annual Submarine Technology Symposium, co-sponsored by the Naval Submarine League and the Applied Physics Laboratory of Johns Hopkins University, will be held at JHU/APL May 13th, 14th and 15th. VADM George Emery is the Chairman of the Symposium. His welcoming remarks to the Symposium are presented here. He also has selected an abstract for one of the papers to be presented in each of the four technology sessions in order to illustrate, for those members of the League not attending, the type and breadth of the subjects normally discussed during a SubTech Symposium. Those sessions will cover SSGN, Tactical Survival, Technologies for Strategic Flexibility and Future Technologies. In addition, he has included a summary agenda for the operational briefings to be given in Session III, Force Needs.

WELCOME

Welcome to the 2008 Submarine Technology Symposium, the twenty-first in a series of Symposia stretching back to 1988. During the next three days, you will hear from an exceptional group of talented individuals representing industry, laboratories, academia and the Navy. Each will bring a fresh view of technologies designed to enhance the submarine's military value to Joint Warfare Commanders.

Joint Warfare Commanders repeatedly reiterate operational requirements for submarines that far exceed their availability. No remedy for this shortfall is visible on the near horizon. Hence the need for this Symposium, like its immediate predecessors, to bring forth new and improved technologies designed to increase the range

of capabilities the submarine brings to warfare commanders in support of emerging military demands.

The theme of the 2008 Symposium is ***Assure, Dissuade, Deter...Through Innovative Technologies***. The sessions presented on the Symposium's first day will focus on:

- The **SSGN**, and
- Tactical Survival

Presentations during these sessions will present technologies with the potential to enhance the war fighting capabilities of the **SSGN** to include command and control, flexible weaponry and UUVs. The afternoon session, **Tactical Survival**, recognizes the growing capabilities of potential foes and presents several intriguing technologies that may improve the submarine's ability to survive in a hostile environment.

The second day of the Symposium will establish a benchmark for the 2009 symposium by informing you of the **Force Commanders' Needs**. This session will include presentations from submarine commanders who have recently completed important missions. The afternoon session will focus on technologies that enhance **Strategic Flexibility**, technologies that may play an important role in the design of the next generation **SSBN**. It has been some time since the Symposium included a session devoted to **Future Technologies**, technologies that may play a significant role in enhancing the submarine's capability in the out years. Hence, the final day of the Symposium will do just that, including an extended session devoted to **Tango Bravo** projects.

In addition to our luncheon and banquet guests of honor, Keynote Speakers will kick-off each session. New to the Symposium will be remarks by **Ms. Allison Stiller**, Deputy Assistant Secretary of the Navy (Research, Development and Acquisition) Ship Programs, and **Dr. Anthony Tether**, Director, Defense Advanced Research Projects Agency. The Symposium will conclude with a Submarine Leadership **Roundtable** with participants from the Submarine Force, DARPA, NAVSEA, OPNAV, and the Chief of Naval Research.

We trust that you find the 2008 Submarine Technology Symposium both satisfying and stimulating. We welcome your comments

and recommendations for improving future symposiums. A survey has been provided in this pamphlet to facilitate your feedback.

OBJECTIVE

Nuclear submarines remain essential to American military operations whether the mission is to ensure access to littoral waters, provide a strategic deterrent, protect the sea-lanes or support the Global War on Terror. The flexibility of the nuclear submarine to support any and all military operations has created a demand for submarines that far exceeds their availability. In support of National tasking nuclear submarines are capable of sustained, worldwide, forward deployed, independent operations. They can hold a potential adversary at risk; conduct covert, non-provocative and sustained intelligence, surveillance and reconnaissance operations in a hostile environment not accessible to other forces; detect and map minefields in advance of a battle force, conduct covert insertion and extraction of special forces; attack targets at land or at sea and provide anti-submarine warfare protection to an expeditionary strike group...all with minimum risk to this highly survivable war-fighting platform.

The military utility and value of submarines is universally accepted. Because of the visibility and expense of creating a surface fleet of sufficient numbers and capability to challenge America's dominance of the ocean surface, submarines have become the weapons system of choice for many of our potential adversaries. The open market for advanced submarines and submarine systems and weapons is replete with a wide variety of air-independent propulsion systems, capable sensors and combat control systems, and new concepts in weapons. Submarines are best suited to meet these emerging threats to our joint forces, a reality now recognized by Fleet and Theater Commanders. Unfortunately, requirements for submarines far exceed their availability, and future force levels will only exacerbate this condition. Therefore the challenge for government and industry is to capture for each and every submarine the maximum capability in unique and enduring war-fighting capabilities. The continuous infusion of innovative and advanced technology will enable that goal.

Over the last century, the Submarine Force has a history of

transforming itself to match capabilities to requirements. In today's world, requirements not only continue to grow, but the acceleration of technology change continues to challenge our ability to ensure the submarine force maintains today's advantage tomorrow. In addition to identifying the technology our submarines require in order to address current and future National tasking, this symposium will examine several near-term advanced developmental technologies, as well as conceptual technologies likely to enhance the submarine's future operational capability.

Our objective is to stimulate your energy and creativity to improve and expand the capability of United States submarines to support National security objectives. Your active participation is encouraged.■

SELECTED UNCLASSIFIED ABSTRACTS FROM STS 2008

Session I SSGN

Prompt Reactive Interdiction Strike Missile

by Tim Czerniak and Conrad Donohue
of Northrop Grumman Mission Systems

ABSTRACT—The Missile Defense Agency (MDA) is developing an intermediate range BMD system (common booster) to fill capability gaps with a missile designed to intercept targets during their most-vulnerable boost-ascent phase of flight. This mobile system will also hold regional/national ballistic missile threats at risk that cannot be engaged by fixed systems such as the Ground-Based Interceptor (GBI) during all phases of exo-atmospheric flight. Northrop Grumman Corporation (NGC) has invested in a detailed examination of additional prospective missions for this fast, energetic, long-range missile. The top candidate is for a Prompt Global Strike missile coined "Precision Rapid Interdiction Strike Missile" (PRISM).

MDA and the Navy (N86 & N87) have jointly sponsored an Alternatives Assessment (AA) for near term fielding of common booster capability in sea-based platforms. During the conduct of this study, it was determined that the dimensions of this booster are physically compatible with the Ohio Class SSBN/SSGN launcher system and that ballistic missile defense operations by these submarines are feasible. This work has provided the technical foundation for integration of PRISM into the SSGN/SSBN weapons system. This Prompt Global Strike missile has a flight profile that will enable it to be readily discriminated from the Trident D5 missile, thus mitigating the risk of a responsive attack due to ambiguity following detection of a Conventional Trident Missile launch.

This paper presents a detailed technical summary of the booster development, required launcher modifications, command and control requirements and expected system performance.

SESSION II Tactical Survival

Full 360-Degree Tactical Awareness with the Non-Hull Penetrating, Non-Rotating, High Resolution Digital Periscope Sensor Head

by Dr. Terry Huntsberger et al of Jet Propulsion Laboratory, California Institute Of Technology

ABSTRACT—NAVSEA PMS 435 has identified the need for a non-hull penetrating, high-resolution (HR), continuous Field of View (CFOV) non-rotating (NR), 360-degree view and display of the sea surface and sky background from a periscope with integrated capabilities for:

Continuous observation of contacts (potential targets)
Automatic detection and tracking of contacts (potential targets)
Recognition of contacts (threat determination)
Ability to digitally zoom to any area for closer inspection

A High-Resolution, Continuous Field-of-View, Non-Rotating Imaging Sensor (HR/CFOV/NRIS) system will need to concurrently carry out a number of diverse visual tasks including search and detection, tracking, recognition, and multi-target cueing.

Search and detection missions require wide field-of-view (FOV) tracking that will need to address fast frame-rate data output from regions of interest (ROI), recognition requires high spatial resolution, while multi-target cueing requires all four tasks concurrently. The use of optical zoom is a much less efficient way of carrying out these diverse tasks for the HR/CFOV/NRIS, since manual zooming cannot simultaneously provide narrow and wide field of view scene visualization. It will be both difficult and time consuming for an operator to quickly zoom in and out of the ROI because of the vast changes in the FOV during zooming and relocating contacts within the search FOV that may be 50x higher than the narrow one.

The Jet Propulsion Laboratory (JPL) is developing a HR/CFOV/NRIS advanced demonstration model (ADM) for NAVSEA PMS 435, that provides a 360-degree, electronically selectable, low and high-resolution fields-of-view of the battlefield environment. The ADM is integrated with a JPL-developed Contact

Detection and Analysis System (CDAS) that automatically scans the full 360-degree FOV of the high resolution imagers and extracts contacts based on tuned matched filters. These contacts are then processed for identification using a software emulation of a gray scale optical correlator (GOC) combined with a radial basis function neural network (RBFNN).

JPL demonstrated a fully populated 360-degree HR/CFOV/NRIS in July of 2007. Basic contact ROIs were autonomously flagged, recorded into a databse, and displayed; and a GUI allowed user-selected and automated electronic zoom of ROIs. This talk will give details of the HR/CFOV/NRIS design, and will detail the field demo of the fully populated sensor head with a contact identification pipeline fully integrated into the automated target recognition algorithms in the CDAS.

SESSION III Force Needs

- Introduction: Captain Perry, ComSubDevRon 12
- Submarine Operations in SouthCom AOR
- Submarine Operations in CentCom and EuCom AORs
- USS OHIO PaCom AOR Experience
- Submarine Operations in PaCom AOR
- Tactical Development Update

SESSION IV Technologies for Strategic Flexibility

Submarine Support of the Sea-Mobile Kinetic Energy Interceptor Missile Defense Mission

by Benjamin Tritt, NSWC Dalgren; Hank Lee, MDA Kinetic Energy Interceptor Program Office; Michael Graham, Missile Defense Systems Engineering Team and Kevin Curtis of Johns Hopkins University Applied Physics Laboratory

ABSTRACT— The Sea Mobile Kinetic Energy Interceptors (KEI) Platform Alternatives Assessment (AA) was a joint MDA-Navy study completed in 2007 that evaluated multiple, maritime platform alternatives (including surface combatants, submarines, and large deck surface ships) for hosting the sea mobile KEI system. In

forming a platform recommendation, the AA study defined the platform alternatives with an integrated KEI capability and examined the performance of platforms in different scenarios against different platform threats and ballistic missile threats. The AA study conclusions and recommendations combine the platforms performance with a force structure assessment, general suitability comparison, Rough-Order of Magnitude life cycle cost estimations, development to IOC schedule comparisons, and risk assessments to recommend a sea mobile KEI platform. The end result of the platform study was a strong preference for the submarine platform as the host for the KEI system.

This presentation will describe the Alternatives Assessment study process and results with particular attention to:

- Dependencies on different ballistic missile defense missions (boost, ascent and midcourse intercepts)
- Unique challenges for the submarine such as timelines, communications and launch environments, and the proposed solutions
- CONOPS and KEI system changes to optimize the submarine approach
- Architectures and commonality with a land-mobile KEI system
- Multi-mission capability evaluation
- Submarine-unique risks and disadvantages
- Submarine-unique advantages including availability and endurance, design reference mission and crewing, shore infrastructure, large missile integration, survivability, and certain aspects of force structure impacts

SESSION V Future Technologies

Virginia Class Efforts to Expand Mission Capability Starting with Block IV

by Alan Blay & Thomas Plante, Electric Boat & Byron Rose, NavSea PMS 450

ABSTRACT - As 21st century warfighting requirements evolve, combatant commanders continue to call for expanded mission capability from existing military platforms. The integration of additional types of payloads on nuclear submarines allows the ability

to capitalize on the platform's inherent stealth and durability to meet these new warfighting requirements.

This paper describes an integrated spiral development approach to the Virginia Class that brings enhanced mission capability through payload development and ship design changes starting with Block III. Four focus areas are addressed as part of the integrated improvement strategy that balances recurring and non-recurring cost with capability enhancement: Design For Capability, Design for Life Cycle Affordability (DF-LCA), Design For Crew Effectiveness and continuation of Design for Affordability (DFA). The goal of this integrated strategy is to maintain the ship SCN cost neutral. Major capability initiatives addressed include, Virginia Payload Tube Launch and Recovery Arm, Att Payload Tube Bottom Drop, Manned Access to Att Tube, and Flexible Payload Sail. Cost reduction initiatives addressing procurement and life cycle cost reduction include: CAVES Wide Aperture Array (WAA), continued electrification of ship hydraulic systems, rotary electromagnetic launcher, warfare management and ship infrastructure improvements. Lastly, the synergies, efficiencies and complementary aspects of SSGN and Virginia Class Block III and IV payload capability development will be discussed.■

ARTICLES

ROSS GUNN AND THE NAVAL RESEARCH LABORATORY'S EARLY RESEARCH INTO NUCLEAR PROPULSION, 1939-1946

by Mr. Joseph-James Ahern

Mr. Ahern is Senior Archivist of University Archives, University of Pennsylvania. When he wrote this he was Assistant Manager of Technical Services with American Philosophical Society. *This article first appeared in the Spring, 2003 issue of the Journal Historical Studies of the Physical and Biological Sciences. It is reproduced here with permission from the University of California Press.*

The following abbreviations are used: APS, American Philosophical Society; Bowen Papers, Mudd, Harold G. Bowen Papers, Public Policy/University Archives, Department Rare Books and Special Collections, Princeton University Libraries; BP LOC, Papers of Harold Gardiner Bowen, Manuscript Division, Library of Congress, Washington, D.C.; NACP, National Archives and Records Administration at College Park, College Park, MD; NAMA, National Archives and Records Administration-Mid-Atlantic Region, Philadelphia, PA; NBL AIP, Niels Bohr Library, American Institute of Physics, College Park, MD; OA NHC, Operational Archives, Naval Historical Center, Washington, D.C.; SCOA, U.S. Senate Special Committee on Atomic Energy, *Atomic energy: Hearings pursuant to S. Res. 179*, 79th Congress, 1st sess, 13, 14, 19, and 20 Dec 1945.

On September 30, 1954 the United States Navy commissioned USS NAUTILUS (SSN-571), the world's first nuclear powered vessel. Credit for making NAUTILUS a reality goes to Admiral Hyman G. Rickover, who, as a captain, was assigned to the Bureau of Ships in 1947 to look into the potential of nuclear propulsion. He later became head of the Division of Reactor Development at the U.S. Atomic Energy Commission and Director of the Naval Reactors

Branch in the Bureau of Ships. While Rickover's engineering and managerial skills provided the impetus for the creation of NAUTILUS, the concept of a nuclear powered submarine dates back to 1939 and Ross Gunn, a research physicist and technical advisor at the Naval Research Laboratory (NRL). Between 1939 and 1946 Gunn directed research at NRL to determine the feasibility of using nuclear energy for submarine propulsion. Though historians mention NRL's work during this period, its influence is regularly overlooked. Naval historian Gary Weir: "historians interested in the naval nuclear propulsion program, and determined to establish cause and effect firmly and clearly, have failed to evaluate properly the elusive influence of the compelling ideas emerging from NRL in the early postwar years."

Why has the influence of NRL been overlooked? Army, that is, the Manhattan Engineering District (MED) controlled all matters relating to the atom bomb project. In their efforts to solve the key problems of nuclear propulsion, Navy scientists developed methods for the production of uranium hexafluoride and for isotope separation using liquid thermal diffusion. Both of these methods, vital to the production of uranium 235, were used to create the atomic bomb. However, the Navy's research was carried out in isolation from and in competition with MED.[1]

With the support of NRL directors Admiral Harold G. Bowen and Admiral Alexander H. Van Keuren, Gunn struggled with MED to get the supplies the program needed and to show the potential of the research to the overall program. Philip Abelson (physicist at Carnegie Institute) later commented, "[i]n my dealings with Ross Gunn, I noted that in a situation where he was certain of the facts, he did not avoid conflict, and he was resourceful when in a fight."[2] The correspondence and files of Gunn and his associates document their confidence in their work illustrate the early influence of the NRL program on the development of nuclear energy, and reveal the affect of the postwar focus on MED and Rickover on Gunn. The Navy, not the Army, deserved credit for laying the groundwork for nuclear energy in the United States. Although the atomic bomb was built by the Manhattan Engineering District under General Leslie Groves, the little-known and nearly suppressed story of the Navy's prior work in this field gives credence to Gunn's claim that the Navy got *hosed*.

1. NAVY'S INTEREST AND RESEARCH

Early interest

The U.S. Navy's interest in developing a nuclear powered submarine originated in the separate quests to find an ideal means of submarine propulsion and a new power source for naval vessels in general. Discussions over the role and mission of the submarine in the Navy date back to 1911 when the General Board determined that submarines would have two roles—coastal protection and fleet operations. For fleet submarines the important task became finding the best means of propulsion to meet their mission requirements. In 1912 the Navy adopted diesel-electric engines, which required that the submarine carry both fuel and oxygen to operate when submerged, restricting its range and speed. Even before the end of World War I the search began for a new means of propulsion. Inside the Navy, Gunn was alarmed at the nation's disappearing coal and oil reserves. To him, the Navy had an obvious interest in new forms of power given its position as one of the world's largest consumers of petroleum.[3]

NRL's Mechanics and Electricity Division was responsible for investigating new power sources and their application. During the early 1930s the division, headed by Gunn, studied new power plants for submarine and torpedo propulsion. Among those under consideration were the fuel cell, the hydrogen peroxide-alcohol steam turbine, and diesel engines operated in a closed cycle. The central limitation in all of these methods was the need for adequate oxygen for propulsion under water and a means of regeneration when running on the surface. The possibility of nuclear energy was very intriguing. According to Gunn, "[i]t was recognized immediately [after the discovery of fission] that perhaps here was an answer to the submarine propulsion problem." Nuclear power would simultaneously remove the oxygen problem and provide the submarine with a long cruising range. Gunn's division had numerous discussions about the application of the nuclear energy to naval problems but decided not to present a research program to the no-nonsense Navy bureau chiefs until they had significant data to back it up.[4]

While scientists at NRL theorized about the use of nuclear energy, it was Enrico Fermi's meeting with Navy representatives in

March 1939 that gave nuclear energy research its start at the laboratory. On March 16, George Pegram, dean of the Graduate Physics Department at Columbia University, wrote Admiral Stanford C. Hooper, director of the Technical Division in the Office of the Chief of Naval Operations, about the possibility of using uranium to create a nuclear weapon. Although Pegram doubted that the project would succeed, he, Fermi, and Leo Szilard thought that the potential should not be ignored. "[T]here is no man more competent in this field of nuclear physics." Pegram wrote two months after Niels Bohr had discussed the discovery of fission with Fermi; his letter to Hooper was the first attempt by scientists to get the United States government involved in nuclear research.[5]

Beginning of NRL nuclear research

The meeting with Fermi on March 17 at the Navy Department building on Constitution Avenue was attended by representatives from the Navy's Bureaus of Engineering. Ordnance, and Construction and Repair, NRL, and the Army's Ordnance Department. In a little over an hour Fermi discussed the discovery of fission, the potential of an atomic bomb, and the possibility of a nuclear power source. Fermi left the meeting feeling that it had yielded little, even though a Navy spokesman said the service was anxious to keep in contact with his work at Columbia University and would have representatives call in person. Fermi had not realized that he had given the NRL representative, Gunn, the evidence that he needed to take his division's idea before the Bureau of Engineering. Three days after the meeting Gunn and Captain Hollis M. Colley, director of the NRL, approached Admiral Harold G. Bowen, director of the Bureau of Engineering, with a request for $1,500 to start uranium research. They outlined the probable operational and military capabilities of a nuclear submarine. When Gunn and Cooley left Bowen they had their funding and within a week had begun research, to "the first organized program in nuclear research in this country at the Naval Research Laboratory." NRL's work began almost seven months before President Franklin D. Roosevelt received Albert Einstein's famous letter about the potential for an atomic bomb.[6]

The first official memorandum on the basic problems of nuclear powered submarine propulsion was prepared on June 1, 1939. In it

Gunn stated that a uranium power source could provide heat to run a steam power plant without requiring "the oxidation of organic material" or that "oxygen be carried down in the submarine." It remained to design a method to obtain the uranium 235 that Bohr had identified as an ideal source for a chain reaction. "[I]f the method will work, it is of outstanding importance and will greatly modify the experimental program at this Laboratory. If it will not work, it is of utmost importance to determine this fact at the earliest practicable date." The Navy did not have a weapon as its primary objective. Gunn again: NRL "realized the two important solutions would fall out together...and we knew that if we could solve the power problem the bomb application would automatically come out with a very small amount of additional work." Further, Gunn believed, or hoped, that the United States would not have a cause to use such a horrible weapon.[7]

Before separation research could begin, NRL needed an adequate supply of uranium hexafluoride (UF6 or *hex*), which exists in either a gaseous or liquid state under ordinary conditions. R. R. Miller of NRL's Chemistry Division and T.D. O'Brien of the University of Maryland began working in April 1939 on hex production. The method they developed passed fluorine gas over a powdered uranium-nickel alloy that "was expensive and laborious to make." the initial samples produced lacked the purity needed for use in isotope separation. By January 1940, after nine months of work, NRL could produce pure gram-sized samples of uranium hexafluoride.[8] While the Miller and O'Brien method allowed NRL enough pure hex for research, it could not meet all research and production requirements. The difficulty of making the uranium-nickel alloy kept hex production to "a hundred grams."

Physicist Philip Abelson at the Carnegie Institution of Washington required more than ten times this amount for his experiments. Abelson set out independently to make UF6 without using the alloy. With the help of H.B. Knowles, Abelson devised a straightforward method using a common salt of uranium that yielded nearly a kilogram of hex per day by July 1941.[9] With the success of Abelson's method, NRL began to arrange for the commercial production of UF6 in October 1941. Following the approval of the Uranium Committee, which oversaw uranium research in the United

States, the Navy asked the Harshaw Chemical Company of Cleveland for an estimate for producing hex in 50-pound lots. Harshaw Chemical had received authorization to begin UF6 production by December 1941.[10]

Once NRL had overcome the hex of hex, it turned to isotope separation. NRL contracted research out to laboratories at some of the nation's top universities and research institutions. Four methods (gaseous diffusion, ultra centrifuge, mass spectrograph, and liquid-thermal diffusion) were developed far enough for trial in pilot plants. Columbia University received $30,000 to study centrifugal fractionating columns; the University of Virginia, $13,000 to carry out the early phase of research on high-speed contrifuges. The Carnegie Institution of Washington conducted research on liquid thermal diffusion under Abelson, at first as a public service and later with an allotment of $3,500. Gunn judged it "a forward-looking program that would ultimately lead to a power-producing pile." The program was financed by the Army's Ordnance Department and the Navy's Bureau of Ships and Ordnance, with NRL coordinating the work.[11]

The Carnegie Institution received the Navy's first contract. Lyman J. Briggs, director of the National Bureau of Standards and chair of the Uranium Committee, recommended to Bowen that NRL enter into a contract with John A. Flemming at the Carnegie Institution to support Abelson's research. Abelson had joined the Institution's Department of Terrestrial Magnetism in August 1939 from the University of California at Berkeley to design a 60-inch cyclotron. Abelson became interested in liquid thermal diffusion in July 1940, when Gunn visited him with a copy of Progress Reports in Physics that contained an article by H.C. Urey reviewing all of the known methods for isotope separation. "Gunn suggested that I look into the methods to see if I could find any that looked promising.... [A] review of the literature showed that...thermal diffusion had considerable promise, especially because it appeared that considerable quantities of material might be handled by this method." The basis of the method is that lighter isotopes diffuse more quickly than heavier ones against gravity toward the warm side of a temperature gradient: material rich in uranium 235 would move to the top of a column sustaining a gradient.

Initially liquid thermal diffusion had not been considered a practical method for isotope separation. Research at four laboratories in the United States had shown that gaseous thermal diffusion did not give measurable separation. Abelson's first columns at the Department of Terrestrial Magentism proved successful. He formally suggested using liquid thermal diffusion in a 17-page memorandum in September 1940. During this preliminary period he had his salary from the Carnegie Institution, his equipment from NRL, and laboratory space and a chemist from the Bureau of Standards. On June 1, 1941 Abelson became a Navy employee and transferred his work to NRL's Anacostia Station. The preliminary work with eleven liquid thermal diffusion columns 1.5 inches in diameter and from 1 to 12 feet long showed that temperature differences and wall spacing were the critical variables. Abelson points to the simplicity and low startup cost of the process as demonstrated by the speedy construction of the first plant. The main disadvantage was the large requirement for steam. Gunn thought Abelson's separation process promising and kept a close eye on it.[12]

Around June 1, 1941, the NRL began to construct a small pilot plant with 36-foot columns next to its Boiler House. "[I]t was felt that a number of columns should be built possessing various spacings and that these columns should be tested at temperatures as high or even higher than the critical temperature of UF6." NRL installed a high-pressure, gas-fired boiler that could deliver 750 pounds of steam per hour at a pressure of 600 lbs./in^2. Construction ended November 1, 1941, delayed by parts suppliers. Over the next six months NRL staff experimented with the spacing for the interior of the columns and their continuous operation. They found that the optimum spacing declined slightly as the temperature difference went up. The columns showed no considerable corrosion. Encouraged by these findings NRL decided to build fourteen 48-foot columns; authorized in July 1942, the installation was substantially completed by November.[13] Since the Navy was focused on submarine propulsion they chose to use an enrichment method that would provide quantity over quality. In supporting the decision to pursue liquid thermal diffusion, Bowen pointed to its many advantages for production under war conditions." It was not optimal because of its high consumption of power. For NRL the next step was designing a

full scale plant.[14]

Army-Navy rivalry

By December 1942 the Laboratory had ten to fifteen columns up, running and producing accurate, usable data. On December 10 General Leslie R. Groves and other representatives of the Army's Manhattan Engineering District visited the NRL plant. Gunn: "a rather complete review was given of the Naval Research Laboratory's research interest in this project in its earliest days, and our part in the preparation of uranium hexafluoride for the original work was emphasized." NRL provided all the information it had. The Army desired detailed information on the pilot plant's performance. NRL could not supply it since the plant had been operating for only a month. NRL then learned that MED had been placed in charge of isotope production by order of the President, and that since the project was regarded primarily as a matter of construction, a civil engineer had been placed in charge. Gunn was not happy with the situation. "[N]one of these gentlemen [in Groves' group] are...familiar" with isotope separation, and would regularly require "expert advice from those actually engaged." What most irritated Gunn was the Navy's lack of representation, "the Navy is not represented on any committee except indirectly through Admiral [W.R.] Purnell, who has no direct access to technical information on the matter." An advisory committee from MED followed up Groves' visit in early 1943 and took a favorable view of NRL's work. However, the use of liquid thermal diffusion by MED was "vetoed by higher-ups and nothing was done." Groves decided that liquid thermal diffusion required too much steam. Groves rated NRL's research as "most competent" but "extremely limited," and the size and pace of the Navy project did not impress him. Finally transfer of the Navy program to MED would have major administrative and security problems.[15]

What finally kept the Navy outside the nuclear research program was an order by President Roosevelt. When Vannevar Bush, director of the Office of Scientific Research and Development (OSRD), heard that Groves intended to visit NRL, he considered it *a mistake*. Bush had recommended the creation of the OSRD (authorized in June 1941), to advise the president on scientific matters and

coordinate research at the various governmental laboratories. Bush had advised Roosevelt to exclude the Navy from nuclear research, perhaps because Bush had influence over and confidence in the War Department, especially Secretary of War Henry Stimson. Bush's dealings with the Navy had been bumpy. Bowen had criticized OSRD for supplanting the service laboratories and taking needed funding from NRL. Bush had no qualms about reciprocating. Only a few naval officers and civilian engineers joined the MED. When the Uranium Committee became the S-1 Committee of OSRD, all Navy members were dropped. "[T]he Uranium Committee which previously had guided atomic research policy was quietly put into the background and the proper degree of exchange of information between laboratories was stopped." This further isolated the Navy's work. Finally, Abelson's findings were not available until after Roosevelt set up the MED in September 1942. The Army developed a $2.5 billion project while the Navy conducted preliminary research on what was considered a secondary separation process.[16]

Still NRL was allowed to continue its research on separation to determine if thermal diffusion could be useful to the MED. A report of September 1943 stated that the NRL process was "extraordinarily attractive because of simplicity of equipment and operation" despite its drawbacks of slowness and steam consumption; and recommended that the NRL program should be included in MED "in its present state... because of its ultimate potentialities." Meeting a week later, the S-1 Committee decided that "it would be most unfortunate for the entire efforts if any further expansion of the work at the Naval Research Laboratory in this field were to result in the drawing away of personnel now being employed on other aspects of this program" NRL could continue, but on a small-scale.[17]

Naturally, Gunn was not happy at being excluded from the main research program. By 1943 MED had expended over $2,000,000, the Navy only $60,000. Gunn, "According to Dr. [E.V.] Murphree... the Naval Research Laboratory method is the furthest along in development and the best engineered of any competing separation process." It had been treated unfairly: "The production requirements set by the S-1 Committee gave their method an unusual advantage over ours." Since NRL had been involved from the beginning, Gunn felt that it was not "in the best interest of progress" to exclude the

Navy from further work. As he saw it, NRL was "a military laboratory entitled to have access to any information in the country available on this subject."[18] Admiral Alexander H. Van Keuren, who became director of NRL in 1942, was equally outraged by the Army's expenditure of "astronomical sums" while the Navy had "independently carried forward a fruitful research program" at considerably less cost. "The history of liquid thermal diffusion at this laboratory has been one of continuing improvements in results."[19]

Philadelphia plant

In January 1943 Abelson noted that "the apparatus [seemed] to be unusually dependable and capable of long time trouble free operation." Isotopes could be separated by the thermal diffusion method of isotope separation on a large scale. However, additional research had to precede a production plant. Abelson made estimates of a 100-unit plant, which could be operational by July 1, 1944. The primary objective of the suppositions plant was "to obtain a real engineering basis for the erection of a large scale installation." Between February and July 1943 NRL constructed eighteen columns, which it operated for 1,000 days. During this period NRL realized that its steam facilities could not support larger columns. They sought a new steam source. The first site examined was the Naval Experiment Station in Annapolis, MD. To obtain the necessary amount of enriched uranium for a chain reaction a 300-column plant would have to run for 270 days. To install such a facility in Annapolis would cost $2,500,000. Finding this option too expensive, NRL made a review of other naval facilities and came across the Naval Boiler and Turbine Laboratory (NBTL) at the Philadelphia Navy Yard.[20]

NRL proposed the construction of a "larger pilot plant or a small production plant" at the Philadelphia Navy Yard in June 1943 to "separate uranium isotopes by our method, with the object of providing insurance against the complete failure of the Manhattan Project." On July 24, 1943 Van Keuren, Gunn, and Abelson visited NBTL to determine if steam production and available facilities would meet their research needs. NBTL estimated that it would cost $500,000 and a support staff of 40 to modify its equipment to

provide the steam required. Eleven days later representatives of NRL and NBTL agreed that NRL's research would move to the Philadelphia facility. The site had building space, cooling water, and engineers with considerable experience in "high-pressure steam and large-scale heavy construction." Abelson stressed that the plant should run continuously, "and asked whether the two pumps on the forced circulation boiler could be arranged so that the second would be cut automatically, in case of failure of the other."

NBTL representatives informed NRL that if they wished to have the plant completed and operational by the beginning of 1944 they would need to bring in an outside contractor because of the work load at the Philadelphia Navy Yard. While NRL was aware that the project would put strain on the Philadelphia Laboratory, they were confident that it could be undertaken with "[c]arefully coordinated teamwork." Gunn requested that both the Public Works Office at the Philadelphia Navy Yard and NBTL be instructed that the project had "priority." These requests probably resulted from the NRL's growing difficulty in getting assistance from the Army. Admiral Earle Mills, assistant chief of the Bureau of Ships, signed the order on November 17, 1943 that authorized NRL to construct a 300-column pilot plant in Philadelphia, with the stipulation that they not use technical personnel possibly needed by MED.[21]

The NBTL informed the Bureau of Ships on December 1, 1943 that NRL's research work was assigned to the boiler division, given project number 2715, and the title "Reflux condensers, Naval Research Laboratory." The building NBTL made available had been designed to test turbines. Using half of the building, the site housed three racks as well as the necessary steam-generating equipment. The space just allowed for a distance of 56 ft between the pit floor and the roof truss, the minimum needed for the columns. On December 22, Van Keuren contacted Admiral Allan J. Chantry, commandant of the Philadelphia Navy Yard, to request that he assist NBTL as frequently as possible. "[W]ithout knowing too much of the progress which our enemies are making along similar lines, we feel here at the Laboratory that they may be ahead of us, and therefore in a position to spring unpleasant surprises on allied countries before we are ready to retaliate." Construction on the Philadelphia plant began on January 1, 1944: "[T]he cooperation of the Administration Officers

and employees of the Naval Boiler and Turbine Laboratory has been excellent and they are doing everything they can to expedite this project in the face of a serious skilled labor shortage."[22] In May 1944, Abelson wrote that progress in Philadelphia was "moving along satisfactorily," even though finding the necessary manpower was difficult. He expressed that the 100-column machine would be completed by July 15. Although the plant could then be increased to 300 columns, NRL was "not particularly anxious to take on a routine production job." They did not want to stop experiments on improving performance.[23]

Hindered access

MED hindered NRL's access to information and materials. By the beginning of 1942 NRL no longer received information from the S-1 Committee. The Navy could not proceed further without information from the Army. Gunn would not spend money on duplicate research. Abelson also complained about the lack of exchange of technical information. Van Keueren joined in: "[t]he scientific mind works best when it has all the information available on a subject, and the whole problem is of such extreme importance to the Navy that every means should, in my opinion, be adopted to forward it." NRL and MED had no contact between September 1942 and April 1943.[24]

MED blocked or hindered NRL's acquisition of material. In January 1943 NRL was informed that it would have to go through the Army to obtain supplies of UF6. The S-1 Committee decided that around Labor Day 1943 NRL would not receive new supplies of uranium hexafluoride, even though it asked NRL to exchange enriched material for normal UF6. When NRL requested supplies of UF6 in October, Groves refused, "for an indefinite period." NRL protested that Abelson had developed the method of producing uranium hexafluoride, and that it had freely shared the information. The Army reluctantly supplied the material. Then, all information exchange between the two projects stopped again. In November MED ordered the War Production Board to withhold UF6 supplies from NRL. Gunn: "it took months of strenuous effort, in the midst of war, to get this sordid and incredible political action reversed."

The Army controlled the nation's entire raw uranium supply and

hence the commercial production of uranium hexafluoride. Abelson learned from Richard Lund at the Rare Minerals Division of the War Productions Board that the monopolists had told him not to give NRL additional uranium. Gunn naturally regarded the order as "unwarranted, unjustified and manifestly an attempt to override the best interests of the Navy in this work." He did not see how his request for a mere 2,000 pounds could effect or jeopardize the Army's project. He mobilized his superiors. Van Keuren contacted Groves at the request of Mills. He reminded Groves that the S-1 Committee had decided that NRL should continue its research "on a small scale...as an insurance against the failure of the isotope separation project...[T]his material is essential for the completion of the present phase of the Navy's work on isotope separation."[25]

After excluding the Navy from the main program, the Army decided to use the electromagnetic and gaseous diffusion processes for isotope separation. As the Philadelphia plant neared completion in Spring 1944, MED had only its electromagnetic plant in operation and so began looking at other separation methods it had discarded earlier. J. Robert Oppenheimer took an interest in liquid thermal diffusion after reviewing two year-old reports on Abelson's works and updates from Captain William S. Parsons, who had made inquiries about the Philadelphia plant and calculated that the steam power available at the Philadelphia Navy Yard could run one three times as large. Oppenheimer considered using enriched uranium as a feed for the other processing plants to speed up production: Groves did not favor the Army's using the Navy's process. A review committee composed of MED scientists and others went to Philadelphia in mid-June 1944 and recommended the construction of a liquid thermal diffusion plant at Oak Ridge. On June 26 Groves and some advisors including the physicist Richard Tolman went to NRL to obtain the blueprints for the Philadelphia plant. The Army broke ground on July 6 for its plant, labeled S-50 and had the first columns ready by September 15.[26]

Philadelphia accident

The Army lacked trained personnel to build and operate the S-50. Groves sent four civilians and ten Army enlisted men to the Philadelphia Navy Yard for training in August 1944. The Army

personnel were drafted engineering graduates given the rank of private first class.[27] A week after arriving in Philadelphia on September 2, they were involved in the plant's only accident. At 1:20 p.m. a cylinder of UF6 in the transfer room exploded, fracturing nearby steam pipes. Samuel B. Weir, superintendent of power transmission at NBTL, witnessed the accident, which occurred as Weir's team tried to improve the valves between the uranium hexafluoride and the pilot plant. A bottle containing 600 pounds of UF6 overheated and exploded. "The bottom blew off the bottle, and the gases escaped like a jet, sending the bottle crashing through the wall of the building." The mixture of UF6 and steam created hydrogen fluoride, a very caustic acid.

It caused violent sickness. The men made for showers that had been set up outside. The injured were taken to the Philadelphia Naval Hospital; thirteen men hd been hurt and two of them died. Although NRL worried about security leaks, the incident went unnoticed, blending into the regular industrial accidents that occurred at the Navy Yard during the war. What set the explosion apart was that the casualties included Army enlisted personnel. The headline in the Philadelphia Evening Bulletin read, "2 Killed, 9 Hurt by Blast that Blows Out Side of Navy Yard Building." The article gave a list of the dead and wounded, and noted that five soldiers were among the casualties. The article gave no cause for the accident. The entry in the Yard's log book read, "[t]he weld of a steel high pressure gas flask carried away a small building south of Building No. 683. The force of the escaping gas injured a number of men working in the vicinity, some seriously, and damaged the side of the frame building in which stored." The Beacon, the Philadelphia Navy Yard's newspaper did not mention the incident.[28]

The accident halted the training of army personnel in Philadelphia. All of the Army trainees and fifteen men from NRL under Abelson went to Oak Ridge, "where preliminary conditioning of equipment began on 10 September." Then a thorough investigation into the accident assigned its cause to the design of the tanks and the lack of cooperation from MED. In a meeting between NRL and the Army, "[i]t was pointed out that the Navy had attempted to secure seamless nickel tubes, but because the Army had preempted all facilities for the production of nickel materials we could not get

them." To compensate, NRL had built the new tanks of "a thin nickel inner-liner carefully gas-welded and free of leaks, which fits very closely in a very strong alloy steel container." Gunn asked how the Army had reached it conclusions. An Army representative replied that "he had been specifically ordered not to disclose the basis of his calculations." This did not sit well with Gunn. He concluded this memo on the meeting: "[B]ecause we cannot check nor understand the details of the estimates we are forced to assume that the Army group's calculations are infallible, an assumption which I am not ready to make. To my mind this leaves the Laboratory in a very bad position and our only defense in an event of a real serious accident would be the statement that the Army had given the Navy certain assurances. In view of the circumstances I consider it essential that the Naval High Command make further representation to the Army authorities for this project."

Repairs were quickly made to the Philadelphia plant. Its work was critical to the development of the atomic bomb. Besides providing a guide for the construction of the larger plant at Oak Ridge, it produced enriched uranium. Over 5,000 pounds were turned over to MED to feed the electromagnetic isotope separator, which contributed to the construction of the first nuclear bombs. According to Gunn, "the national production of uranium for the atomic bomb was increased by 20% through the erection of the Oak Ridge Plant." Thus NRL's expenditure of $2,000,000 was critical to the timely production of the atomic bomb. "[W]e were credited with shortening the war by a week or more, in spite of the delaying tactics and fumbling politics imposed on us by some members of the Manhattan Project." In testimony before the Senate, Gunn said, "we think that by means of our very early work we have shortened the time it took to produce the critically required material. If we had not worked on the thing at the start and early supported these university people we think perhaps the national production might have been delayed."[29]

The Philadelphia plant continued to operate after the S-50 plant was shut down. A memo from NRL to NBTL specified that upon completion of the current work, "the project be temporarily closed and no further work carried out." The personnel there were to maintain the plant to allow it to resume operation within thirty days

of notice. However, it was not to be dismantled "until a more definite policy on a high level is promulgated." NRL personnel went back to Washington, and their former work place began a training ground in the proper use of radiation detection instruments in preparation for Operation Crossroads. In September 1946 it was decided to dispose of the Philadelphia plant. Following a telephone conference with Groves, Mills informed the Commander of the Philadelphia Naval Shipyard that the NRL plant was considered "surplus to the needs of the Manhattan District." "[T]he Commander Philadelphia Naval Shipyard is therefore authorized to proceed with the removal of subject facilities from the Naval Boiler & Turbine Laboratory and to dispose of the removed facilities," either by declaring useful parts surplus, by returning them to the NRL, or by having them "jettisoned at sea."[30]

2. POSTWAR EFFORTS

Restarting the program

With the end of World War II, NRL scientists were eager to continue with their research into nuclear propulsion. However, as a result of the security restrictions placed on nuclear work, NRL still could not get information about Manhattan research. Bowen felt that if the Navy was to pursue the creation of nuclear propulsion, it needed to control all the related activities. The Navy would have to create its own capabilities in both basic nuclear science and propulsion. In his plea for the Navy's re-entry into nuclear research, Gunn noted that submarine propulsion was at the top of the list for the Navy's prime interest. Despite the security blackout, Gunn was able to organize a symposium at NRL on November 19, 1945 for submarine leaders to discuss the facts of nuclear propulsion. The interest generated by this symposium eventually lead to a report prepared by Abelson, R.E. Ruskin, and C.J. Raseman, issued on March 28, 1946, which predicted that "only about two years would be required to put into operation an atomic-powered submarine mechanically capable of operating at 26 to 30 knots submerged for many years without surfacing or refueling."[31] A submarine that could operate at twice that submerged speed could be developed in five to ten years. The report predicted a ballistic missile nuclear submarine, an ideal platform for operations in a nuclear war.

Abelson did not hesitate to point out that the Navy's work on submarine propulsion had been deferred first to conduct the preliminary work on isotope separation, and then to assist in completing the atomic bomb. The lack of cooperation between NRL and MED made an additional cause of delay. The report stated that NRL needed adequate support from the Navy, the President, and the Manhattan District, and hoped that "the present cooperation between the Manhattan District and the Navy is expanded somewhat to permit greater emphasis on the Naval participation in design and construction of a Uranium pile of proper characteristics for this application."[32]

To gain access to atomic information and obtain permission to start a nuclear power program, Bowen and Parsons drafted a letter to Secretary of War Robert Patterson for Secretary of the Navy James Forrestal to sign. Dated March 14, 1946, the letter sought to obtain Army cooperation to overcome restrictions on atomic energy. "One of the first justifiable and practicable uses of atomic energy for power will be in the propulsion of naval vessels." Toward that end, Bowen and Parsons hoped for an "interim arrangement" to allow the Navy to proceed with its work until the Atomic Energy Act was passed, "[t]he Navy feels that it must, as soon as possible, assume responsibility for a program leading to the powering of its ships by atomic energy."[33] Colonel C. H. Bonesteel, Chief, Strategic Policy Section, Operations Division, forwarded Forrestal's letter to Groves for comment.

Bonesteel advised that the armed forces consider whether the development of atomic energy for the purpose envisioned by Forrestal should result from civilian applications. "[T]his application will cover the whole field of modern industrial effort as well as merchant shipping and raises the grave question as to whether the military should attempt to monopolize or even lead in such a field." Groves replied that the military should continue the development of atomic energy, since commercial development was more likely to be influenced and delayed by economic considerations: "the Armed Services must take the lead in the development of atomic energy for power purposes in military equipment, including ships." Patterson's reply to Forrestal agreed with Grove's comments regarding the role of the armed services and the potential for delay by the commercial

sector. Patterson wrote that before atomic energy could be applied to power purposes, new experimental piles were needed. He suggested that Navy personnel working on these piles develop the knowledge the Navy wanted. "[T]he best and most rapid method for initiation of a strong Navy program on atomic power is to assign personnel to work in organizations now engaged on this new pile work under the Manhattan District." Forrestal accepted Patterson's offer, even though it did not give the Navy its own nuclear propulsion program until 1948 when the Bureau of Ships formed the Nuclear Power Branch under Rickover.[34]

NRL recognition

After the publication in 1954 of an article about Rickover and the development of the atomic submarine, Gunn wrote to Bowen that he was *surprised* that the authors "gave credit for a conception and early work on the atomic submarine to Admiral Rickover." He later lamented to Bowen that he did not expect that NRL's wartime work would ever be properly recognized. "[Y]our attempt to get some recognition for the war work at NRL on submarine propulsion is most encouraging even though I have long since given up much hope." He regretted that he had not obtained title to some of the patents he applied for during the war. After the war Gunn learned that his patents were never filed, and that the one for the isotope separation method he and Abelson had developed had been given to "some German." "Never trust the Government."[35] Gunn expressed and Abelson both recognized that Bowen's initial support had allowed them to 'advance the program by many, many months." They could have had a power reactor in operation by 1946 or 1947, if it had not been "for our political friends."[36]

Exactly how much NRL research advanced the production of the atomic bomb is a matter of speculation. According to Abelson's historical summary of 1946, officials from MED stated that the construction of S-50, "which was direct outgrowth of the work at [the Naval Research] Laboratory, shortened the war by at least 8 days." Cochran estimated that "as a result of the early, foresighted, and vigorous support of the Navy at the very beginning of the Uranium Research Program, the whole program was advanced some six to twelve months." Briggs said that Bowen's initial funding in

1939 proved critical in the development of the atomic bomb. "[I]f it [had] not been for your generous cooperation and foresight in making funds available at a critical time, the work on the atomic bomb would have been set back at least six months." Bowen wrote in 1957 to Captain F. H. Horn, Director of NRL, that he and Gunn debated how much MED was *advanced* by the adoption of the liquid thermal diffusion method. "I claimed two years. Gunn conceded one year. When one considers the large amount of time and energy expended over several years to perfect this process to a point of large scale production, I think Gunn's estimate of one year is conservative."[37]

Ross Gunn's views

Gunn was proud of his performance, especially in terms of cost. He wrote "with some pride that the entire program of research carried out...cost the taxpayer less than $2,000,000, or less than one-thousandth of the cost of the Manhattan District program."[38] He blamed the Army's dog-in-the-manger control of the nuclear research program for preventing NRL from producing a nuclear submarine sooner. He saw the flow of information between the NRL and MED as one way. In 1945 he noted that although the Navy was represented in the beginning of atomic energy research, it had not had "access to the technical developments of the Army since the middle of 1941." The close relationship between the Army and the Uranium Committee had "jeopardized the Navy's interest in the work" and put NRL "years behind in knowledge and details of operation of atomic power plants." All Gunn knew about MED was that it must have been large because he could not get additional personnel. And also that it "missed no opportunity to scuttle the NRL program and no useful assistance was ever obtained from them," an action that "prolonged the war by many months."[39] MED only renewed its interest in the NRL's work when confronted by possible failure. "[F]aced with the successful production of enriched material by our process, and the spectre of possible failure of their own two-billion-dollar program, General Groves suddenly became interested and requested that the detailed plans for the Philadelphia plant be turned over to the District." In his autobiography, Bowen concurs: "[t]he isolation of the Navy from the main program and the

political chicanery that even the Secretary of the Navy could not correct were indefensible in time of war and delayed the arrival of the atomic bomb by many months."[40]

Writing to Bowen in 1954, Gunn accused "the Bush-Conant-Oppenheimer team with their fellow travelers [of putting] the U.S. Navy and its work behind the eight-ball." Groves and Oppenheimer had ignored the Navy's work in order to promote their own programs, "a sad commentary on what happens when you mix a stupid general and a submissive scientist." Overall, Gunn believed that the separation of the Navy's work from the Army's "had its roots in partisan Presidential politics." "Roosevelt had no business appointing an independent political group to be responsible for atomic energy when there was already established, under forward-looking Navy management, a team and program designed not only to produce a bomb, but who were dedicated to its long range utilization as a military tool and implement of public welfare... I think we had the hose turned on us!"[41]

No doubt Ross Gunn and the Naval Research Laboratory made significant contributions to nuclear research in the United States. But the main reason that the Army sidetracked NRL's work was not politics or incompetence. The Army aimed at a bomb, the Navy at nuclear propulsion. From the beginning of Gunn's work a nuclear powered submarine was the primary goal. The Navy did not begin to view NRL's work as contributing to a weapon until 1943. The Army, believing itself to be in a race to produce an atomic bomb before the Germans, did not want the NRL to siphon off personnel and material they needed. After the war, Grove blocked the Navy by his unwillingness to release information without higher authority. His action delayed the Navy's nuclear reactor program until 1947. Once the Navy did begin work on a nuclear powered submarine, Rickover built a base that allowed him to control the Navy's nuclear program for over thirty years. His ability to get NAUTILUS and other boats in the water overshadowed the early efforts of Gunn and NRL, which sank in the wake of the two major military history events of the nuclear age—the atomic bomb and NAUTILUS.

ENDNOTES

1. Gary E. Weir, *Forged in war: the naval-industrial complex and American submarine construction, 1940-1961* (Washington, D.C., 1993), 158.
2. Philip Abelson "Ross Gunn," *Biographical memoirs, 74*, National Academy of

Sciences (Washington, D.C., 1998), 100-125, on 123.

3. Ernest Andrade, Jr., "Submarine policy in the United States Navy, 1919-1941," *Military affair, 35* (1971), 50-56, on 50; Norman Polmar, *Rickover* (New York, 1981), 117; SCOA, 364-365, 367; Ross Gunn, "Notes prepared for the Senate, 13 December 1945," p. 1, Navy's role in development of atomic energy, OA NHC.

4. SCOA, 364-365; Ross Gunn, "The early history of the atomic powered submarine at the U.S. Naval Research Laboratory March 1939 to March 1946," revised 1959 (unpublished msc., 7 p., Gunn biographical file, NBL AIP, 1-2).

5. Admiral Stanford Hooper had learned about the potential of nuclear energy in 1937 from Henry Andrews, a physicist at Johns Hopkins University. Laura Fermi, *Atoms in the family: My life with Enrico Fermi* (Chicago, 1954), 162-163; Arthur H. Compton, *Atomic quest: A personal narrative* (New York, 1956), 25-26; Vincent C. Jones, *Manhattan: The army and the atomic bomb* (Washington, D.C., 1985), 12; William Lawren, *The general and the bomb: A biography of General Leslie R. Groves, Director of the Manhattan Project* (New York, 1988), 11; Pierre de Latil, *Enrico Fermi: The man and his theories* (London, 1965), 98-99.

6. Gunn had to request funds from Admiral Harold Bowen since the Bureau of Engineering controlled funding for NRL. Philip Abelson, "Early history of uranium power for submarines," Naval Research Laboratory (Washington, D.C., 1 May 1946), 1; Lewis L. Strauss, *Men and decisions* (New York, 1962), 236; Memorandum for File, 17 Mar 1939 [Box 1/Folder 1] S-1 Files, Naval Research Laboratory Correspondence, 1939-1946, Records of the Office of Scientific Research and Development, RG 227, NACP; Fermi (ref. 5), 163; Richard G. Hewlett and Oscar E. Anderson, Jr., *The new world, 1939-1946* (University Park, PA, 1962), 15; Richard G. Hewlett and Francis Duncan, *Nuclear Navy, 1946-1962* (Chicago, 1974), 16-17; Gunn (ref. 4), 2; Ivan Amato, *Pushing the horizon: Seventy-five years of high stakes science and technology at the Naval Research Laboratory* (Washington, D.C., 1998), 140-142; "World War II nuclear research at NRL," 1958, p. 1, General Correspondence, BP LOC.

7. Harold G. Bowen, *Ships machinery and mossbacks: The autobiography of a naval engineer* (Princeton, 1954), 182-183; Abelson (ref. 6), 2; Ross Gunn to Director, NRL, 1 June 1939, Submarine submerged propulsion—uranium power source—Status as of this date, Gunn, Biographical File, NBL AIP; SCOA, 366, 371; Weir (ref. 1), 155.

8. Gunn (ref. 4), 4; Abelson (ref. 6), 1; J.B. Cochran, "History of uranium project at the Naval Research Laboratory," (Washington, D.C., 9 Aug 1945), 1; Director NRL, "Uranium Project, memorandum of progress 1940-1941," 8 Apr 1942, Bureau of Ships, RG 19, NACP; Bowen (ref. 7), 183-184; Ross Gunn to George Pegram, 27 Nov 1939, Gunn to Jessie Beams 27 Nov 1939, Pegram to Gunn, 9 Dec 1939, Gunn to Pegram, 19 Dec 1939, Gunn to Pegram, 10 Jan 1940 [Box 1/Folder 1], S-1 Files, RG 227, NACP.

9. Philip H. Abelson, "An exciting era in nuclear physics" (talk presented at the Washington Academy of Sciences, 15 Mar 1951), 7-8, Archives of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C.; R.P. Briscoe to Lyman J. Briggs, 9 Jul 1941 [Box 1/Folder 2] S-1 Files, RG 227, NACP.

10. The Uranium Committee, established in Oct 1939 by presidential order and

headed by Lyman J. Briggs, director of the National Bureau of Standards, was charged with determining the state of uranium research in the United States and the potential role of the government. Gunn to Briggs, 17 and 27 Oct 1941, Briscoe to W.J. Harshaw, 27 Nov 1941, Gunn to Harshaw, 10 Dec 1941 [Box 1/Folder 3] S-1 Files, RG 227, NACP; Gunn to Briggs, 3 Dec 1941 [Box 4/Folder Ross Gunn] Briggs Alphabetical Files, S-1 Files, Records of the Office of Scientific Research and Development, RG 227, NACP.

11. Gunn (ref. 4), 3; Hewlett and Anderson (ref. 6), 22-23; Philip Abelson, "Progress report on liquid thermal diffusion research" (Naval Research Laboratory, Washington, D.C., 3 Jan 1943), 1; Bowen (ref. 7), 184; SCOA, 367; Director NRL (ref. 8).

12. Briggs to Bowen, 10 Sep 1940 [Box 7/Folder NRL] Briggs Files, RG 227, NACP; Abelson (ref. 9), 4, 6-7, 8; Richard Rhodes, *The making of the atomic bomb* (New York, 1986), 550; R.E. Ruskin, "Separation of isotopes," Sep 1947, 2; Henry DeWolf Smyth, *Atomic energy for military purposes: The official report on the development of the atomic bomb under the auspices of the United States Government, 1940-1945* (Princeton, 1945), 68, 161-162; SCOA, 367, 371; Abelson (ref. 11), 2, 3; Amato (ref. 6), 144; Bowen (ref. 7); Gunn (ref. 4) 2-3; Weir (ref. 1), 156.

13. Abelson (ref. 11), 4-5; Philip Abelson, *Liquid thermal diffusion* (Washington, D.C., 1946), 23; Notes on statements by Abelson and Gunn, Naval Research Laboratory, 9 Nov 1944, Series I, Henry DeWolf Smyth Papers, APS; Jones (ref. 5), 173.

14. Philip J. Abelson memorandum for Director and files, "Present status of uranium problem—centrifugal separation of isotopes," 14 Jul 1942 [Box 1/Folder 4]; Harold G. Bowen to Briggs, 2 Sep 1942 [Box 2/Folder 5] S-1 Files, RG 227, NACP; Rhodes (ref. 12), 551; Jones (ref. 5), 172-173; Abelson (ref. 11), 20-21.

15. Abelson (ref. 6), 3; SCOA, 368; Gunn, Memorandum for file, "Production of separated isotope 235," 10 Dec 1942 [Box 2/Folder 5], S-1 Files, RG 227, NACP; The recommendation for the Lewis Group to visit NRL was made by Briggs on 9 Dec, Hewlett and Anderson (ref. 6), 169170; Gunn to Bowen, 9 Apr 1952, Bowen Papers, Mudd; Leslie R. Groves, *Now it can be told: The story of the Manhattan Project* (New York, 1962), 119; Jones (ref. 5), 172, 174. The follow-up committee in January 1943 consisted of Briggs, Urey, E.V. Murphree, Karl Cohen, and W.I. Thompson; Abelson (ref. 13), 23.

16. Robert William Love, *History of the U.S. Navy* (2 vols, Harrisburg, PA, 1992), *1*, 271; Groves (ref. 15), 22-23; Statement of the Secretary of War [Box 80, "Nuclear physics' folder], Records of the Office of Naval Research, RG 298, NACP; G. Pascal Zachary, *Endless frontier: Vannevar Bush, Engineer of the American century* (New York, 1997), 119-128; Hewlett and Anderson (ref. 6), 20; Hewlett and Duncan (ref. 6), 15, 18, 20; Cochran (ref. 8), 2; Weir (ref. 1), 156.'

17. Leslie R. Groves to W.R. Purnell, 27 Feb 1943 [Box 2/Folder 5] S-1 Files, RG 227, NACP; Stephane Groueff, *Manhattan Project: The untold story fo the making of the atomic bomb* (London, 1967), 338, 340; Briggs, Urey, Murphree and Lewis to James B. Conant, 8 Sep 1943, and Conant to Purnell, 15 Sep 1943 [Box 2/Folder 8] S-1 Files, RG 227, NACP; Jones (ref. 5), 175.

18. Amato (ref. 6), 146; Gunn, Memorandum for Director, NRL, "The uranium

problem and the utilization of uranium fission by the Navy" [Box 2/Folder 5], S-1 Files, RG 227, NACP.

19. Director of NRL to Chief of the Bureau of Ships, "The uranium problem and the utilization or uranium fission by the Navy. Review of present status," 15 June 1943 [Box 2/Folder 6], S-1 Files, RG 227, NACP.

20. Abelson (ref. 11), Abstract, 21; Abelson, "Memorandum for the Director, NRL," 4 Jan 1943 [Box 2/Folder 5], Director NRL to Chief of Bureau of Ships (ref. 19); Philip Abelson, "Fourth partial report on liquid thermal diffusion research" (Naval Research Laboratory Washington, D.C., 30 Jul 1943), 1, 3.

21. The design work for the Philadelphia plant, conducted between June and October 1943, was based on the 14-column plant at NRL. The main goal was to construct a unit that could be expanded to a production plant. After a conference in Philadelphia on 20 Oct 1943 it was tentatively decided that a 100-column pilot plant would be installed and operated utilizing steam from the boilers originally intended for Annapolis, NBTL estimated that the facility could be up and running by 1 Apr 1944. Abelson (ref. 13), 60, 62; C.A. Bonavillian to Director, Naval Research Laboratory, "Proposed chemical reflux installation at the Naval Boiler and Turbine Laboratory," 7 Aug 1943, S-1 Files, RG 227, NACP; Memorandum for file: "Reflux heat exchanger test," 21 Oct 1943 [Box 2/Folder 9], Gunn, Memorandum for the files, "Uranium problem—Steam and facilities at Naval Boiler and Turbine Testing Laboratory, Navy Yard, Philadelphia," 24 Jul 1943, "Minutes of meeting between representatives of the NRL and NBTL," 4 Aug 1943, [Box 2/Folder 7], S-1 Files, RG 227, NACP; Abelson (ref. 6), 3-4; Jeffery M. Dorwart, *The Philadelphia Navy yard: From the birth of the U.S. Navy to the nuclear age* (Philadelphia, 2001), 188; Director NRL to the Chief of the Bureau of Ships, "Uranium Project, Transfer of, To Naval Boiler Laboratory, Navy Yard, Philadelphia, Pa.," 10 Aug 1943 [Box 2/Folder 7]; Gunn to Director NRL, "Erection of isotope separation pilot plant at the Naval Boiler and Turbine Laboratory, Philadelphia, Pa.," 3 Nov 1943 [Box 2/Folder 9], S-1 Files, RG 227, NACP; Abelson (ref. 13), 24-25; Weir (ref. 1), 156.

22. Memo, "Test authorized at Naval Boiler and Turbine Laboratory during the month of November, 1943—Assignment of numbers to" (1 Dec 1943), RG 19, NACP; Abelson (ref. 13), 62; Van Keuren to RADM. Allan J. Chantry, 22 Dec 1943 [Box 2/Folder 9], Gunn to Earle Mills, 16 Feb 1944 [Box 3/Folder 10], S-1 Files, RG 227, NACP; Notes on statements by Abelson and Gunn, Naval Research Laboratory, 9 Nov 1944, Smyth Papers, APS.

23. Abelson to Gunn, 9 May 1944 [Box 3/Folder 10], S-1 Files, RG 227, NACP.

24. Hewlett and Anderson (ref. 6) 169, 171; SCOA, 374; Abelson (ref. 11), 20-21; Van Keuren to Purnell, 11 Feb 1943 [Box 2/Folder 5], S-1 Files, RG 227, NACP; Jones (ref. 5), 175; Weir (ref. 1), 156-157.

25. H.W. Elley to R.W. Dole, 14 Jan 1943 [Box 2/Folder 5]; Gunn to Mills, "Raw materials for isotope separation plant," 3 Nov 1943; Van Keuren to Groves, 10 Nov 1943 [Box 2 Folder 9], S-1 Files, RG 227, NACP; Gunn (ref. 4), 4.

26. Groves (ref. 15), 94, 120-121; Abelson (ref. 13), 25; Hewlett and Anderson (ref. 6), 168, 172. Groves selected the H.K. Ferguson Co. To be the prime contractor for the Manhattan Project's liquid thermal diffusion thermal diffusion plant, the Philadelphia Plant would not be under Army control and the Manhattan

Project plant could be built quicker if not distracted by operation at the Navy's plant. Jones (ref. 5), 175-179; Smyth (ref. 12), 202-204.

27. Groves (ref. 15), 122-123; Hewlett and Anderson (ref. 6), 297; Karl Abraham, "Navy Yard has its own atom secret," Atomic Activity File, Box 173 A, Philadelphia Navy Yard mounted clippings, *Philadelphia Evening Bulletin* newspaper Clipping Collection, Urban Archives, Temple University, Philadelphia, PA; Jones (ref. 5), 179.

28. Dorwart (ref. 21), 187-188; Accidents File, Box 1732A (ref. 27); Abraham (ref. 27); Log Book, Philadelphia Navy Yard, Records of Naval Districts and Shore Establishments, 2 Sep-1 Oct 1944, RG 181, NAMA.

29. Notes on statements by Abelson and Gunn, Naval Research Laboratory, 9 Nov 1944, Smyth Papers, APS; Gunn (ref. 4) 5; Abraham (ref. 27); Gunn to Chief, Office of Research and Inventions, "Review of the Navy's part in the utilization of atomic energy and necessity for re-evaluation of its bearing on Naval problems," 21 Aug 1945, Draft, Bowen Papers, Mudd, SCOA 368.

30. Memo to Director, NRL, "Naval Research Laboratory Project at U.S. Naval Boiler and Turbine Laboratory, Philadelphia—Future Work on," 13 Dec 1945, RG 19, NACP; Philip Abelson et al., "Atomic energy submarine" (Naval Research Laboratory, Washington, D.C., 28 Mar 1946), cover memo; Groves (ref. 15), 385; Mills to Commander PNSY, "Reflux Plant—Disposition of," 5 Nov 1946, Box 74, Folder 600.12, Records of Office of the Commanding General, Manhattan Project, General Administration Files, General Correspondence, Manhattan Engineering District, Records of the Office of the Chief of Engineers, RG 77, NACP.

31. Carol O. Holmquist and Russell S. Greenbaum, "The development of nuclear propulsion in the Navy," United States Naval Institute, *Proceedings, 86* (Sep 1960), 65-71, on 67; Hewlett and Duncan (ref. 6), 25; Gunn to Chief, Office of Research and Inventions; "Review of the Navy's part in...," 21 Aug 1945, Draft, Bowen Papers, Mudd; Gunn (ref. 4), 6. 32. Abelson et al. (Ref. 30), 1, 5.

33. Holmquist (ref. 31), 68; Forrestal to Secretary of War, 16 Mar 1946 (Box 67/Folder 400.73), RG 77, NACP.

34. Col. C.H. Bonesteel III to L.R. Groves, 19 Mar 1946, "Use of atomic power for the propulsion of Naval vessels," and reply, 27 Mar 1946, Secretary of War to Secretary of Navy, 2 Apr 1946 (Box 67, Folder 400.73), RG 77, NACP; Polmar (ref. 3), 124-125.

35. Gunn to Bowen, 28 Sep 1954, Gunn to Bowen 18 Oct 1958, General Correspondence, BP LOC.

36. Gunn to Bowen, 15 Nov 1958, General Correspondence, BP LOC.

37. Abelson (ref. 6), 4; Cochran (ref. 8), 4; Briggs to Bowen, 10 Jan 1956, General Correspondence, BP LOC; Bowen to F.H. Horn, 5 Mar 1957 Atomic Energy, OA NHC.

38. Gunn (Ref. 4), 6-7.

39. Gunn, "Review" (ref. 31); Gunn (ref. 4), 4-5.

40. Gunn to Bowen, 9 Apr 1952, Bowen Papers, Mudd; Gunn (ref. 4) 5; Bowen (ref. 7), 189.

41. Gunn to Bowen, 29 Sep 1954, General Correspondence, BP LOC.

REGISTER NOW!

June 17 - 19, 2008 | Virginia Beach Convention Center, Virginia

Joint WARFIGHTING 08

DoD Capabilities for the 21st Century:
Dominant – Relevant – Ready?"

Co-sponsored by AFCEA International and the U.S. Naval Institute, in coordination with the U.S. Joint Forces Command and with the support e NDIA Greater Hampton Roads ter and the AFCEA Hampton Roads Tidewater Chapters.

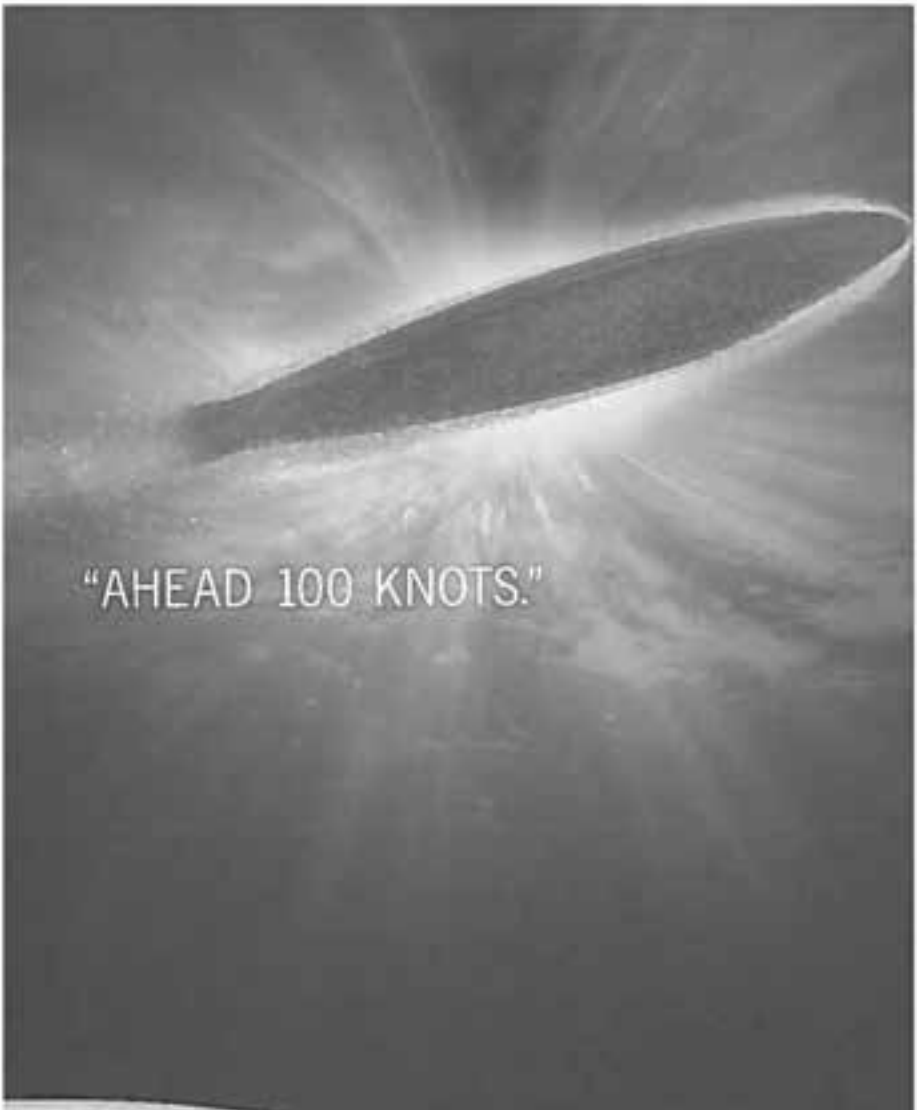
NDIA

s for the second annual Joint Warfighting erly East/Transformation Warfare) rence and exposition at the Virginia Convention Center. This event offers an Coast companion to the popular AFCEA West conference held each year for the 8 years in San Diego, CA. It will provide mier venue for engaging the military sionals and industry leaders who are ng the nation's military strategies and ghting platforms.

Featured Speakers Include:

- Gen James E. Cartwright, USMC (invited) Vice Chairman of the Joint Chiefs of Staff
- Gen John D. W. Corley, USAF (confirmed) Commander, Air Combat Command
- The Honorable Robert M. Gates (invited) Secretary of Defense
- Gen James N. Mattis, USMC (confirmed) Commander, U.S. Joint Forces Command and Supreme Allied Commander for Transformation
- ADM James G. Stavridis, USN (confirmed) Commander, U.S. Southern Command
- LTG David P. Valcourt, USA (confirmed) Deputy Commanding General and Chief of Staff, U.S. Army Training and Doctrine Command
- LTG John R. Wood, USA (confirmed) Deputy Commander, U.S. Joint Forces Command

FREE REGISTRATION! www.jointwarfighting.org



Where do you turn when you need to rewrite the rules of undersea warfare? The Defense Advanced Research Projects Agency came to Electric Boat. We're a driving force in DARPA's Underwater Express program to bring unprecedented speed to the underwater battle space. For more about our focus on innovation, visit gdeb.com.

GENERAL DYNAMICS
Electric Boat
Changing the way the world thinks about submarines

ORIGINS OF THE NATIONAL RESEARCH COUNCIL (NRC): A PRESENCE IN 20TH CENTURY NAVY MATTERS

by Mr. John Merrill

Mr. Merrill is a frequent contributor to THE SUBMARINE REVIEW and is a published author of several books on the history of undersea technology. He is a retired engineer with lengthy experience at the New London Lab of the Naval Undersea Warfare Center. He currently lives in Waterford, CT.

"...it is impossible to distinguish sharply between science as needed for national defense and science as the basis of industrial progress." --George Ellery Hale[1]

Introduction

The 92-year history of the NRC chartered by President Wilson in July 1916 reveals an early association with Navy antisubmarine warfare during World War I (WWI) and a continuing and gradually-expanding relationship with the Navy in the 20th Century and beyond. Initially, the Council was created to address immediate serious national preparedness problems related to the increased need for scientific and technical services presented by the ongoing World War. This need was due to the rapid growth of physical science and technology starting in the last half of the 19th Century and continuing.

In late September 1916, attention to Navy matters in a newly-formed NRC Military Committee was assured with committee membership including Admiral William S. Benson, Chief of Navy Operations (CNO), and four rear admirals in charge of areas such as ordnance, construction, and engineering.[2] During the 1916-1918 phase of the Council, aiding the government in pursuit of the war was the primary focus.

It should not be interpreted that the coming together of civilian scientists and the military was a perfect arrangement. The arrange-

ment provided progress but not without awkward instances of controversy. Vannevar Bush and James Conant, involved in military research in WWI, had a firsthand view of how an American war effort could be hampered by bureaucratic inefficiency and inadequate communication and partnership between scientific institutions and the government.[3] Interaction between scientists, engineers, and government personnel also does not foster calm relationships even when pursuing common goals. During the 20th Century, these relationships improved but slowly. WWI joint efforts witnessed occasional difficult situations.

As the 20th Century ended, the NRC was involved in and responding to a broad number of national science and technology areas including matters of interest and need for the United States Navy. At present, NRC consists of approximately 1,000 committees and a membership of just under 10,000.[4]

The Council's scientific interests in the 21st Century are enormous and broad. The NRC became a reality due to the foresight, energy and skills of George Ellery Hale, an accomplished scientist and member of the National Academy of Sciences (NAS).*

Shortly after the start of WWI in August 1914, it became clear that certain imports essential to industry and the military would not be available. Some of the problems were in the domain of the physicist, chemist, meteorologist, and as well as in other areas of science. Wartime science and technological innovations including the successful German submarines provided questions and challenges. In some instances, answers were beyond the military's knowledge.

Examples of shortages included optical glass for gun sights, range finders, and periscopes. Chemicals needed for high explosives and gas warfare also developed and sourced from Germany were not accessible. Addressing these problem areas was of immediate interest to the newly-formed Council. Attention in this paper is directed to the Council and the submarine detection problem.

*Today, a consortium that includes the National Academy of Sciences (1863), the National Research Council (1916), National Academy of Engineering (1964) and the Institute of Medicine (1970) are collectively known as the National Academies, "Advisors to the Nation" on scientific issues.

The May 7,1915 sinking of the Cunard ocean liner LUSITANIA with extensive loss of life became a tipping point in the long-held neutrality of the nation. This event and other aspects of the war and how it was proceeding caused Hale to raise questions about a need to bring those engaged in science and engineering from industry, academia, government, and the military together in the likelihood of United States becoming involved in the ongoing World War. An important aspect of Hale's thinking about the NAS was that the organization's approach to science should include keeping pure and applied science together. The success of England's Royal Society was attributed to a similar view.[3]

Hale, with the NAS, successfully brought the idea of a council to the attention of President Wilson in 1916. This was ten months before the United States' declaration of war with Germany. The ground swell that brought about the implementation of the Council was the result of the convergence of national and international events.

This commentary primarily includes the early history of NAS, the WWI activities of the Council, the status of science and industry at the time of WWI, the scene when the Council was being established, the emergence and continuation of the Council at the end of WWI, and mention of the Naval Studies Board (NSB) created at the request of the Chief of Naval Operations (CNO) in 1974. The NSB is an example of the NRC's interaction with the Navy as the Council continued to grow as the operational arm of the NAS.

Brief History of the NAS

During the Civil War, Congress and the War and Navy Departments were inundated with ideas and devices in aid of the war. Private citizens wanted to contribute to the war effort by submitting inventions and proposals to the government. It was recognized that some organizational arrangement was needed to pass judgment on the technical submissions from around the country sent to Washington.

Alexander Bache, Head of the Coast Survey, Joseph Henry, head of the Smithsonian Institution, and Rear-Admiral Charles Henry Davis, head of the recently established Bureau of Navigation Office (Navy's first scientific bureau) considered establishing a permanent

commission to deal with the value of the vast number of concepts being given to the government and having a predominance of Navy-related ideas that in some cases required scientific evaluation.

Further meetings and discussions by the above three principals and others resulted in a consensus reached in February 1863. A drafted bill for Congressional consideration, suggested by Admiral Davis, named fifty men of science chosen to be the incorporators of the National Academy of Sciences. Natural history was the most widely-pursued scientific activity of the 19th Century. It is interesting that, among the Academy incorporators, physical sciences and technology were represented in a ratio of two to one those in natural history.

On March 3,1863, the bill was passed by the Senate and House of Representatives and signed by President Lincoln later in the day. The charter established the Academy, a private organization as an official scientific advisory agency to the government. The first meeting of the NAS was held April 22 at New York University.

> ...the Academy would whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science, or art., the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purse, but the Academy shall receive no compensation whatever for any services to the Government of the United States. (NAS 100 year history p. 53)

During its first year (1863-64), NAS in a reactive role responded to ten requests by the government. Three requests were about Navy matters and no requests related to those of Army. Two Navy requests were concerned with protection of the bottoms of iron ships and magnetic deviations in iron ships and improving compass corrections. The third was to evaluate and assess the navigational work of former United States Navy Commander Matthew Fontaine Maury, now a member of the Confederate Navy.

For the remainder of the century and into the early part of the next century, occasions for the government to need to call upon the

Academy were slight. "At its founding, military and naval engineers prominent in the science or art of engineering had comprised almost a fifth of the incorporators..."[6]

NAS membership was primarily honorific and in the late 1800s natural history was the predominant scientific activity. From 1863 to 1908, the Federal Government made 51 requests to the Academy. By 1912, engineer representation included a single representative and the membership in the Academy was less than 100. One of Hale's biographers commented about the status of NAS in the early part of the 20th Century, "but since the Civil War, despite all the advances in all branches of science, it had been largely moribund."[7]

Science in United States circa 1915

Science research was carried on by a group of agencies working for the most part in independence of one another. Pure science was primarily the province of universities and small privately-endowed research institutes. Beginning at the turn of the century, private industries, General Electric, American Telephone and Telegraph Company, and others were sponsoring their own laboratories. In the rapidly-evolving physical science of the last half of the 19th Century and the early decades of the new century, the number of industrial research laboratories slowly increased and developed into important resources.

In the early part of the 1900s, backing for basic scientific research became an objective for very wealthy industrialists such as Andrew Carnegie and John D. Rockefeller Sr. The Carnegie Institution of Washington funded a total of five billion dollars in current dollars and became a research institution that supplemented the work of established universities by providing financial support to scientists to engage in basic research projects. According to D. J. Kelves in The Physicists, this initial funding of "$10,000,000 equaled Harvard's entire endowment and it amounted to far more than the total endowment specifically for research in all American universities combined."

Concerning Hale

Hale, MIT Class 1889, was elected to the National Academy of Sciences in 1902. In 1915, he was serving as NAS foreign secretary

and active in enlarging and reorganizing the Academy to give it a larger role in American science. He was well- known nationally and internationally from his contributions to astronomy and influence on the evolving field of astrophysics. With respect to the war, Hale was pro-preparedness, enthusiastic for the Allies, and critical of neutrality. It can be supposed that Hale had two intentions: to have NAS scientists contribute to military preparedness and to initiate a continuing government-to-science relationship in peacetime. Government patronage, however, was not one of Hale's goals.

As NAS membership included the country's scientific societies, Hale was anxious to move the Academy into a leadership role in national preparedness. A few days prior to the LUSITANIA disaster in May 1915, Hale expressed his view to the NAS president and other Academy members of the need for action on scientific preparedness. Few members shared Hale's concern.

On July 3, 1915, Hale wrote to the NAS president regarding the Academy's strong obligation to offer NAS's services to President Wilson in event of war with Mexico or Germany. With President Wilson's neutral stance at that time regarding the war, no immediate steps were taken by the NAS.[8]

Congress and LUSITANIA sinking

Congress responded to the German submarine U-20's May 7 torpedoing and sinking of the LUSITANIA. As preparedness measures for defense, two technical groups were established on July 15 the Naval Consulting Board (NCB) and the National Advisory Committee for Aeronautics (NACA) (that at a later time would become the National Aeronautics and Space Administration).[9] Membership of the NCB, headed by the Board's president Thomas Edison, consisted primarily of senior inventors and representatives from eleven of the largest American engineering societies.

NCB membership, structure, and deliberations did not include the NAS nor the American Physical Society. Primarily, physicists. Thomas Edison, Henry Ford, Simon Lake, Elmer A. Sperry, and Alexander Graham Bell are representative of the NCB makeup. "...save for two mathematicians, of representatives from America's major engineering societies. The National Academy of Sciences, the government's official scientific adviser, had been omitted."[10] Initial

interest of the NCB included organizing to consider problems, not of science, but of manufacturing and standardization.[11]

Formation of the NRC

Beginning in February 1916, the excessive loss of life in the long battle at Verdun (eventually 500,000), the earlier torpedo U-boat losses, of the British ocean liner ARABIC in 1915 followed by the French cross channel ship SUSSEX in March, plus President Wilson's April 18 ultimatum to Germany regarding unrestricted submarine warfare moved Hale to press again to bring in the nation's scientists and others to assist in military preparedness.

On the day following the ultimatum, Hale presented a resolution to the NAS annual meeting in Washington to offer the services of the Academy to President Wilson. The resolution was accepted. NAS services proffered were for the coordination of the non-governmental scientific and technical resources of the country with the military and naval agencies of the government for national security and preparedness.[12] In retrospect, the NAS involvement was logical, but at the time it was unexpected and unique. Looking back at the 20th Century, it was prescient.

On April 26, Hale and Academy personnel met with the President. The resolution was presented and discussed. The President advised them to form a committee and proceed, but with the caveat that no public disclosure be made at this time.[13]

By June, the new endeavor was called the National Research Council and on July 24, President Wilson approved the preliminary Council plan. The New York Times on September 21 reported the results of the first full Council meeting. A week later, the White House listed senior government civilian and military leaders appointed to the Council. "For the first time in the country's history science, education, industry and the federal government joined hands in a plan for the promotion of research, as such, without stipulations or preoccupations as to immediate "practical returns."[14] This initial wartime interaction was with the government's scientific bureaus and the Army and Navy technical departments. Primary Council effort with the Navy at that time was investigation related to antisubmarine warfare. By 1916 German submarines were larger and more seaworthy, adding to the need for ASW capability.

Hale's view of these 1916 events later in 1933 was "When I first took the job I had no funds for the Council, no office rooms, no friends (except Stratton*) in Government Departments—little, in fact, but the pleasant difficulty of overcoming the prejudices of the chiefs of military and naval bureaus against 'the damned professors.' It was a bully game, and I wish I could try it again."[13]

NRC World War I Navy Matters

By early February 1917, the above-mentioned Military Committee that included Army representatives prepared a number of Army and Navy projects. Many were on submarine problems. The first official act of this Committee was to provide a plan to CNO for the development of a listening device for submarines. This plan provided the basis for a considerable amount of the WWI antisubmarine effort. Gradually, from this time until the post-Armistice after mid-November 1918, under the aegis of the NRC, a wide variety of academic, industrial and military agencies and activities busily came to grips with researching ways to solve problems related to the effective German submarines. Antisubmarine problems continued throughout the 20th and into the 21st Century.

As early as February, Frank Rieber, secretary of the California War Inventions Committee and a member of the Submarine Defense Commission started some underwater experiments in the Bay at San Francisco. It was during his war work with sonic submarine detection and depth sounding that he became interested in using seismic technology in oil exploration to locate oil structures.[14] Prior to the declaration of war, under Council sponsorship, Dr. M. I. Pupin of Columbia University (with Council members) began investigating the use of supersonic frequencies to detect submarines.

Throughout 1916-1918, chairman of the Council's Physics efforts Dr. Robert A. Millikan, noted physicist and a future Nobel Laureate, had a variety of important ongoing assignments with the Council. Even with his extensive involvement and travel associated with organizing the Council, Millikan found time in March 1917 to do research work at the Western Electric Laboratories in Manhattan.

*Samuel W. Stratton, Director of the Bureau of Standards 1901-1923.

Missions

Two missions during 1917 helped to enlighten, focus, and encourage the efforts of the growing Council. In April, under the aegis of the NRC, ten American scientists traveled to Europe to acquire insight regarding the wartime technical efforts of England, France, and Italy. By mid-1916, there was interchange between British and French scientists regarding scientific and technical work in each country. The goals of the US mission were to offer France and England assistance from U.S. laboratories and scientific workers and learn of the work already done in various fields bearing upon the war. During the American's mission in Europe, the dire nature of the Allies' military situation and the heavy dependence on U.S. efforts for survival were made abundantly clear and reported upon return. Joseph S. Ames wrote from Paris on May 18, "This country (France) can hold out for about four months more[17]". England with the heavy loss of shipping from the German submarines was in a situation similar to France.

Franco-British Mission

This return mission accredited to the NRC arrived in New York on May 29, 1917. Meetings and conferences with broad U.S. representation took place at a number of locations, including Washington, D.C., Massachusetts, New York, and Connecticut. Meetings took place at industrial and academic sites until July 9. Sir Ernest Rutherford, Nobel Laureate and highly respected scientist, actively engaged in research related to submarine detection for the preceding three years, led the delegation. Important French members of the mission included experienced researchers in the fields of optics, electrical engineering, wireless, and chemistry.

A particular meeting with the mission for three days in mid-June with representatives from the military, NCB, and NRC led Millikan in his autobiography to comment "Out of this conference grew a very large part of the experimental work on submarine detection and other new applications of science to warfare which was thereafter undertaken by the American groups."[18]

Primary US Anti-Submarine Research Centers WWI*	
NRC New London, CT Fort Trumbull	**NRC** New York, NY, Western Electric Company Laboratories
New York, NY Columbia University	Pasadena, CA, San Pedro Committee
San Pedro, CA, Submarine Committee	**NCB** Nahant, MA Western Electric, General Electric, Submarine Signal Co.
Schenectady, NY, General Electric Laboratories	**Government** Washington, DC Bureau of Standards
Middletown, CT, Wesleyan University	**USN** Key West, FL Navy Yard
*Seek and Strike, Willem Hackmann, HMSO, P. 41	

The American mission brought to the United States the extreme danger of the Allies at this point of the war. Rutherford's mission brought and shared an awareness of the extensive research efforts already accomplished by the Allies of which the Americans were not aware. The Allies were about *a year or eighteen months* ahead of the U.S. efforts.

The tour by the Franco-British mission to various antisubmarine research activities included the NCB Nahant, MA, facility that was staffed by Western Electric (AT&T), General Electric, and the Submarine Signal Company of Boston. Critical comment by the Mission about the Nahant operation to the NRC resulted in the setting up of a new naval research center at New London, Connecticut. A later comment by Rutherford indicated, "We were also instrumental in the formation of a second experimental anti-subma-

rine research station…at New London."[19] The basis for the criticism was directed at the limitations of the primary submarine detection technique being pursued at Nahant.

Not long after the mission returned to Europe, the NRC established the New London Fort Trumbull Navy Experimental Station. Twenty-three scientists under the auspices of NRC conducted submarine detection experiments at that location. Universities represented included Chicago, Cornell, Columbia, Harvard, McGill, MIT, Rice, Swarthmore, Tufts, Wesleyan, Wisconsin, and Yale.*

Many of this group of scientists who comprised the resident, visiting and technical managers of the research, at the NRC/Navy Fort Trumbull laboratory, would grow professionally during the next twenty years in stature and prominence at both the national and international level, some in academia and some in industry. Later in 1940, when the submarine threat again became more menacing, they provided the core of leadership that once more made the Fort Trumbull area a high technology site for pro- and antisubmarine research. Their overall WWII efforts resulted in a multiplicity of diverse, extensive, and countrywide laboratories and research activities.

It should be noted that Vannevar Bush worked on submarine detection during WW I in New London. In 1940 Bush's role as head of the National Defense Research Committee (NDRC) placed him as President Roosevelt's advisor and chief contact on all matters of military technology, including the atomic bomb.[20]

Research areas at the above-mentioned primary research centers included sonic and ultra sonic hydrophones using quartz, Rochelle salt, and magnetostriction elements. Sea testing was provided at a number of the centers. Of the ten research facilities listed, seven were under NRC auspices.

* Regarding missions from England, in the summer and early fall of 1940; President Roosevelt and Prime Minister Winston Churchill encouraged a British Scientific and Engineering Mission to the United States. The information exchange led by British scientist and administrator Henry Tizard provided the United States with what turned out to be a sixteen-month window of preparation before December 7, 1941. Tizard brought with him the cavity resonant magnetron that became the cornerstone of the United States radar systems developed during the next five years.

Prior to October 1917, fiscal support for those engaged in the submarine detection research and equipment came in some instances from their academic institutions and others. During the NCR's first eighteen months, the Carnegie Corporation and Rockefeller Foundation made $74,000 available. The Engineering Foundation of New York made their entire income for 1916 available to the Council. Ambrose Swasey, a Foundation member, made a separate gift of $5,000. In October 1917, as Assistant Secretary of the Navy Franklin D. Roosevelt transferred $300,000 to the Navy Experimental Station at Fort Trumbull. By the end of the War, nearly $1 million funded the Station.

In early July 1917, Max Mason, a member of the NRC research team at New London invented a submarine detection device known as the *M-V tube*, a multiple unit acoustic device for detecting submarines from a ship underway. The idea for this type of detector was due to the French Navy, and Mason learned of the French device at a meeting at the National Research Council. "For listening to audible frequencies in ships under way the performance of this equipment has not been excelled even during World War II..."[21]

To keep the Navy and the NRC current on Allies work on underwater sound and echo ranging developments, the NRC set up the Research Information Service in London, Paris, Rome and Washington, DC.[22]

Other NRC WWI Technologies

The Council met with progress or success in technological areas such as gun battery sound ranging, physiology of battlefield shock, preventive medicine, organic chemicals, bomb-dropping techniques, aerial photography, aeronautic instrumentation, radio telephone, wireless communication between airplanes, infrared and ultraviolet signaling, antipersonnel gases, gas masks, optical glass, and ballistics tables for Army projectiles.

NRC After the Armistice

Various Council members and the scientific community engaged in the war effort began to consider continuing the NRC and its governmental relationships on a permanent basis. On May 11, 1918 President Wilson signed an executive order providing the Council's

perpetuation in peacetime. In addition to permanence, the order established the NRC as an independent activity supported by private sources only. The primary role was to assist in the development of science as an effective tool for national benefit in the broadest of terms for the remainder of the 20th century and into the 21st. Along with supporting and encouraging science with a national perspective, specific efforts by the Council with the Navy gradually increased throughout the century.

Executive Order No. 2859 of May 11, 1918, Relating to the National Research Council

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its Congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing co-operation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as ...."

The Council's initial charter included encouragement of mathematical, physical, and biological sciences and the application of the sciences in peace and war. Among its many roles as the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services, the Council demonstrated during most of the 20th Century constructive participation in the Navy's slowly-evolving and growing interests and needs in science and technology.

The early May Executive Order heralded support for the now permanent NRC. The Carnegie Corporation made a grant to the Council of $100,000 for operating expense followed in March 1919, a $5 Million grant to NAS/NRC. The fund provided for a permanent endowment for the NRC with the remainder for the erection of a building for the NAS and the NRC. On April 9, 1919, the Rockefeller Foundation approved an appropriation of $50,000 for NRC's first year's operations and pledged $500,000 for National

Research Fellowships for the first five years.

Interwar Years

The NRC, now permanent and charged to organize U.S. scientific research, had broad interests not directly related to military interests. Highlights of NRC's involvements with either direct or indirect Navy interests follow.

Frank Lillie, a future chairman of the NRC in 1935 and in 1924 director of the Woods Hole Marine Biological Laboratory, was strongly interested in the evolving field of oceanography. He stimulated interest by interfacing with interested activities, foundations, universities, and the NRC. Within the Navy and civilian scientists there was a growing awareness of oceanography and its potential political, economic, and scientific benefits.[23]

Earlier, Harry C. Hayes, an experienced underwater sound scientist and depth finder inventor at the newly-opened Navy Research Laboratory in Anacostia, MD, made an effort to establish an oceanographic office within the Navy but failed due to lack of support. The interest stimulated by Hayes continued to grow. Acting Assistant Secretary of the Navy Theodore Roosevelt Jr. convened a widely-attended federal Interagency Conference on Oceanography (ICO) in July 1924. The task of the Conference, NRC members among the many attendees, considered the most advantageous application of naval and national resources for oceanographic exploration. Learning how to use the resources of the sea was the top objective of this first meeting. Geology and geophysics problems relevant to oceanography were given priority. In January 1960 the ICO became a permanent part of the Federal Council for Science and Technology.[24]

The Navy provided the submarine USS S-48 for use by Princeton University to conduct a study of geological structure in the Bahama region. Sponsors included NRC, the United States Coast and Geodetic Survey, and the Royal Society of Great Britain. The six weeks of measurements took place from February 7 to March 17, 1932. The submarine provided a suitable platform for making gravity measurements with the equipment available at that time. Other interests included tectonics, oceanography, sedimentation, and marine microbiology.

During the interwar years and beyond, NRC met Navy maritime commitments with committees that proved to be lasting and effective: Submarine Detection, Undersea Warfare, Oceanography, Oceanography of the Pacific, Submarine Configuration and Oceanic Circulation, Submarine Topography and Structural History of the Caribbean and Gulf. Some committees were post World War II. Selected examples of two committees follow.

Committee on Undersea Warfare (CUW)

As WWII ended, advances in submarine design and operating capability required improvements in submarine detection and location systems. To address these issues the CUW was established October 23, 1946, reporting directly to the executive board of the NRC. The Committee was provided with a broad pro- and antisubmarine mandate and direct access with the executive board of the NRC, ONR, and Navy bureaus.

In April 1950 Deputy Chief of Naval Operations Rear Admiral F. S. Low issued the Studies of Undersea Warfare report also known as the *Low Report*. The studies brought attention to the priorities for future research and development with awareness of the forthcoming nuclear submarine and long-range torpedoes.[25] In May, the fifth CUW Undersea Symposium in Washington provided additional attention to defense issues and planning.

As a result, the CUW arranged for a wide-ranging study called Project Hartwell at MIT. Well-known scientists from industry, colleges, and universities and military representatives considered questions and problems related to protecting shipping against submarines and mines.[26] The study was completed August 31, 1950. It was intended that most of the recommendations with adequate support could be in service in two years.

Committee on Oceanography

A CUW follow on summer study, Project Nobska was held in 1956 near Woods Hole, Massachusetts. Undersea warfare and

technology were the focus. Oceanography was an important topic in the study. When the study finished, there was a consensus that an oceanographic committee would be nationally beneficial in moving ahead in resolving civilian and scientific oceanographic concerns. The importance of knowledge of the sea was a continuing and increasing factor for the Navy.

The Committee on Oceanography was established in 1956 and marked the beginning of a 10-year period of increased interest in U.S. ocean exploration. Previously, industry, mariners, fishermen and the political community mostly ignored marine science. In the post Sputnik period, the Navy's oceanographic needs and goals were made known in Ten Years in Oceanography. In February 1959 the Committee on Oceanography's landmark report Oceanography 1960-1970 supported future basic research, applied research, and surveys. A comment made in 1972, "The key to the growth of oceanography in the United States lies in basic research—that is done for its own sake without the thought of practical application."[23] Oceanography would be supported in the years ahead.

Naval Studies Board (NSB)

The Board, under the auspices of NRC Division on Engineering and Physical Sciences, was created in 1974 at the request of the Chief of Naval Operations (CNO). It was chartered to be a source of independent, long-range, scientific and technical planning advice for Naval Forces.

During the Cold War from 1978 to 1990, twelve reports were issued and two symposiums held to advance the Navy's understanding of the importance of space and its threat to the Navy. With the end of the Cold War, as new strategies appropriate to Navy and Marine Corps missions evolved, the NSB studied the implications of advancing technology and the new strategic and military operation needs to respond to regional conflicts in the world's littoral zones.

The titles of some of the NSB documents issued in 2007 provide examples of the importance and the diversity of the work being done by this NRC activity:

- Manpower and Personnel Needs for a Transformed Naval Force
- The Role of Naval Forces in the Global War on Terror
- Distributed Remote Sensing for Naval Undersea Warfare

Comment

The NRC is a vast activity. This paper only highlights in a cursory way some of the more than 90 years of interaction with the Navy that continues. An interesting question would be "Supposing there never was a National Research Council?"■

Endnotes

1. Robert M. Yerkes editor, *The New World of Science: Its Development During the War*, reprint, Ayer, 1977, p. 9.
2. Robert A. Millikan, *Autobiography of Robert A. Millikan*, Prentice Hall, New York, 1950, p. 137.
3. Peter K. Paridies, To Run With the Swift: Vannevar Bush, James Conant and the Race to the Bomb: How American Science was Drafted into Wartime Service, New York City College of Technology of the City University of New York.
4. AIP History News Letter, Vol. XXX, No. 1 Spring 1998.
5. Millikan, *op. cit.*, p. 133.
6. *The National Academy of Sciences: The First Hundred Years (1863-1963)*, p. 207.
7. Helen Wright, Explorer of the Universe, Dutton, New York, 1966, p. 185.
8. Ibid. p. 286.
9. Daniel J. Kelves, The Physicists, New York, Alfred A. Knopf, 1978, p. 106.
10. Daniel J. Kelves, "George Ellery Hale, The First World War, and the Advancement of Science in America," ISIS, 1968, No. 212, p. 427.
11. Kelves, *op cit.*, p. 106.
12. W. H. Howell, *A History of the National Research Council, 1919-1933*, reprint Scholarly Sources, 1973, p. 7.
13. Wright, *op. cit.*, p. 287.
14. Scientific American, 115:56, September 16, 1916.
15. Wright, *op. cit.*, p. 293.
16. Millikan, *op. cit.*, p. 138.
17. Millikan, *op. cit.*, p. 157.
18. Millikan, *op. cit.*, p. 153.
19. David Wilson, *Rutherford*, Cambridge, MA, MIT Press, 1983, p. 379.
20. G. Pascal Zazhary, *Endless Frontier: Vannevar Bush, Engineer of the American Century*, The Free Press, New York, 1997, p. 112.
21. NAS, Biographical Memoir "Max Mason" Warren Weaver, p. 214.
22. Gary Weir, *An Ocean in Common: American Naval Officers, Scientists, and the Ocean Environment*, Texas A&M University Press, College Station, TX, 2001, p. 8.

23. Vicky Cullen, *Down to the Sea for Science*, Woods Hole Oceanographic Institution, Woods Hole, MA, 2005, p. 8.
24. Weir, *op. cit.*, 342.
25. Willem Hackmann, *Seek and Strike: Sonar, anti-submarine warfare and the Royal Navy 1914-54*, London, Her Majesty's Stationery Office, 1984, p. 341.
26. Project Hartwell, http://handle.dtic.mil/100.2/ADA800012
27. Edward Wenk, *Politics in the Ocean*, Washington University Press, Seattle, WA, 1972, p. 43, 44.

A CLARIFICATION

The October 2007 issue of THE SUBMARINE REVIEW featured an Obituary for Captain Warren R. Cobean and a pair of accompanying articles saluting Bus Cobean and his contributions to the Submarine Force. One item referred to his tour as Commanding Officer of HALIBUT with the following:

"His most harrowing assignment (at least of those he would talk about) was during the Cuban Missile Crisis in 1962. Instead of joining the blockade of Cuba, the HALIBUT's orders were to travel to Vladivostok and sit on the sea floor to monitor the movements of the Soviet fleet. Should the Soviet Navy appear to make a move to confront the naval blockade around Cuba, that would be considered an act of war, and HALIBUT was to surface and attempt to stop the Soviet fleet. Fortunately, the Soviets backed down in Cuba and the order was never sent."

Captain Jack O'Connell has noted the possibility of misunderstanding in that passage and in clarification has offered the following excerpt from Regulus–The Forgotten Weapon by David Stumpf:

"Returning to Pearl Harbor on 15 September 1962, HALIBUT commenced a short upkeep period prior to departure for Mare Island and a reactor core change. Enroute to Mare Island, HALIBUT became aware of the mounting tensions of the Cuban Missile Crisis. Cobean volunteered to proceed to San Diego, the Regulus I depot location, take on a load of missiles and proceed as needed. HALIBUT was directed to continue to Mare Island as scheduled, arriving on 23 October 1962, the third anniversary of the start of Regulus I submarine deterrent patrols."

Jim Hay, Editor

THE COST OF DOING BUSINESS

by Captain James Patton, USN(Ret.)

Background

When I complained several years ago to a businessman that I respect highly about a new computer *operating system* coming out just as I was getting comfortable with its predecessor, he gave me some good advice: "You have no choice but to remain current with whatever operating system most everyone else is using—it's part of the cost of doing business". This cost of doing business consideration appears in many forms—it is, for example, the cost of dressing appropriately for whatever your line of business is, the cost of remaining intellectually current in matters of your profession or the cost of purchasing the necessary tools of your trade.

More and more, the business of submarining involves establishing a greater degree of connectivity with national information grids and other operating forces. In fact, the whole thrust of the costly, nearly decade-old *Comms at Speed and Depth* program is to define and develop the tools of the trade necessary to execute this business. It appears certain, both here and abroad, where similar developments are underway, that part of this tool kit will consist of a family of fiber-optic tethered buoys launched from the ubiquitous 3-inch signal ejector that will provide 10s of minutes of such as high speed two-way comms, navigational GPS information, ESM and photonic above-surface situational awareness and Automatic Identification System (AIS) reception among any number of other services—often combining two or more of these features in the same buoy. An as yet to be quantified hazard, however, is that even when these buoys soon reach the fleet, their contribution will not be exploited because of a failure to acknowledge *the cost of doing business*.

Discussion

In the military, as in most of government enterprises, it makes a great deal of difference from which *pocket* money comes to pay for something. For example, even though they are *expendables* by the very nature of their existence, submarine CO's don't have to save up operating funds to buy another torpedo, nor do Navy Pilots have to

pay for their own bombs. For other items of a *consumable* or *expendable* nature, such as pencils, toilet paper or Submarine Expendable Bathythermographs (SSXBTs), a submarine must purchase these things through some Supply System from their Operating Target (OPTAR) funds—a quarterly fixed *allowance* to cover a multitude of expenses—sometimes having to make difficult choices as with any budgeted funds.

Here several different but related difficulties arise. Once an item enters a Supply System for further tracking, storage and distribution, there are associated overhead costs to cover the personnel and real estate required to warehouse and issue these materials. In some cases, these additional costs which are added to the dollar value as bought from the civilian contractor can be significant—even reaching 200-300% in some cases. For example, an SSXBT sold to the government for a little over $200, costs the ship almost $400 when ordered from, in this case, the Defense Logistic Agency or DLA. Similarly, lower usage rate but pricier items within the Navy Supply System such as towed VLF buoys or floating wire antennas have markups in the order of 140%.

Although those sorts of mark-ups are tolerable from a bottom line perspective, the employment of a Submarine Expendable Communication Device (SSXCD) that enters the system at, say $3000, but exits at a cost to the ship of $6000 to $7000 would be greatly inhibited, regardless of the clear situationally-specific operational advantage it could offer. Given what would then be a very low continuing usage following initial outfitting would make the expense of developing these devices less than cost-effective.

Conclusions

Although it is expedient and beneficial for a ship to manage its expenditures for various consumables and expandables from an assigned OPTAR, it seems clear that some high-cost operational consumables should be excepted. Some such are the SSXCD and related members of the 3-inch fiber-optic tethered family which have associated costs which are certainly viable from an operational perspective, but are too high to reasonably be expected to compete within the constrained bounds of an OPTAR based replenishment scheme.

Furthermore, it would seem prudent to bypass Supply System *overhead* mark-ups by having the somewhat predicable usage rate of these devices organized where, following initial load-out, replacements for those devices be provided directly from the Type Commander (TYCOM) via the parent squadron when used as directed (i.e. a requirement to launch an optical/ESM above-surface situational awareness buoy by all submarines immediately preceding their quarterly Emergency Main Ballast Tank blow test) or as tactically expedient during exercises or real-world operations. It has been reported that the U.S. Navy Supply System does have procedures in place that allow for a zero mark-up *pass-through* of high usage rate items when a major fleet entity desires to encourage their use.

In the best of all possible worlds, these operationally enhancing devices would be funded by the TYCOM or higher, and if a Supply System is involved at all, would pass through them with no mark-up. There is much to be learned in these sorts of things by the way in which Special Operating Forces purchase the tools of their trade, or in the way that *black* acquisitions are financed.■

ETERNAL PATROL

RDML Charles "Chip" H. Griffiths, USN (Ret.)
Mr. John B. Delaney, Jr.
LCDR Stanley K. Nicholls, USN (Ret.)
CAPT James Bush, USN (Ret.)

DRIVING A NAIL WITH A WRENCH: THE UNEXPECTED AND CHANGING STRATEGIES OF IMPERIAL GERMANY'S U-BOAT FLEET DURING THE GREAT WAR

by Mr. Stephen L. Jackson

Mr. Jackson is a former submariner, qualified on USS LOS ANGELES, (SSN 688). He is currently a student of American history in the Master program at Providence College.

If you need to drive in a nail and you don't have a hammer it is possible to bang the nail in with a wrench. It's not always successful and it's hard on the wrench but if the wrench is the only tool available, you use it. In the Great War, the UNTERSEEBOOT (U-boat) was the wrench that Imperial Germany used to bang the nail of naval offensive warfare. This examination will analyze the motive for fundamentally changing the mission of this weapon platform and will attempt to determine if expediency was the rationale for the German's choosing the U-Boat as their primary offensive weapon.

At the onset of the Great War, the Imperial German Navy had twenty-eight submarines, and of these, twelve were of the long-range, ocean-going type and the rest were of the short-range, coastal defense type.[1] Undersea warfare research was still very much in its infancy and Germany, though their total number of U-boats was small, was at the forefront of submarine research and development. Limitations in speed, weaponry and crew support features of the earliest models made it impossible for these boats to travel with the fleet and rendered them as purely defensive weapons. Many pre-war versions of German submarines were propelled by gasoline or paraffin-oil engines making them shorter range, dangerous to operate, and easy to locate on the surface by their plumes of smoke.[2] Conditions on board were unpleasant, especially for longer duration cruises. Johannes Speiss, watch officer of the U-9 wrote, "It was

really like living in a damp cellar."[3] These early submarines were always assumed to be close to their homeport or chaperoned by a support craft or submarine tender since their range was understood to be very limited.

Grand Admiral von Tirpitz, Secretary of State of the Imperial Naval Office, was not a supporter of U-boats as an offensive component of his battle fleet and refused to waste money on submarines "so long as they could only cruise in home waters..." But once sea going, long range submarines were available, according to the Admiral he "was the first to encourage them on a large scale" and supported their increased production "...as far as the limits of our technical production would allow."[4] Indeed, the U-boats, and all submarines of this period, were odd and fragile things. But the technology evolved rapidly and as the war progressed, the Imperial German U-boat became an effective ocean-going weapon. The introduction of the diesel engine, increased torpedo load and improved cruising range evolved these coastal defenders into true ocean-going predators. Submarine construction, also in its infancy, prevented the rapid production of replacement submarines, additions to the fleet, or improved models.[5] In 1914, submarines were thought to be excellent support craft to defend harbor and coastal regions, but for the U-boats of the Imperial German Navy, this role would quickly change.

Three events at the end of 1914 caused the elevation of the U-boat from support craft to preeminent offensive weapon. First, on August 6, 1914, a ten U-boat flotilla was sent on a mission to the Orkney Islands in search of British battleships. In terms of tangible results the mission was a failure, and two of the boats never returned, but the mission created a panic in the British fleet when the astonishing range of the German submarines became evident. So startling was the presence of U-boats at such a distance from home, British Admiral of the Fleet Jellicoe commented that when U-boats were first sighted outside the North Sea, it was presumed that they must be supported by an unknown forward base or by submarine tender ships[6]. The Royal Navy battle-fleet retreated from its base at Scapa Flow, to Loch Ewe and then again to Loch Swilly, each relocation more remote from the anticipated scene of conflict in the North Sea.[7] Speaking of this panicked retreat Winston Churchill

said; "The idea had got round – "*the German submarines were coming after them into their harbors.*"[7] Thus, due to their improved range and the perceived danger, the U-boat became a credible threat to the British surface fleet even before the first torpedo had been fired.

The second event was the shocking fact that U-boats could engage and defeat British warships. On September 5, 1914 Captain Hersing commanding the U-21 encountered and sunk the British destroyer HMS PATHFINDER. This was the first ship to be sunk by a submarine in battle since the sinking of the USS HOUSATONIC by CSS HUNLEY during the American Civil War. Less than three weeks later Captain Weddegen in the U-9 attacked and sunk the HMS ABOUKIR, HMS CRESSY and HMS HOGUE, all armored heavy cruisers, for a total of 36,000 tons.[8] What makes this especially surprising is that the U-9 was one of the *coastal defense* type U-boats with only six torpedoes on board, a maximum depth of 164 feet, and a cruising range of a mere 3000 miles. Admiral von Tirpitz acknowledged the value of the U-boat when he said, "...the fine achievements of Weddegen (captain of the U-9), Hersing (captain of the U-21), and others, soon fixed the real importance of this new weapon..."[9]

Finally, in addition to extended range and unexpected combat effectiveness was their ability to move forward the German offensive at time when all other fronts were at a stalemate. By late 1914, the German land forces were locked in the immovable grip of trench warfare. The realization was dawning that this would not be a short war and for a country enamored with the *cult of the offensive* there were diminishing opportunities for advancement or victories. This was especially true for the German High Seas Fleet, which spent almost the entire war in port. However, the German Admiralty could take pride in their U-boat heroes, their aquatic *Storm Troopers* that could boldly break through blockades and bring the war directly to the enemy.

Now that it enjoyed a new prominence in the fleet, the U-boat needed a mission. The British remote blockade conveniently provided one as the U-boat's role was changed to a *weapon of retaliation* against what was considered the illegal blockade of the German trade routes.[10] Before turning against the British merchant

shipping the U-boat's war was almost exclusively waged against British warships. Starting on February 4, 1915 with the declaration of unrestricted submarine warfare, the submarines would be bringers of the HANDELSKRIEG or commerce war against British merchant shipping. By definition, unrestricted submarine warfare is waged by the suspension of the Cruiser Rules of international law; the destruction of merchant shipping without giving prior warning. When observing these rules, the *cruiser*, whether a surface or sub-surface combatant, was required to fire a warning shot, stop and examine the ship's papers, and if determined to be an enemy asset, either put a crew on board and take possession, or remove the crew to safety and destroy the vessel. The tiny submarine crew could neither spare men for a prize crew nor could they take on board the merchant sailors although in some rare cases this was done. Also, the U-boat was a fragile craft, even compared to some of the lesser merchantmen and the commanders were given direction that, "The first consideration is the safety of the U-boat."[12] Surfacing and giving warning exposes the U-boat to attack as they give up their advantage of stealth. The insistence of the British that the Imperial German U-boat comply with cruiser conventions was little more than attempting to remove this advantage from a very effective weapon. The British First Sea Lord, Fleet Admiral Fisher seemed to accept the concept of unrestricted submarine warfare when he stated, "There is nothing else the submarine can do except sink her capture...the essence of war is violence; moderation in war is imbecility!"[13]

Rather than to sweep the seas clean of commerce, the Imperial Germany submarine campaign of early 1915 was designed more to *frighten* neutral shipping from British waters by continuing the threat of U-boat attack.[14] This first installment of unrestricted submarine warfare was not successful due to the relatively small number of U-boats available and the effective storm of propaganda that the British were able to employ, eventually causing Germany to suspend the campaign shortly after the sinking of the RMS LUSITANIA.

The British made especially good use of propaganda by characterizing the U-boat commanders as unfeeling murderers. The unfair characterization as *ravening wolves* may be the sole responsibility of Kapitänleutnant Walther Schwieger, commander of the U-boat

that sank the RMS LUSITANIA. While there is little question that Schwieger knew the identity of the ship he was attacking as reports concerning his own crew showed reluctance to fire on "a ship carrying women and children."[15] The expectation that a single torpedo would sink a 30,398-ton[16] ocean liner in fifteen minutes is like expecting to kill an elephant with a slingshot. It is possible, but very unlikely.

Due to international political pressure, Germany's U-boats abandoned unrestricted submarine warfare and returned to cruiser rules during the period June 1916 to January 1917. Circumstances then dictated another change in the evolving role of the U-boat. Chief of the Admiralty Staff of the Imperial German Navy, Admiral Henning von Holtzendorff, presented compelling arguments in favor of resumption of unrestricted submarine warfare in his memorandum to Field Marshal von Hindenburg. His argument focused on the opportunity to significantly affect the British food supply after the crop failure of 1916 that produced an "exceptionally poor world harvest of grain".[17] Dr. Hermann Levy, Professor of Economics at Heidelberg, correctly identifying England's supply of wheat as the vulnerable commodity due to the British policy of not storing large quantities but instead preferring to supply itself *hand to mouth*.[18] Holtzendorff estimated that where cruiser tactics had reduced neutral tonnage arriving in Britain by 18 percent, unrestricted submarine warfare could increase this number to 39 percent. Additionally, he highlighted the declining success of the U-boats under the cruiser rules, due to armed merchantmen, and felt that "it would be irresponsible not to make use of the submarine weapon now". Holtzendorff and the German High Command understood the possibility of drawing the Americans into the war with unrestricted submarine warfare but believed that any confrontation with the United States was an acceptable risk. "It is unlikely that it [i.e., the United States] would decide to continue war with us, since it has no means to strike at us decisively..." Holtzendorff incorrectly concluded, but acknowledged that Germany must risk war with the United States, "...because we have no choice."[19] While the German Admiralty believed that Great Britain could be so economically damaged by six to eight months of unrestricted submarine warfare that they would be forced to seek peace terms, Chancellor Bethmann-Hollweg believed

"England will sacrifice its last man and its last shilling" before surrendering to German naval might.[20] The German Chancellor and Minister of the Interior warned of ignoring the American potential, and even proposed that a campaign of unrestricted submarine warfare might increase British food supplies as an aroused America made sacrifices to supply its ally in ways that it would not if it remained neutral.[21]

The resumption of unrestricted submarine warfare in April of 1917 was poorly coordinated. Though the U-boats *tonnage warfare* had a significant impact on the Great Britain-bound merchant shipping, it highlighted the intrinsic weakness of the submarine as stated by Vice Admiral Wolfgang Wegner of the German Navy, "The submarine can destroy sea lanes but cannot protect them. Submarines can dive under a blockade but cannot break it."[22] The U-boat could deny the enemy control of the sea-lanes but it alone could not make those lanes safe for Germany's merchant fleets. But an effective submarine fleet can destroy enough shipping to prevent movement of supplies of war from reaching the enemy and eliminate enough warships to render the enemies fleet ineffective. The Germans tried and nearly succeeded in this strategy that would be proved viable by the American Pacific submarine fleet years later. Denial of the sea-lanes to the Imperial Japanese was so effective in World War II that the submarine war in the Pacific was *effectively over* in December of 1944.[23]

At the same time as successes were being achieved by the German undersea forces, their geographic control of the ocean was severely reduced by the losses of the forward U-boat bases in Flanders and the Adriatic. This weakness became very evident when the U-boats were unable to stop the faster, better protected troop transports of the Americans, who as feared had entered the war in April 1917, due to their lack of strategically located bases and to the insufficient number of the U-boats themselves.[24] The U-boat fleet reached a peak population of only 127 boats in October of 1917.[25]

The effectiveness of Germany's return to unrestricted submarine warfare peaked in April of 1917 when U-boats sank 881,000 tons of merchant shipping.[26] But as early as May of 1917 the German command began receiving reports of the effectiveness of the convoy system, an early form of anti-submarine warfare, where a group of

merchant ships sails together escorted by one or more warships. The April record tonnage was never again matched and, not unexpectedly, U-boat losses also began to increase. The reality that the Imperial German U-boats could not stop shipments from the United States was evidenced when the British Ambassador in Bern wrote to the foreign office, "There is no chance now that U-boat warfare will force England into peace..."[27]

The U-boat began the Great War as an auxiliary support adjunct to the German's High Seas Fleet. It ended the war as the major naval offensive weapon. The U-boat did not fit into any strategic plan but instead was the motivation for the changing of the strategic plan itself. Similarly to the use of poison gas, airplanes, and the unexpectedly inactive German surface fleet, the U-boat's mission was changed as an expedient response to the unexpected and changing conditions in the naval war theater. Given the experimental nature of the technology, it would have been impossible to anticipate the uses and surprising successes that accompanied the wider U-boat applications. Grand Admiral of the Fleet von Tirpitz, the architect of Imperial Germany's naval strategy apologizes, "The question of how the submarines were to be used could not be answered until the instrument was there itself".[28] They could have been used more effectively if it had been possible to divine their ultimate capabilities and the true nature of the war that they were fighting.

Thus in the Great War, due to a stagnation of offensive movement on all fronts, the surprising effectiveness of the German submarines, and the lack of other available aggressive resources, the U-boat was the wrench that ultimately was able to drive in the nail of naval offensive warfare. The completed structure was not what was planned and a better-supplied toolbox would certainly have made it sounder. But the U-boats and German naval strategy sympathetically adapted to make the best use of the tools available.

Selected Bibliography

Books

Art, Robert J. *The Influence of Foreign Policy on Seapower: New Weapons and Weltpolitik in Wilhelminian Germany*. London: Sage Publications, 1973.

Bergen, Claus. *U Boat Stories: Narratives of German U Boat Sailors*. ed. Karl Neureuther, trans. Eric Sutton, London: Constable, 1931.

Birnbaum, Karl E. *Peace Moves and U-Boat Warfare: A Study of Imperial Germany's Policy Towards The United States*. New York: Archon Press, 1970. First Published, London: Almquist & Wiksell, 1958.

Blair, Clay. *Silent Victory*. New York: Viking Penguin, 2004.

Clark, William Bell. *When The U-Boats Came To America*. Boston: Little, Brown, 1929.

Compton-Hall, Richard. *Submarine Boats: The Beginnings of Submarine Warfare*. New York: Arco Publishing, 1984.

Frost, Wesley. *German Submarine Warfare: A Study of its Methods and Spirit*. New York: D. Appleton, 1918.

Gibson, R. H. and Prendergast, Maurice. *The German Submarine War: 1914 – 1918*. London: Constable, 1931.

Gray, Edwin A. *The Killing Time: The U-Boat War, 1914 – 1918*. New York: Charles Scribner's Sons, 1972.

The Underwater War: Submarines, 1914 – 1918. New York: Charles Scribner's Sons, 1971.

Hobson, Rolf. *Imperialism at Sea: Naval Strategic Thought, the Ideology of Sea Power, and the Tirpitz Plan, 1975 – 1914*. Boston: Brill Academic Publishers, 2002.

Preston, Diana. *Lusitania*. New York: Walker, 2002.

Simpson, Colin. *The Lusitania*. New York: Little, Brown, 1972.

von Tirpitz, Grand Admiral. *My Memoirs, Volumes I & II*. New York: Dodd, Mead and Company, 1919

Wegener, Vice Admiral Wolfgang, German Navy. *The Naval Strategy of the World War*. [Seestrategie des Weltkrieges] translated by Holger H. Herwig. Annapolis, Maryland: Naval Institute Press, 1929.

Papers, Reviews, and Journal Articles

Bird, Keith. "The Tirpitz Legacy: The Political Ideology of German Sea Power." *The Journal of Military History* 69 (July 2005): 821-826

Davis, Gerald H. "The "Petrolite" Incident: A World War I Case Study on the Limitations of Warfare." *The Historian* Vol. 29, No. 2, (Jan. 1967): 238-248

Herwig, Holger H. and Trask, David F. "The Failure of Imperial Germany's

Undersea Offensive Against World Shipping, February 1917 – October 1918." *The Historian* Vol. XXXIII, No. 4 (August 1971): 611-636

Lundeberg, Philip K. "The German Naval Critique of the U-Boat Campaign, 1915-1918." *Military Affairs* Vol. 27. No.3. (Autumn 1963): 105-118

McKillip, Robert W. H. "Undermining Technology by Strategy: Resolving the Trade Protection Dilemma of 1917." *Naval War College Review* Vol. XLIV, Number 3, Sequence 335, (Summer 1991): 18-35

Offer, Avner. "Economic Interpretation of War: The German Submarine Campaign, 1915-1918." *Australian Economic History Review*, Vol. XXIV, No. 1, March 1989,
21-41.

Steffen, Dirk. "The Holtzendorff Memorandum of 22 December 1916 and Germany's Declaration of Unrestricted U-Boat Warfare." *The Journal of Military History* Vol. 68, No. 1. (Jan. 2004): 215-224.

ENDNOTES

1. Richard Compton-Hall, *Submarine Boats: The Beginnings of Submarine Warfare* (New York: Arco Publishing, 1984), 172.
2. Robert J. Art, *The Influence of Foreign Policy on Seapower: New Weapons and Weltpolitik in Wilhelminian Germany*. (London: Sage Publications, 1973), 14.
3. Compton-Hall, *Submarine Boats: The Beginnings of Submarine Warfare*, 176.
4. Grand Admiral Albert von Tirpitz, *My Memoirs* (New York: Dodd, Mead, 1919), 180.
5. von Tirpitz, *My Memoirs*, 408.
6. R. H. Gibson and Maurice Prendergast, *The German Submarine War: 1914 - 1918* (London: Constable, 1931), vii.
7. Ibid., 4.
8. Art, *The Influence of Foreign Policy on Seapower: New Weapons and Weltpolitik in Wilhelminian Germany*, 27.
9. Compton-Hall, *Submarine Boats: The Beginnings of Submarine Warfare*, 172 - 174.
The term tonnage refers to the amount of gross displacement of a ship and is used to measure the success of a sinking since tonnage has a direct correlation to either shipping capacity or weapons armament.
10. von Tirpitz, *My Memoirs*, 413.
11. Edwin A. Gray, *The Killing Time: The U-Boat War, 1914-1918.* (New York: Charles Scribner's Sons, 1972), 56.
12. Gibson and Prendergast, *The German Submarine War: 1914 - 1918*, 29.
13. Gray, *The Killing Time: The U-Boat War, 1914 - 1918*, 19 & 20. This also contains a reference to the British First Sea Lord, Fleet Lord Fisher's, *Memorandum: The Oil Engine and the Submarine*, (June, 1913).

14. Philip K. Lundeberg, *The German Naval Critique of the U-Boat Campaign, 1915-1918*, Military Affairs, Vol. 69. No. 3. (July 2005), 109.
15. Diana Preston, *Lusitania* (New York: Walker, 2002), 191.
16. Ibid., 439.
17. Dirk Steffen, *The Holtzendorff Memorandum of 22 December 1916 and Germany's Declaration of Unrestricted U-Boat Warfare*. The Journal of Military History, Vol. 68, No. 1. (Jan., 2004), 220.
18. Avner Offer Economic Interpretation of War: The German Submarine Campaign, 1915-1918. Australian Economic History Review, Vol. XXIV, No. 1, March 1989, 26.
19. Steffen, *The Holtzendorff Memorandum of 22 December 1916 and Germany's Declaration of Unrestricted U-Boat Warfare*, 215, 220-223.
20. Lundeberg, *The German Naval Critique of the U-Boat Campaign, 1915-1918*, 114.
21. Offer, *Economic Interpretation of War: The German Submarine Campaign, 1915-1918*, 32.
22. Vice Admiral Wolfgang Wegener, German Navy, The Naval Strategy of the World War. [Seestrategie des Weltkrieges] trans. Holger H. Herwig, (Annapolis, Maryland: Naval Institute Press, 1929), 62.
23. Clay Blair, *Silent Victory*, (New York: Viking Penguin, 2004), 794.
24. Holger H. Herwig and David F. Trask, *The Failure of Imperial Germany's Undersea Offensive Against World Shipping, February 1917 - October 1918*. The Historian, Vol. 33, Issue. 4, (August 1917), 625.
25. Lundeberg, *The German Naval Critique of the U-Boat Campaign, 1915-1918*, 116-17.
26. Art, *The Influence of Foreign Policy on Seapower: New Weapons and Weltpolitik in Wilhelminian Germany*, 12.

FRENCH BARRACUDA CLASS NUCLEAR ATTACK SUBMARINES

by Dr. George Sviatov
Naval Architect
Captain 1 Rank (Ret.) Russian Navy

There are five countries which are building nuclear powered submarines: the United States, Russia, Great Britain, China and France. They are building Ballistic Missile and Attack classes.

The French Barracuda class nuclear attack submarines are to be built for the French Navy to replace the existing force of the four SSN Rubis class submarines which entered service from 1983 to 1988 and two SSN Amethyst class submarines which were commissioned in 1992 and 1993.

Chronologically, the BARRACUDA submarine is a contemporary of the American VIRGINIA, British ASTUTE and Russian ACULA (Project 971) and SEVERODVINSK (Project 885) classes and Project 093 Chinese nuclear attack submarines. But the general assessment is in comparison with other countries' similar submarines BARRACUDA is a less ambitious and relatively smaller nuclear sub.

BARRACUDA missions include anti-surface ships and fast deep submarine warfare, land attack using stealthy long-range cruise missiles, surveillance and intelligence gathering, crisis management and special operations.

The feasibility study for the Barracuda class submarine was successfully completed in 2002 and the program entered the design definition phase in late of 2002. The construction of the first of that class submarine started in 2006. The first of the class sub might be launched in 2011, with sea trials in 2012 and entry into service in 2013. The six Barracuda class attack submarines will enter service at two-yearly intervals from 2013 to 2023.

BARRACUDA will have a surface displacement of about 4,100 tons (approximately half that of the USA Virginia class), but which is an increase of 70% compared to the Amethyst class submarines. The maximum underwater speed is a classified figure but it would be certainly more than 25 knots (probably, more than 30 knots) and

diving depth more than 350m (probably, about 600 m).

The high level of automation integrated into the submarine's operational and mission systems will allow the submarine a complement of 60 (in each of the two crews) compared to 78 in the Rubis and Amethyst classes. The operational cost will be reduced by 30% compared to that of the Rubis class.

BARRACUDA incorporates a range of diving, safety and damage control technologies and the Integrated Platform Management System (IPMS). The ship's design incorporates a range of stealth technologies to minimize the acoustic, magnetic, radar and visual signatures. BARRACUDA will provide a high silent running underwater speed and maneuverability for the anti-submarine role.

The submarine will have four 533mm torpedo tubes and accommodate 18 torpedoes and missiles in a mixed load.

She will carry new heavyweight Black Shark torpedoes: which is a new dual-purpose wire-guided torpedo with Astra active/passive acoustic head and a multi-target guidance and control unit incorporating a counter-countermeasures system.

BARRACUDA's anti-surface missile is an upgraded version of the SM39 Exocet missile (Naval Scalp) which will be launched from a standard torpedo tube. It's armed with a 165 kg warhead, uses inertial cruise guidance and active radar homing in the terminal phase of flight. The missile flies at a high subsonic speed, Mach 0.9 to a target range.

This new naval land attack cruise missile, Naval Scalp, will enter service in 2012. The missile is derived from the Scalp EG and Storm Shadow air-launched missiles. It will have long range precision attack capability against targets at ranges up to 1,000 km.

The Scalp naval version has a longer body than the air-launched version and its wings are extended from the missile body after launch. The missile is being developed for both submarine torpedo-tube ejection and surface ship vertical launch.

BARRACUDA will be configured to enable a future back-fitting of Unmanned Underwater Vehicles (UUVs).

Thales Underwater Systems has been selected as prime contractor for the sub's sonar suite. The submarine will be fitted with bow sonar, wide-aperture flank sonar and towed sonar arrays.

BARRACUDA's nuclear propulsion system will be a new hybrid

design providing electric propulsion for economical cruise speeds and turbo-mechanical propulsion for higher speeds. The power plant will be based on technologies developed for the 150 MW K15 pressurized water nuclear reactor with power of 41.500 shp installed in the Triomphant class ballistic missiles nuclear submarines and the CHARLES DE GAULLE aircraft carrier.

To understand the French philosophy of nuclear attack submarines design it is reasonable to return to naval architectural characteristics of the first nuclear attack subs of that country: the Rubis class. They are the most compact nuclear attack submarines to date.

They have a computer central system for targets detection, processing of information and firing of weapons. The submarines have two crews, *Blue* and *Red*, who man the ships every three months in turn.

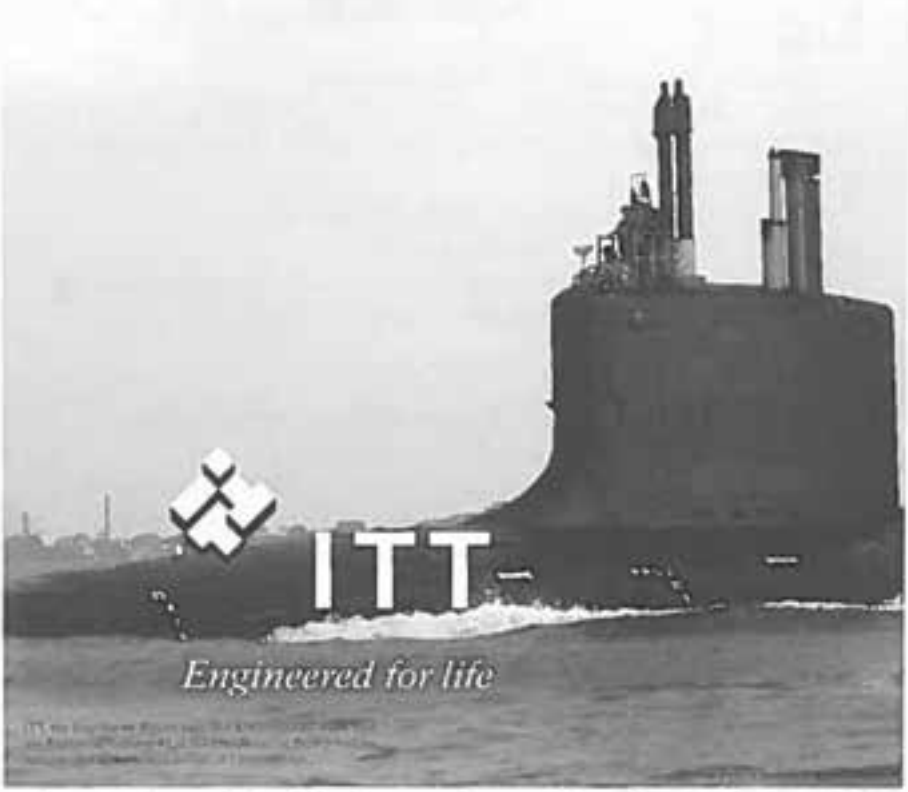
There are six submarines of that class: S601 RUBIS, S602 SAPPHIRE, S603 CASABLANCA, S604 EMERAUDE, S605 AMETHYSTE, S606 PERLE with the general characteristics:

Displacement 2400 t (surfaced), 2600 t (submerged)
Length - 73.6 m, Beam - 7.6m, Draft - 6.4m
Propulsion and power: Pressurized water K48 nuclear reactor (48MW), one propeller, one diesel-alternator as an auxiliary engine, 5MW.
Speed - over 25 knots
Complement - 10 Officers, 52 Warrant Officers, 8 Petty Officers
Armament: 4 x 533mm torpedo tubes, 14 weapons:
F17 mod 2 torpedoes and anti-surface: Exocet SM 39 missiles, mines
Sensors: DMUX 20 multifunctional (tugged antenna, microphone system and radar)

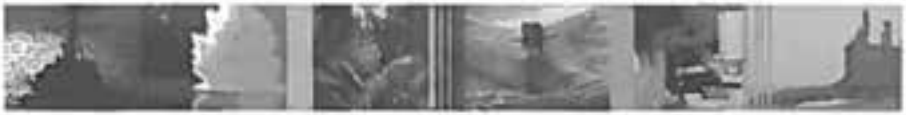
The French Government tried to reduce the price of a Barracuda class submarine from approximately 1000 million dollars to about 800 million dollars, but such a goal is difficult for accomplishment. But the fact that the displacement of the French new attack nuclear submarine is approximately half that of its American, British and Russian counterparts says for itself. But her weapons payload is also approximately half.■

EDO and ITT have joined together. Combining our strong teams and complementary capabilities will allow us to grow our business, take technologies to new markets, and better meet the transformational needs of our customers. Visit us at www.defense.itt.com.

EDO & ITT merge to form a top-ten US defense supplier



Communications • Sensing & Surveillance • Space • Advanced Engineering & Integrated Service



NUCLEAR AIP – A NEW THREAT?

by Captain James Patton, USN(Ret.)

Captain Patton is a retired submarine officer who is a frequent contributor to THE SUBMARINE REVIEW.

Background

In the September 1987 issue of the now defunct journal *Defense Science & Electronics*, there was an article titled "The SSn –A New Player?" Although it is not mentioned by name, the writing of the article was stimulated by a then current issue involving whether the Canadians would incorporate something called the Auxiliary Marine Power Supply (AMPS) into some of their Oberon-class diesel electric submarines, AMPS being a somewhat self-contained mini-reactor that could provide a *continuous* source of some 300KW. Purportedly, the reason behind their interest in such a device was the fact that both U.S. and Soviet submarines were *using* ice-covered waters within the Canadian Arctic Archipelago without first obtaining permission. Since international law is clear in that a national entity only rates claiming that which they can reasonably enforce, the Canadians had a reason to seek the *endurance* of an SSN without really needing its *mobility*, since the waters in question were regional in nature and global deployability was not part of the problem.

As the article pointed out, however, once a nuclear reactor is operated at power, be it 300KW or 300MW, the radiological, training and maintenance issues are exactly the same, and require an enormous infrastructure. Again purportedly, when the Canadian government asked if they could have access to the existing U.S. nuclear propulsion infrastructure, the response was understandably "Sorry, but no".

A take-away from the subject article above was that a country could not aspire to an *SSn*, where the power contributed by nuclear power was minimal, unless it already had infrastructure capable of supporting SSNs and/or SSBNs, and if that was the case, why settle for a regional capability when for a few dollars more one could exert global maritime influence?

Discussion

So, if a logical inference from the above is that the only entities that could build an SSn (i.e. a submarine with nuclear AIP) are those that already have SSNs and or SSBNs, is there still no real incentive for them to do that? Since the SSn has limited mobility, to be useful there must be a need for *regional* endurance, and if so, to have them serve as more affordable brown water complements to an existing fleet of more powerful blue water boats. Barring really dramatic developments vis a vis the naval forces of such as Hugo Chavez, the U.S. doesn't really have a level of regional need for such vessels, and as also with the U.K., it would be politically and fiscally dangerous to imply that even some of the U.S. submarine needs could be met with *cheaper* SSn's vice Virginias.

However, in the realm of more controlled economies less influenced by popular perceptions, China and Russia come to mind as powers with existing nuclear submarine infrastructures *and* a far greater need to field regional submarine presence of significant stealth, endurance and firepower. It is a little early to evaluate the needs of nuclear submarine wanna-bees such as India and Brazil, but it is a reasonable assumption that they would *first* want to gain the prestige and potential for global maritime influence that would be accrued through the operation of an indigenously-produced SSN.

Just one more existing or close to existing nuclear-submarine power remains, and that is France. As the U.S. and U.K., France needs to be sensitive to public perceptions on the relative cost of their submarines, but on the other hand, they tend to be more focused on the fairly restrained waters of the Mediterranean rather than the vast stretches of the Atlantic, Pacific and Indian Oceans that the U.S. and U.K. deal with, and have tended to build smaller SSNs. At a *Naval Strike* conference in London in July, 2007, a senior French submariner making an UNCLAS presentation about their forthcoming Barracuda class submarine indicated that its uranium fuel would be enriched only to that level found in commercial power reactors—in the order of 4 to 8%—far from the much more highly enriched fuel of *normal* naval nuclear propulsion plants. This came as somewhat of a shock to other nuclear submariners due to the associated limitations in total stored energy and poorer performance as regards large maneuvering transients.

Related to that statement are words quoted from the conference advertising brochure another London conference presentation in January 2008 where French Naval, Defense Sales and ARENA Business Development personnel address the following:

- Using civilian nuclear safety standards for nuclear-powered submarines and related harbour facilities
- Nuclear-powered reactors and sustainable development changes (on shore support, in operation, life cycle fuel, decommissioning)
- Safety assessment analysis and naval nuclear reactors integration in operation

Taken together, a disconcerting conclusion can be drawn from these two conferences, which is that the BARRACUDA might be offered for foreign sales, and since it does not use very highly enriched uranium, would be free of any stigma associated with the proliferation of such material. Furthermore, it is somewhat implied, that unlike the U.S./Canadian affair, they the sellers would be happy to provide all the infrastructure and support needed, to include training, nuclear maintenance and defueling/refueling.

Conclusions

There are major world naval powers who already have the required infrastructure for nuclear submarines and who *could* see a benefit from deployment of SSns employing nuclear AIP. In littoral waters close to the owner's shores, the restrictions imposed by top speeds constrained to a dozen or so knots would not be a show-stopper, but any ASW against these units would be significantly complicated—far more so then even the best non-nuclear AIP schemes now available that provide 20-30 days at very slow speeds without snorkeling.

Even more disconcerting would be the proliferation by export of commercial-grade enriched SSNs, capability-limited as they might be, to nations (some extremely wealthy), that presently have no credible path to indigenous production or care of nuclear propulsion plants.

Just as there are internationally accepted treaties, conventions, regimes and restrictions regarding ballistic missiles, chemical weapons, mines and the like, it would appear appropriate that some similar arrangements be made concerning the sale or proliferation of such as SSNs and similar submarines.■

SUBMARINE NEWS FROM AROUND THE WORLD

Reprinted with permission from AMI HOT NEWS: an internet publication AMI International, PO Box 30, Bremerton, Washington, 98337.

From the January 2008 Issue

SWEDEN — Moving Forward With New Submarine Program

In late December 2007, the Swedish government approved the design phase for a new class of submarines that will replace the current force of Gotland and Vastergotland submarines (five units being reduced to four) for the Royal Swedish Navy (RSN). The new program identifies the future submarine as the A-26 class. This new class will apparently be a new submarine rather than the Viking class that was anticipated throughout the 1990s.

Viking started as a Nordic Program having anticipated participation with Denmark and Norway. However, both countries have since withdrawn from the program, with Denmark departing the submarine business altogether. With Viking now virtually defunct, Sweden decided to pursue its own independent submarine program by early 2007.

Feasibility studies by the RSN began in late 2007 and when completed will be followed by the design stage, both of which will be completed by the end of 2008. A final decision regarding procurement of the A-26 class will be dependent on the outcome of the design phase and funding options.

The government believes that development of a domestic program for the submarine could not only reduce the overall life-cycle cost, but it would prove to be a huge economic and technological boost as opposed to procuring a similar vessel on the international market. Domestic development of the A-26 would ensure Sweden's naval shipbuilding capability as well as its maintenance capability not only for submarines but for surface ships as well.

It is AMI's assessment that the A-26 would be comparable in size and capability to the German Type 214 class and will include an air-independent propulsion (AIP) system for prolonged under water

operations. It will likely be equipped with a SAAB Systems combat management system and be armed with four 533mm (21 inch) torpedo tubes for Bofors Type 62 torpedoes as well as mines.

With the RSN's two remaining Vastergotland class submarines needing replacement by around 2015, the sea service would need to begin the construction phase no later than 2010. With the design phase being completed by the close of 2008, a construction contract could be in place as early as 2009 provided Sweden will replace its Submarine Force on schedule and that there is a genuine concern in maintaining the nation's naval shipbuilding capability.

It is also possible that the A-26 could be a candidate for the Singaporean Navy's (SN) future submarine requirement as well as that of Norway. The Royal Norwegian Navy (RNoN) has a requirement to replace its six units of its Ula class beginning in 2020 and began concept studies in December 2007 very similar to Sweden. In regards to Singapore, it currently operates four Swedish Sjoormen and two Vastergotland class submarines that will also need to be replaced in the next decade.

A commitment by Singapore, Norway or both would make the A-26 program (or a joint program) much more attractive for all three countries as the total hulls could potentially climb to as many as 14, surely improving the economies of scale for all participants.

CHINA — Moving Toward a Carrier Force

In late December 2007, rumors again began circulating that the Peoples Liberation Army — Navy (PLAN) was planning to develop a three aircraft carrier fleet over the coming decade. Sources in both Hong Kong and Taiwan have echoed rumors lending some credence to the initial report.

For the past two decades, China has been continually gathering information as well as scrap carriers from around the world in an effort to increase their knowledge of at-sea fixed-wing flight operations and carrier ship designs. The latest example of this has been the on-going work over the past three years, refurbishing the ex-Russian carrier VARYAG. Originally, VARYAG was purchased under the guise of making it a floating casino on the island of Macao.

Images of VARYAG over the past year have shown considerable

refurbishment work being conducted as well as it receiving a fresh coat of paint in PLAN grey. In early January 2008, a posting on a Chinese website stated that the VARYAG was renamed the SHI LANG, after the Chinese General who took possession of Taiwan in 1681.

It has been AMI's assessment since early 2000 that the carrier would eventually be refurbished as a training platform in preparation for an indigenously designed carrier program. In addition to refurbishing the SHI LANG, the PLAN and PLA — Air Force (PLAAF) has been conducting simulated Short Take-Off but Arrested Recovery (STOBAR) operations on a simulated flight deck. The PLAAir Force has also ordered 100 Su-27 (Flanker) fighters from Russia and has a local license agreement to produce at least 200 additional aircraft (Su-27SK) at the Shenyang Aircraft Factory. Russia has operated the naval variant of the Flanker (the Su-33) from its STOBAR carrier, Admiral Kuznetsov for over ten years.

AMI projects that the SHI LANG will be the PLAN's training carrier while a program to build a class of three operational units begins. The new carrier could begin with a construction contract as early as 2010, with construction beginning immediately there after if the PLAN intends to move forward with a modern carrier force. The first unit will likely commission around 2018 with the remaining units commissioning in two-year increments.

AMI looks for increased discussion of carrier design and engineering issues in Chinese naval circles as an indicator that the PLAN is moving towards lay-down and construction of an indigenous aircraft carrier.

VARIOUS DID YOU KNOW?

JAPAN - On 05 December 2007, the first Soryu class (Improved Oyashio class - AIP capable) submarine for the Japanese Navy was launched at Mitsubishi Heavy Industries Kobe Yard.

SPAIN - On 13 December 2007, the keel of the first S 80 class submarine (S 81) was laid at Navantia's Cartegena yard. On the same date, first steel was cut for the Spanish Navy's second unit of the class, S 82.

SOUTH KOREA - On 26 December 2007, the first Type 214 class submarine, SON WON Il, was commissioned into the Republic of Korea Navy (ROKN).

FRANCE - On 15 January 2008, the Le Redoutable class Nuclear Powered Ballistic Missile Submarine (SSBN) L'INFLEXIBLE was decommissioned from the French Navy.

From the February 2008 Issue

VENEZUELA–Submarine Deal on the Brink

On 05 February 2008, AMI received information that the Venezuelan Navy (Bolivarian Armada de Venezuela - ADV) was planning to sign a construction contract for three Kilo class submarines in April 2008. The signing will take place when Venezuelan President Hugo Chavez visits Russia. Originally, Venezuela had planned to buy the state-of-the-art Amur class submarine (built to supersede the Kilo), but was persuaded by Russia to buy the older Kilo design, as the Amur class has yet to be fully tested or exported.

Two of the submarines will be built at the Admiralty Shipyard in St. Petersburg and the third in a shipyard in the Russian Far East (probably Komsomolsk-na-Amur). Komsomolsk built Kilo class submarines for export to China until production was shifted to Northern and Western Russian yards earlier this decade (2002). Venezuela reportedly had options to buy the French/Spanish Scorpene and the German Type 212 or 214 but has apparently opted for the Russian Kilos. The decision to purchase the Russian Kilo class is probably politically rather than economically motivated.

The acquisition of the Russian submarines comes after Venezuela recently began to explore its options on expanding the country's Submarine Force. The two Sabalo (German Type 209) class submarines in Venezuela's inventory are undergoing modernization efforts in Porto Cabello, extending the operational life of the 30-year old submarines.

The upcoming submarine sale from Russia is possibly a political maneuver by President Hugo Chavez in the hopes of upsetting the United States. The ADV would use the submarines to protect its

interests in its exclusive economic zones (EEZ), of which Venezuela views a large portion of the Caribbean Sea as falling under its purview. Moreover, Venezuelan officials are stating that military capabilities are expanding in order to fight an *asymmetrical conflict* with the U.S.; claiming that all systems purchased would be for the defense of Venezuela against a U.S. invasion.

The Project 636 submarines are designed for anti-submarine warfare and anti-surface warfare, as well as, reconnaissance and patrol missions. They are often called *The Black Hole* because of their uncanny ability to *disappear*. The boats are able to launch torpedoes and mines as well as Klub anti-ship missiles (ASMs).

BRAZIL – Modernization of the Submarine Force

As of February 2008, AMI continues to receive information concerning upgrades to the Brazilian Submarine Force. Brazil is currently planning for three phases in the modernization of the force including the development of a nuclear-powered submarine, a follow-on to the Tikuna class diesel submarine and the modernization of its five Tupi/Tikuna class submarines. The programs are as follows:

A. Nuclear-Submarine (SNAC-2) Program: As mentioned in AMI's Hot News in November 2007, the Brazilian Navy (BN) continues to struggle with its SNAC-2 nuclear submarine program. Development of an operational submarine nuclear reactor apparently continues to elude the sea service. Under development since 1979, the BN now estimates that a reactor will not be available until at least 2015. The reactor development in conjunction with Brazil's extremely low budgets and historically long building times at its naval shipyards have pushed an in service date for the first nuclear submarine well past 2020.

These delays have prompted Brazil to seek foreign assistance for the nation's civil and military nuclear programs. Reports continue to surface that Brazil is interested in possibly Indian, French or Argentine assistance for the enrichment of uranium. Any type of assistance would require a major policy shift by either India or France. AMI believes that Brazil will have to continue going it alone in its development of the reactor although it could possibly receive

design assistance for the submarine hull once an on-line reactor is available.

B. Diesel Attack Submarine (SMB-10) Program: Information received in January and February 2008 indicates that the BN is interested in the DCNS Scorpene design for its SMB-10 program. The SMB-10 program is the follow-on to the single Tikuna class submarine that was delivered to the BN in 2006.

AMI sources indicate that the BN would like to build the Scorpene design in Brazil in order to further develop its indigenous capabilities. Apparently, the deal includes the construction of a single Scorpene submarine in Brazil with DCNS assistance for around US$600M. Included in the deal would be technology transfer agreements so Brazil could continue the submarine line with additional units if necessary.

The offer of the Scorpene may be the most realistic option available for Brazil if it intends on building a submarine locally. The only other plausible modern export design is the ThyseenKrupp Marine (HDW) Type 214, of which AMI sources have indicated that the design was not offered to Brazil. The biggest issue in a Scorpene purchase is funding, although sources indicate that Brazil may be able to fund the US$600M though a 20-year loan with an interest rate of 2.4%.

C. Tupi/Tikuna Attack Submarine Modernization Program: In January 2008, Lockheed Martin was awarded a US$35M contract to deliver an advanced open architecture combat system for the five active units of the Brazilian Submarine Force; four Tupi class and one Tikuna class as well as one shore-based trainer.

Administered by the US Navy under a Foreign military Sales (FMS) agreement, Lockheed Martin will provide systems engineering, sensors, software and electronics for the modernization of the submarine's combat management, sonar, fire control and weapon launch systems. This combat systems upgrade follows the recent decision by the BN to replace its submarine torpedo inventory with the Raytheon Mk 48 Mod 6AT torpedo under a US$60M agreement in 2006.

The Brazilian Navy's total budget for 2008 will be around

US$1.2B. Of the allocated US1.2B for the Navy, approximately US$560M is currently slated for nuclear submarine developments and US$95M for the submarine modernization programs. The remaining budget will be undoubtedly be utilized for operations, maintenance and personnel issues.

Assuming that the 2008 defense budget remains a baseline for annual defense budgets through the next decade, it will still take a significant infusion of additional funding at the Defense Ministry level as well as creative financing efforts for the Brazilian Navy to continue moving forward with its SNAC-2 nuclear submarine program and the SMB-10 diesel submarine program. This does not even take into account any modernization efforts in Brazil's surface force or naval aviation requirements.

ECUADOR–DCNS/ASMAR to Upgrade Ecuadorian Submarines

In late February 2008, AMI received information that DCNS of France and Astilleros y Maestranzas de la Armada (ASMAR) of Chile were awarded contracts to upgrade the two Ecuadorian Navy (Armada de Guerra - ADG) Shyri (Type 209/1300) class submarines. DCNS's share of the contract is worth €10M (US$14.8M) and includes the modernization of the combat system and assistance to ASMAR with hull cutting to expedite the associated refits.

The Ecuadorian submarines will receive hull, mechanical and electrical (HM&E) maintenance as well as the overhaul of the combat system. New systems will include the UDS International SUBTICS combat management system (CMS), a Thales sonar suite and the new generation Whitehead Alenia Sistemi Subacquei (WASS) WASS torpedo decoy system. Integration will be accomplished by DCNS and Chile's SISDEF. The first unit will probably enter ASMAR by the close of 2008 with the second unit beginning in 2010.

INDONESIA–Country Highlight

The Indonesian Navy (IN), traditionally the least important of the country's military services, is currently hard pressed to effectively patrol the vast Indonesian archipelago of over 13,000 islands with its current aging fleet. A rise in piracy and a series of maritime disasters

since the late 1990s (including the Tsunami of 2004) has highlighted the Navy's deficiencies. Navy short-comings as well as those in the other services lead to the release of a Ministry of Defense white-paper in 2003 that formulated a new national strategy through 2024. In order to meet this new strategy, the Ministry called for major increases in defense expenditures, more creative ways to procure new equipment, as well as increased investment in indigenous shipbuilding capabilities. More importantly, the new white-paper also identified the sea service as being a major player in the defense of Indonesia and its territorial waters, effectively raising its status.

With its new found status, the IN, following over twenty years of neglect (with the exception of one new landing platform, dock - LPD), hit the center stage in 2003 when it began announcing plans for a modern fleet of new surface combatants, submarines, patrol vessels and amphibious ships. According to Indonesian sources, the sea service will build at least 24 new vessels through 2013 from an approved procurement budget of US$1.95B and through various counter-trade deals. These 24 new vessels probably include two Kilo submarines (with options for more), four Sigma corvettes, nine patrol vessels (one delivered), five amphibious vessels (LPDs) and four auxiliary vessels delivered through 2005. Additional Kilo submarines, national corvettes (Nasional Korvet), mine countermeasures vessels (MCMVs), amphibious vessels and auxiliaries will also be procured from 2014 through 2024 as the second phase in the modernization effort. It will take a sustained effort over the next two decades in order to replace the bulk of the IN's current operational force.

Long-range plans by the IN through the next two decades include a combination of modernization programs for existing units as well as the construction of new units. If new units are not funded as expected, the sea services may also utilize the used international market to achieve its goals. The IN currently has plans to modernize the following classes of ships until suitable replacements can be procured:

- Two Cakra (Type 209/1300) class submarines. Modernization of the first unit was contracted for in March 2004 with Daewoo Shipbuilding and Marine Engineering (DSME) of South Korea

and completed by the close of 2006. The second unit could be funded and begin construction in 2008.
- Six Ahmad Yani class frigates.
- Three Fatahillah class corvettes.
- Two Samdaikun (Claud Jones) class corvettes.
- Sixteen Kapitan Patimura (Parchim) class corvettes.
- Twelve Frosch I class LSMs. The first three units were re-engined by DSME in South Korea through 2007.

The IN currently has plans to procure the following vessels from 2004 through 2013 under the ten-year modernization plan:

- Two Kilo class submarines, which will probably be under contract in 2008.
- Four Sigma class corvettes from the Netherlands, of which the first two were commissioned by 2007.
- Five Tanjung Dalpele Class dock landing platforms (LPDs) of which the first unit was commissioned in 2003.
- Eight 60-Meter class patrol boats that will probably begin in 2009 plus the last unit of 12 PB 57 class patrol boats commissioned in 2004.
- Twenty PC-36 class patrol craft in addition to those commissioned in 2003 (not counted in the 24 vessels).
- Four auxiliary vessels delivered through 2005.

Long-range requirements (projections) indicate that the IN may attempt to procure the following types of vessels from 2014 through 2024:

- Six additional Kilo class submarines plus two units of the Amur class. AMI believes that the IN will procure only the Kilo class.
- Ten National Corvettes (Nasional Korvet), which will probably begin in 2016.
- Up to four additional 60-Meter class patrol boats.
- Twelve medium landing ships (LSMs), which will probably begin in 2018.
- Two Underway replenishment ships (AORs), which will probably begin in 2024.

VARIOUS DID YOU KNOW?

PORTUGAL — On 06 January 2008, the Portuguese Navy named its two ThyssenKrupp Marine Type 209 PN submarines TRIDENT and ARPAO. The new submarines will be delivered in 2009 and 2010.

SOUTH AFRICA — On 30 January 2008, the South African Navy took command of the third and final Type 209/1400 class submarine, SAS QUEEN MODJADJI, from Germany. The submarine was handed over from ThyssenKrupp's HDW following successful completion of sea-trials. The submarine will arrive in South Africa on 22 May and commissioned at a later date.

ITALY — On 18 February 2008, the second Italian Navy Type 212A class submarine, SCIRE, was commissioned at Livorno, Italy.

UNITED STATES — On 22 February 2008, the fourth Virginia nuclear-powered attack submarine (SSN), USS NORTH CAROLINE (SSN-777) was delivered to the US Navy.

From the March 2008 Issue

MALAYSIA-Timeline for Future Procurements

In March 2008, AMI received information regarding the Royal Malaysian Navy's (RMN) most current modernization plan. Sources indicate that the most pressing procurement is the acquisition of the Batch II Lekiu class frigates from BAE Systems. With a Memorandum of Understanding (MoU) already in place, a construction contract could occur at any time. The RMN desires to have a third batch of two additional units under contract by 2011, although sources indicate that this may not be achievable due to funding issues. The Batch II frigates will be delivered to the RMN four years after construction contract signing.

Additional programs that are underway or planned included:

- Scorpene Class Submarine: The first two units of the class are currently under construction and will be commissioned into the RMN in 2009. The RMN has also revealed plans for the acquisition of two or three additional units with funding being secured around 2016 (2016-2020 five-year plan).

RUSSIA-Defense Budget Increase in 2008

In late February 2008, it was announced that Russia's Defense Ministry would increase defense spending to around RUB1 trillion (US$40B), 20% more than what was reportedly spent in 2007.

Russia's Deputy Defense Minister, Lyubov Kudelina stated "The Defense Ministry will spend a little less than one trillion Rubles in 2008, which is about 20 percent more than last year."

She also stated that between 2008 and 2010, defense spending would account for nearly 16% of the total federal budget expenditure, adding that most of the funds would be spent on procurement and repair of military hardware, research and development and construction programs.

Although the amount to be spent on procurement was not specifically stated, in 2007 over RUB300B (US$12B), was spent on procurement, which represented a 20% increase from 2006 figures. It may stand to reason that the 2008 increase will follow suit, accounting for about RUB360B (US$14.4B).

Although the manpower requirements of the Russian military has been reduced to about 1.1 million, defense spending had continued to increase under President Putin, and will likely reach about RUB1.2T (US$45B) by 2010. It is unlikely that President elect Dimitry Medvedev will propose any drastic changes in defense spending.

What these increases mean for the Russian Navy (RVF) is uncertain at this time. However, the sea service could surely use an infusion of procurement funding in order to move forward with its Borey class SSBNs, Saint Petersburg class diesel submarines and Steregushchiy class frigates. The fact remains that the RVF has only commissioned six new construction submarines and surface combatants over the past fifteen years.

VARIOUS DID YOU KNOW?

FRANCE—On 21 March 2008, the fourth and final Le Triomphant class nuclear-powered ballistic missile submarine (SSBN) LE TERRIBLE, was launched at DCNS in France.

CHINA—On 23 March 2008, the third Yuan class diesel submarine (SS) was launched from Wuhan Shipyard in China.■

THE SUBMARINE COMMUNITY

AN EXPRESSION OF RESPECT WORTH NOTING

by Mr. Leonard D. Steffanelli

Mr. Steffanelli qualified in submarines in CATFISH. He lives in San Francisco, CA., and is a Life Member of the USSVI, a member of the Holland Club and very active in the preservation of the USS PAMPANITO, SS-383.

Some months past I had an unexpected and rewarding experience which I thought Submariners would enjoy. My Shipmates and I refer to the PAMPANITO effort, as the *Three Ps*, i.e. *Protect, Preserve and Perpetuate* the life of this magnificent piece of American Naval History, the men who served and those on eternal patrol.

Part of the *Three Ps* program was the success in getting the PAMPANITO into a long overdue dry docking in Alameda. After two weeks of cleaning, painting, new zinc plating etc., she was scheduled to return to her pier at Fisherman's Wharf at 0300 to accommodate tide and ship traffic.

I was privileged to be part of her crew on the return voyage powered by two tug boats. Aside from the inconvenience of the early hour, we experienced strong winds, pouring rain and, to complicate the problem, when the dry dock was flooded, PAMPANITO took on a decided list to port. This was caused by water and/or fuel still remaining in a couple of the ballast tanks. The problem was compounded by the fact that the balance of the tanks were empty and no batteries were aboard so PAMAPNITO was riding high in the water.

In either case, the list could not be corrected because there was no air pressure or hydraulic power available as we left the dry dock. At one point crossing the bay, in a raging wind and rain, the forward tug was on the port side and between the list, weather and the tug pulling on the port, the list increased. It was so severe gear was falling on the decks and if it were not for the efforts of one Jim Adams, who radioed the forward tug to get over to the starboard

side, we felt we were close to capsizing. Sinking PAMPANITO in San Francisco Bay would have been a disaster; not to mention the loss of reputation of the alleged *experienced crew* bringing her home.

After some seven hours, PAMPANITO was back at her home, anchor chains installed and power restored. Once that was completed, a well deserved cocktail hour was sought by several shipmates who served as *crew* on a somewhat trying and memorable seven hour voyage.

In lieu of a local watering hole, we elected to go to a *new* one and upon arrival, we were greeted by a young man by the name of Bo Fox. Bo was clearly a pleasant and smart young man and we were chiding him in a friendly manner about an earring and his somewhat long hair, at least by naval standards. After a time, he noted our caps and asked if we served in the Submarine Service, and of course the response, "Once a Submariner, always a Submariner...."

He casually responded that his grandfather was in the submarine service but he hardly knew him and he had passed on some years ago. We asked what boat he served on but Bo did not know. He did, however, call his Mom in Southern California to find out.

He came back, stating that she also could not remember the name of the boat but what he did know was that his grandfather had served in the Submarine Service during World War II and retired as an Admiral, but knew not much more about him.

Needless to say, his grandfather was clearly something special. I asked for his grandfathers name, which he responded as Henry Monroe. When I got home, I looked up his name in Roscoe's US Submarine Operations in World War II and there was Lt. Commander Henry Monroe, who served in 1942 as Captain of the S-35, a boat built in 1918, yet with this very old boat, had success in wartime against Japan in the early days of the war.

According to the record, in 1944, Henry Monroe became Plank Owner and Captain of USS RONQUIL (SS-396) and continued a successful career as a combat commander. He subsequently retired as a Rear Admiral and as noted, he must have been something special. As all Submariners in Wold War II were *Heroes* regardless of rank, as far as this writer is concerned.

Although the name of Henry Monroe does not rank in the annals

of Submarine Legends such as Mush Morton, Richard O'Kane, George Street and many others, his contributions to his country were comparable as most other submarine Captains, especially when you consider the records.

However the more I read about Admiral Monroe, with added data from the internet, I was so overwhelmed about this man's history in the Submarine Service and that coupled with my introduction to his grandson and his daughter, I felt obligated to provide Bo Fox a comprehensive history of his grandfather's contributions and sacrifices to the American Way of Life which I did by way of a 40 page report and pictures of his Grandfather. History that he never knew existed before I brought it to their attention, with the intent to allow them to understand and respect the sacrifices he made.

I apparently succeeded, as this young man now, as well as his Mom, have a new found respect and pride for her father and his grandfather, for the sacrifices he has made to his family and Country, by their comments back to me.

However that is another story for another time and not the purpose of this memo. He apparently never discussed some of the incidents in his service with his family, following the traditions of the *Silent Service*.

Now, to the point of this memo, in Roscoe's book, he gives almost three pages (page 141, 142 & 143) to an incident that occurred just before Christmas Day, 1942. Titled Fire and Ice, he relates an incident in the Aleutians where the S-35 was charging batteries in a raging storm, and a huge wave overwhelmed the bridge and flooded the Control Room.

As a result, a significant electrical fire occurred that took 50 hours to put out, putting boat and crew clearly in harms way. They lost power, could not submerge and smoke filled compartments required much of the crew to go on deck and endure a fierce ice driven storm. Eventually the fire was controlled after 50 long hours, electrical repairs were made and the engines were started. S-35 staggered into Kuluk Bay, Adak Island for repairs.

Captain Monroe, wrote in his Log Book a summary of the event, which in this writers humble opinion, represented the basic philosophy, spirit and commitment of the extraordinary breed of man who volunteers to serve in the Submarine Service and especially

those men who served in World War II. He wrote:

"I had opportunity to observe the reactions of numerous occasions of submarine personnel under various condition of strain, both physical and mental, which attended the counter measures employed by the enemy following an attack.

None of the conditions prevailing during and after encounters with the enemy could compare with the hardships met during this patrol, in a three day storm...."

"In spite of the seemingly hopelessness of our condition, there was, throughout the entire return trip, an outward calm, an efficient, tireless performance of duties by all hands..."

While researching Henry Monroe's naval service and coming across this log entry, I felt that I knew him personally. I presented the document I had prepared for Bo Fox (his Grandson) who subsequently shared it with his Mother.

After taking the time to consider his thoughts that gave cause for Captain Henry Monroe to write such a memo, regarding his crew on the S-35 during this extremely difficult patrol, written almost 70 years ago, clearly represents his personal pride for his crew.

However, I believe that his thoughts, representing only one crisis of how many unknown incidents that all submarine crews encounter, especially during war time conditions, his words do in fact represents the dedication, spirit, commitment and service of all the special men who have served in the past, present and will serve in Submarine in the years to come.

I thought it appropriate to share his thoughts with all of you from clearly a very special man who acknowledged and respected the men for their combined contributions as a submarine crew.■

GROWING UP ON THE THAMES RIVER

by Mr. Richard Boyle

Upon graduation from Sub School in late 1953, the author, a young LTJG, reported aboard USS SEA OWL (SS-405), a Portsmouth-built Fleet Snorkel boat. She was normally moored at the Submarine Base piers on the Thames River in Groton, Connecticut.

Often called upon to be a school boat, SEA OWL would conduct daily operations in the waters south of the Thames River Estuary.

The return trip up the Thames was routine most of the time, but during the spring thaw the southbound flow of the river could be swift. Mooring port side to a pier oriented at right angles to the river could be exciting when the current was rapid. Most piers projected from shore toward the west. The author will attempt to recreate a port side to landing at a pier quite far upstream.

Proceeding north against a fast moving current, SEA OWL would be maneuvered two piers above the target pier. Orders to the helm might unfold as follows:

ALL STOP
PORT AHEAD 2/3, STARBOARD BACK 2/3

As the boat twisted east toward the pier, timing of the remaining bells would be crucial. When the boat was nearly parallel to the pier:

ALL STOP
ALL AHEAD STANDARD
(Rudder orders as required)
ALL STOP
ALL BACK FULL
ALL STOP

Needless to say, all watch stations below the bridge realized the urgency of each bell, and the line handlers on the pier were poised to quickly receive and secure the mooring lines.

Officers of the Deck who had the opportunity to make several of these landings during the spring season, gained confidence with experience. The ALL BACK FULL bell in the slip could be memorable, and had to be timed very carefully to prevent damage to the bow at the head of the pier.■

LETTERS

MORE ABOUT LANCETFISH

by CAPT. Harry H. Caldwell, USN(Ret.)

I was pleased to see the sad tale of LANCETFISH finally surface in the April 2007 edition of THE SUBMARINE REVIEW. There is a bit more to the story. After LANCETFISH was de-watered and decommissioned she was placed in a graving dock for extensive repairs including removal and overhaul of all machinery, replacement of the batteries and all wiring that got wet. I was told by a knowledgeable and reliable source that while the boat was on the blocks, the drydock gate collapsed, permitting the boat to fill with harbor water a second time. I have found it difficult to confirm this episode, presumably because casualties to ships under construction attract less attention than similar accidents to commissioned warships manned by a military crew which may share responsibilities.

Completion of LANCETFISH was evidently a low priority project for she was not assigned to the First Naval District until 27 February, 1947, when she joined the Reserve Fleet. Even then she was incomplete, with major propulsion units set on their foundations but not aligned, and smaller equipments boxed and set in the proper compartments but not installed. In December, 1952 LANCETFISH was assigned to the New London Group of the Reserve Fleet. The Chief, Bureau of Ships proposed that LANCETFISH be converted to a GUPPy for $10,500,000, but this overture was evidently declined for on 9 June, 1958 she was struck from the List of Naval Vessels, and was offered for sale as scrap.

As the SubBase Repair Officer I had often cast covetous looks up the Thames River to where the Reserve Fleet submarines were berthed, but we had very strict orders not to raid them for parts or equipment, no matter how desperately needed. With many of the Reserve Fleet boats slated for disposal in the summer of 1958 we were allowed one week to salvage bits and pieces before the boats

were auctioned off. LANCETFISH was a popular target for our ship-strippers because her equipment had no wear, had been refurbished recently and required no time-consuming rip-out or disassembly. Quite a bit of LANCETFISH was used by various boats, including the periscope shears which went to a Key West boat some four or five years later.

Sorry to say, LANCETFISH never went to sea under her own power. Maybe that's why she failed to make the list of boats lost during World War II.

Cheers,

Harry H. Caldwell

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 Perfect. 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, P.O. Box 1146, Annandale, VA 22003.

BOOK REVIEWS

FULL FATHOM FIVE
A Daughter's Search
By Mary Lee Coe Fowler
University of Alabama Press
ISBN-13: 978-0-8173-1611-6

Reviewed by RADM Maurice H. Rindskopf, USN (Ret.)

You, the reader, have reason to ask why this book is being reviewed in THE SUBMARINE REVIEW. True, the title suggests water—ocean, but not very deep; and the sub-title suggests the author, clearly a woman, is looking for something.

Let us explain. Full Fathom Five is the opening line of a song by Ariel, the airy spirit, in Act I Scene II of Shakespeare's The Tempest. The song later includes the words *sea change*, the title of Part III of the book. Mary Lee Coe Fowler, the author, is the daughter of Commander James Wiggins Coe, USNA Class of 1930. Her search seeks the identity of her father who was lost in CISCO (SS290) in early 1943 before Mary Lee was born.

A review of this book would be shaped in great measure by the background of the reviewer who might be a Family Counselor, might be a Post-World War II submariner, or might be a World War II skipper.

Should it be the counselor, he would emphasize how Mary Lee grew up in a family with her Mother and two siblings, headed by a difficult step-father who did all he could to ensure that Jim Coe's name was never mentioned. The counselor would tell a story of conflict but would say little about the stirring exploits of the three submarines in which Jim served as Commanding Officer—S-39, SKIPJACK (SS184) and CISCO.

Were the reviewer a young submarine officer, the emphasis would be upon the war patrols Jim Coe conducted, with some passing mention of the difficulties Mary Lee faced as she grew to womanhood. However, his critique of the patrols would be impersonal, gleaned from the many submarine books on the market.

But, this review is being written by one who spent three years

during World War II in DRUM (SS228) making four war patrols as Torpedo and Gunnery Officer, five as Executive Officer and two as Commanding Officer. His view of the book is balanced because he experienced most of the trauma which Jim Coe describes about taking submarines to sea against a dogged enemy, about inadequate torpedoes, if not that about the poor material condition of his commands. He also knows the sadness associated with submarine losses because two of DRUM's original officer complement were lost after transferring to new construction submarines, both leaving young children with despairing wives.

Mary Lee is a teacher of creative writing and a published writer as well, living in Maine. Clearly she never went to sea in a submarine in war or peace, nor did she attend Submarine School. However, she did talk with many, many officers and former enlisted personnel about submarines, and about their recollections of her Father. One of these was my classmate Captain Guy Gugliotta '38 who served with Jim Coe in S-39 and whose wife, Bobette, later wrote a stellar history of that ill-fated ship. Another of Mary Lee's major sources was my surface shipmate, and later submariner, and long-time family friend, Paul Loustaunau '39, who served with Jim in SKIPJACK as his Torpedo and Gunnery Officer. Mary Lee has ventured into deep water, if we can use that term, in describing not only technical details of submarine operating systems; but also into the realm of tactics when she describes attacks against Japanese shipping and escape from depth charge counterattacks. We accept Mary Lee's detailed descriptions because they paint a picture of valiant submarines achieving optimum attack positions only to have torpedoes malfunction. Her stories of deep running torpedoes which failed to fire magnetically, suffered premature explosions at perhaps 400 yards, produced duds when they hit targets without exploding, and circular runs, a scourge unwanted, are accurate and chilling. I was there and did that!

She also describes in vivid detail Jim Coe's unending battle with the material condition of S-39, and for that matter the unreliable engines in SKIPJACK. *When* Jim Coe finally achieved the goal of every World War II submariner—to serve as Prospective Commanding Officer (PCO) of one of the Navy's finest—he was faced with complex repair tasks on the ways and thereafter concerning the

tankage in CISCO. But Jim was rapacious in his strong recommendations to his superiors concerning torpedoes and railed against the denial of responsibility of the Bureau of Ordnance.

Full Fathom Five is divided into three sections which I describe briefly in the following paragraphs

Part I of the book entitled "Ghost Dad" is a mere 20 pages in which Mary Lee uses flashbacks of her youth, growing up in a home with an overbearing step father who ensured that Jim Coe's name would not cross the lips of anyone in the house. She also explains the happenstance of drawing upon Shakespeare's *The Tempest* in which the first two lines of Ariel's song are "Full fathom five thy Father lies/Of his bones are coral made". She notes that her Father lies on the bottom of the ocean with green water all around, but has a smile on his face which says "This is what happened. Don't worry".

Part I concludes in 1997 when Mary Lee was called to the West Coast by the heart attack and sudden death of her Mother. In the process of disposing of her Mother's belongings, she discovered a photograph of her Father with sister Jean and brother Henry taken no doubt in 1943 in Portsmouth, NH when he was outfitting CISCO. That lit a light for Mary Lee that said 'I must know my Father".

In Part II, "The Search", Mary Lee collects and reports in detail not only on her Father's wartime experience taken in great measure from the voluminous patrol reports produced by each submarine, but also on his interpersonal relations with peers and crew alike. She points out that Jim was one of the few skippers who were in command at war's kick-off who demonstrated fierce aggressiveness in attack and valorous ingenuity in escaping from many Japanese depth charge counterattacks. He succeeded in sinking ships with an S-boat, and after four war patrols was rewarded with command of a Fleet Boat, one of the best pre-war submarines in the Navy inventory. Mary Lee also notes that several of Jim's peers were less aggressive, less successful and were sent to shore billets after one patrol. But, she also emphasizes that the toll of seven consecutive war patrols in two submarines without appreciable rest and relaxation was obvious in the few photographs available and in the first hand reports which she received in her many interviews. She asks, knowing there is no real answer, whether this was in some way

connected with his loss on the first patrol of his newly commissioned submarine? CISCO's loss was my loss, too. Lieutenant Howard B.(Pete) Berry was the fourth officer, no doubt the TDC operator, as was I in DRUM. He was one of the 11 in the Class of 1938 lost in the War, whose names appear on the Submarine Memorial in Groton, CT.

Part III returns to the song in "The Tempest": "Nothing of him that doth fade/But doth offer a sea change". When Mary Lee says "And so, a little more than 60 years after disappearing, Jim has caused a "sea change" in me, fulfilling the promise of Ariel's song". She sees herself in her Father's mold, being happy as Jim would have wished. Now that she does better understand her Father, she regrets that she did not initiate her search before her Mother left her.

Full Fathom Five is a different submarine story, one which every submariner should have in his personal library to show his Grandchildren what valor in war is all about. It's a force that can resound through a family, changing it even after sixty years. Publication date is 29 April 2008.■

UNKNOWN WATERS
A FIRST-HAND ACCOUNT OF THE HISTORIC UNDER-ICE SURVEY OF THE SIBERIAN CONTINENTAL SHELF BY USS QUEENFISH (SSN-651)

by Alfred S. McLaren
Captain, U. S. Navy (Ret.)

Reviewed by Merrill H. Dorman, Captain, U. S. Navy (Ret.)

The Arctic Ocean is the smallest of this planet's oceans and the least understood. It is larger than the entire United States and yet those that have been there number only in the thousands. It is surrounded by five countries, with Russia claiming almost half of the boundary. In August of 1970 our astronauts had walked on the moon but only six submarine crews had been in the Arctic Ocean, and those trips had all been brief; the last of which had taken place more than seven years earlier. This gap in Arctic exploration was due to loss of THRESHER in April 1963 and the Navy focus on development of safer deep diving submarines. CDR Fred McLaren, Commanding Officer of the first SSN 637 Class submarine was tasked to collect bathymetry data over half of the then Soviet Union claimed continental shelf. The charts he had available showed coast lines only, and that information was not always accurate. Eleven years later I had the privilege of conducting a similar mission in another littoral area while commanding USS SILVERSIDES (SSN 679). I had significantly more supporting information available before hand and yet the apprehension I felt and the exciting memories I recall were brought back vividly by Captain McLaren's first person account of the preparations for and conduct of his truly remarkable adventure.

The strategic implications of his mission at the height of the Cold War cannot be overlooked. The capital ship in the Soviet Navy was the nuclear submarine and they out-numbered us throughout that period. Their homeports were all in the Arctic, often surrounded by winter sea ice. The concern that their missile submarines could hide under the sea ice was very real. We had capable ASW forces around the world, but in the Arctic only our attack submarines could pursue.

Captain McLaren tells his story from his start in submarines, through becoming a qualified nuclear officer, and up to selection for command of the newest class of deep diving attack submarine. He includes several humorous personnel observations from interviews by Admiral Rickover that he witnessed. He has provided a thorough accounting of the training sessions and team practice that he and his crew conducted prior to first transiting under the Arctic ice. The detail of his personal discussions with his men and observations of events during what had to be an exhausting mission is impressive and far more descriptive than the notes a Commanding Officer normally added to a mission patrol report. He has done his research well and studied the Arctic geography extensively, providing over 200 footnotes for those that wish to continue exploring this subject. Many readers will find the extensive list of Russian names somewhat confusing and appropriately will only focus on the building excitement and complex set of events encountered. Chartlets, or small map sections, are added to help keep the Russian terms and endless changes of speed and heading into perspective.

Captain McLaren includes many old black and white photographs that bring the story to life. He has also added sketches that help describe the way a submarine safely transits under the ice and around ice keels or ice bergs, and how, if necessary, it surfaces through the ice. He noted that even the Arctic experts he carried on board could not predict the variety of ice conditions they observed. Keep in mind that sea ice is generally in motion, pushed by the wind above and that the Arctic Ocean currents constantly move the water over the ground though in a somewhat predictable manner. The two directions of motion are often at odds. The ice cover also precludes the mixing of fresh water river runoff from four of the largest rivers in the world which empty into the Arctic. This runoff then layers above the salty ocean. All these factors make for the most complex of environments. A submarine must be essentially stopped to safely vertically surface. Over the years submarine sails have been dented and periscopes bent over many degrees due to miscalculations of submarine movement through the water resulting in contact with the ice. Most of the procedural details to vertically surface his first of class single screw submarine were developed by Captain McLaren and his crew.

He calmly describes how his submarine arrives in what he terms an ice garage, surrounded by deep ice keels only yards away as displayed on high frequency sonar and the sea bottom not far below. With absolute control of neutral buoyancy and minimum speed he maneuvered his submarine around on sonar information only and proceeded on his mission. From personal experience I can assure you that situation must have been an adrenalin rush moment that seemed to go on for hours.

The Forward for this book was written by Captain William R. Anderson, USN (Ret.) who commanded USS NAUTILUS (SSN-571), the first submarine to reach the North Pole in August 1958. Another review was written by Vice Admiral George P. Steele, USN (Ret.) who commanded USS SEADRAGON (SSN-584) in 1960 during the first voyage from the Atlantic to the Pacific via the North Pole and first ever survey of the Northwest Passage. Both these distinguished early submarine explorers speak very highly of Unknown Waters and that in itself is reason to read it.■

REUNIONS

USS THEODORE ROOSEVELT SSBN-600 Jun 5-8, 2008 Jacksonville, FL
Loc: the Clarion Hotel & Conference Center
POC: Jim Irwin, Phone: 518-383-2481/ Joel Grainger, Phone: 813-713-1587

USS BOSTON SSN-703/CA-69/CAG-1 Jul 10-13, 2008 Portland, ME
POC: Art Hebert, P. O. Box 816, Amherst, NH 03031-0816
Phone: 603-672-8772 E-mail: Secretary@ussboston.org
Web site: http://www.ussboston.org

USS SIMON BOLIVAR SSBN-641 Jun 12-15, 2008 Baton Rouge, LA
POC: Jimmy Fountain E-mail: bolivargroup@cox.net

USS SUNFISH SSN-649/SS-281 Jun 18- 22, 2008 San Diego, CA
For details: http://www.ssn-649.net

USS BERGALL SS-320/SSN-667 Sep 1-6, 2008 Louisville, KY
Loc: The Chariot Hotel, 1902 Embassy Square Blvd. Phone: 502-491-2577
POC: Dick Fiske, Phone: 401-789-7099 E-mail: dixf@cox.net
Web Site: http://www.bergall.org/reunions/reun2008.html

USS PICKEREL SS-524/SS-177 Sep 1-7, 2008 Fort Worth, TX
Loc: TBD
POC: West- Bill Staab E-mail: BillStaab@aol.com
East- Dick Helm E-mail: subvet66-ss524@yahoo.com

POWER, FAITH AND FANTASY: AMERICA IN THE MIDDLE EAST, 1776 TO THE PRESENT

by Michael B. Oren

Published by W. W. Norton & Company, New York and London, 2007
604 pages, ISBN -13: 978-0 393-05826-0
ISBN-10: 0-393-05826-3

Reviewed by Capt. Fredrick H. Hallett, USNR(Ret.)

CAPT Hallett is a 1951 Northwestern NROTC graduate, served aboard USS ROCHESTER (CA124) during the Korean War, attended Submarine School and won his dolphins aboard USS TIRU (SS416) before going to Electric Boat. He was Guarantee Engineer aboard USS PATRICK HENRY (SSBN599) and USS THOMAS EDISON (SSBN 610) during shakedown and initial missile firings and served as Commanding Officer, Submarine Reserve Division 3-11, New London, CT. He now lives in Arnold, Maryland.

What experience and history teaches is this—that nations and governments have never learned anything from history, or acted upon any lessons they might have drawn from it—
George Wilhelm Friedrich Hegel

I have always tried to convince my progeny that the study of history adds a third dimension to an understanding of current events, much as flying can add greatly to an understanding of geography. That being so, we are indebted to Michael B. Oren for this soaring overview of America's peculiar relationship with the Middle East over more than two centuries. For the author's purposes, that overview stretches from the Straits of Gibraltar to the Straits of Hormuz, and from Georges Washington to Bush. Present day critics of the U.S. war in Iraq who believe "it's all about oil" will be

surprised to find that we were overthrowing Middle Eastern tyrants and trying to reform and democratize Muslim societies long before the invention of internal combustion engines.

A talented writer with an eye for fascinating details, Dr. Oren, the Columbia and Princeton-educated American son of a U.S. Army officer, combines a scholar's intensity with the straightforward get-on-with-it approach of an Israeli paratrooper, which he was. He has condensed 230 years of American experience into a *first-of-its-kind* volume which should be required reading wherever understanding the area is important.

From the days of Jefferson and Franklin, the U.S. has often trod a different Middle Eastern policy path than the rest of the world—not unlike the thorny one on which we find ourselves today. In a few instances, American innovations have led the way to a better outcome. More often than not, these initiatives have stumbled and been trampled by oncoming realities. Oren's careful retelling offers new perspectives on whatever policy successes or failures emerge from the Iraq War. Chances are we've been there before.

It is in the recounting that patterns of stubborn facts emerge—not least the endless circle of Christian-Muslim confrontation. But I think few American readers will be familiar with the persistent themes and occasional goofiness which have marked America's efforts in that part of the world. Oren explores both, sometimes producing surprises.

One of those surprises is the origins of the drive to establish a Jewish homeland in Palestine, sparked and supported by American Protestants in 1819, long before Zionism emerged elsewhere. Another is our history of aggressively confronting dictators, along with efforts, sometimes by invitation, to set up modern democratic governments supported by reform of a nation's military trained by U.S. senior officers (Egypt, 1869-73). A third is massive American efforts to intervene to end oppression of minorities, which became an issue in McKinley's presidential campaign (Armenia, 1896) and again in Wilson's critical decision not to declare war on Turkey in 1917. This decision, strongly opposed by Theodore Roosevelt, excluded the U.S. from the peace conference which dismembered the Ottoman Empire and gave rise to many of the border problems of today.

It should be some comfort to the current administration to realize that the only American presidents who haven't suffered frustration and failure in the Middle East are the ones who never tried to do anything there. Giants like Franklin Roosevelt, Harry Truman, Dwight Eisenhower and John Kennedy all confronted intractable problems and were unhappy with the results. One of the reasons was the inherent contradiction between our anti-colonialism and our chronic urge to replace dictatorial regimes with democratic institutions, not to mention our longstanding support of a Jewish homeland and our desire to maintain friendships with Iran and the Arabs, almost all of whom owe their independence to American post-WWII policies. It appears that in the Middle East there are no right answers, so America must find the least wrong one.

Navy readers may not be surprised to discover that the term *Middle East* was coined by Alfred Thayer Mahan and that he was very conscious of the strategic significance of the area even in the days when America was its chief supplier of petroleum products. The U.S. Navy can trace its birth to conflict with Barbary pirates and has often been the visible manifestation of U.S. Middle Eastern policy from the days of Steven Decatur until today. Such exploits as USS TENNESSEE's evacuation from Palestine of 6,000 Russian Jews imperiled by the Turks in 1915 are among obscure bits of U.S. naval history retold here.

Dr. Oren also tells of the antics of Mark Twain, sardonic debunker of exotic *Oriental* travel brochures and of his strange personal relationship to Zionists among the Jews of Vienna. Oddball American missionary efforts in the Ottoman Empire are described along with the serious initial penetration and exploration of the Saudi empire by a guy from Michigan who sold T. E. Lawrence his first books on Arabia.

The meatiest part of the book deals with the incredible hodge-podge of U.S. policies in the Wilson administration springing from American pro- and anti- Zionists, pan-Arabists, isolationists, missionaries and League of Nations boosters contending with British and French interests determined to grab as much control as possible of Turkish and Arab lands in the post-World War I settlement negotiations. One of Wilson's strangest decisions was to seek policy recommendations from commissioners who knew absolutely nothing

about the area and would therefore favor none of the factions. Just a few years later (after our State Department had declared the area to be *of little commercial importance*), rich oil fields in Mesopotamia and the Arabian peninsula were discovered , spawning a new set of problems still unsolved today.

Those in the current administration who have suffered from Middle East intelligence failures may be wryly amused by Oren's accounts of Teddy Roosevelt's dispatching the U.S. Navy to the area a) to avenge the killing of an American who turned up alive and b) to rescue from captivity an American citizen who wasn't one. As it turns out, we've been sending our Navy to impress or intimidate potentates in the area almost as long as we've had one...and as I write this another carrier task force has just arrived off Iran.

Anyone hoping to comprehend events in the Middle East today needs to read this book. It may not supply needed answers but it will certainly augment one's ability to ask intelligent questions grounded on humbling experience. – a sort of antidote to George Santayana's famous observation about "those who cannot remember the past ..."■

REUNIONS

USS SEADRAGON SSN-584 Sep 3-5, 2008 Dallas- Ft Worth TX
Loc: Renaissance Hotel, Dallas-Fort Worth, TX
POC: Tome McCabe Phone: 707-429-4796 E-mail: tompops@aol.com
Web site: http://www.ussseadragon-ssn584.org

USS TRITON SS-201/SSN-586 Sep 3-7, 2008 Charleston, SC
Loc: Embassy Suites Hotel, 337 Meeting St., Charleston, SC 29403, 843-723-6900
POC: Henry Jackson, Phone: 843-884-7330,
E-mail: henryjak@bellsouth.net
Cal Cochrane, Phone: 770-682-7935, E-mail: cochranecal@aol.com

USS GURNARD SSN-662/SS-254 Sep 4-5, 2008 Fort Worth, TX
Loc: Courtyard Blackstone Marriott
POC: Phil Green, Phone: 608-269-1464
E-mail: pag9985@gmail.com

THE HUNTER HUNTED
SUBMARINE VERSUS SUBMARINE ENCOUNTERS FROM WORLD WAR ONE TO PRESENT

By Robert C. Stern
Annapolis, Maryland
Naval Institute Press, 2007, 248 pp. $31.25

Reviewed by LCDR Mark R Condeno,
Philippine Coast Guard Auxiliary

Submarine versus Submarine encounters are quite unknown to many except to those in the naval community and those who have read the novels and seen Hollywood movies like The Hunt for Red October and Crimson Tide. The former is between the trailing Alfa Class boat to the defecting Red October while the latter depicts an engagement of an Akula Class against an Ohio Class SSGN.

In this pioneering work on the subject, author Robert C Stern (Battle beneath the Waves) provides an excellent and informative read. The book is divided into 25 chapters with its early segments taking us to the First World War from the encounter between U-27 and His Majesty's Submarine E.3 to the sinking of U-40 by HMS C.24. The 18 subsequent chapters capture and cover the suspense of clashes between the submarines of both the Allied and Axis navies from the Mediterranean to the Pacific during the Second World War. Notable within are the encounter between U-14 against the Polish Submarine ORP Sep along with HMS SPEARFISH, between that of USS CORVINA against the IJN I-176, resulting in the loss of the former. A few chapters focus on incidents where submarines were sunk by their own navy's submarines such as the tragedy that struck the Italian GEMMA sunk by the TRICHECO, and the collision between U-254 and U-221 during a convoy attack. The final chapter covers the undersea encounters of post World War Two to that of the Cold War till the present, although no warshots were fired against each other during this period, some of the boats involved in the collisions were retired early.

The book is destined to be a classic. It is well researched and finely written. Being the only one of its kind providing a comprehensive account of an unknown field in Submarine Warfare History in specific and to Naval History in general. It would be a standard reference for years to come.

The author is to be commended for this outstanding work. An impressive 16 page photo account, charts, an appendix of gun calibers and end notes for each chapter supplements the book. A ten-page bibliography along with on line sources is also provided. The Hunter Hunted is Highly Recommended.■

REUNIONS

USS DALLAS (SSN-700) Sep 11-14, 2008 Groton, CT
All officers and crew from pre-commissioning to the present.
POC: John Carcioppolo, Phone: 860-464-8770: Cell: 860-514-7064
E-mail: ussdallasreunion@comcast.net

USS ETHAN ALLEN SSBN/SSN 608 Sep 11-14, 2008 Silverdale, WA
POC: Dennis Anderson E-mail: deanders@wavecable.com
Herb Richardson E-mail: herb.richardson@comcast.net

USS SANDLANCE SSN-660 Sep 18-21, 2008 Charleston, SC
POC: Bernard O'Neill E-mail: bernard301@aol.com
Phone: 410-795-7071

USS HENRY CLAY SSBN-625 Sep 19-21, 2008 Charleston, SC
POC: John Troia, Phone: 239-481-7689 E-mail: Stargazer7058@aol.com or
Charlie Patch, Phone: 910-328-3565
E-mail: icpatch@charter.net

USS FULTON AS-11 Sep 22-26 Las Vegas, NV
POC: Richard Hartman, 400 Belleview Ave., Apt. 305, Newport, RI 02840
Phone: 401-846-6536, E-mail: rhnkhs@verizon.net
Cost: Hotel-$59.00 per night Reunion $200.00 (includes tours, meals, memory book, entertainment)

USS NAUTILUS SSN-571/SS-168 Sep 25-29, 2008 Groton, CT
POC: Joseph Degnan Box 1197, Westerly, RI 02891
Phone: 860-460-4265 E-mail: panopo@gmail.com

GEORG VON TRAPP, TO THE LAST SALUTE MEMORIES OF AN AUSTRIAN U-BOAT COMMANDER

Translated and with an introduction by
Elizabeth M. Campbell,
with an essay by Robert C. Lendt
ISBN13: 879-0-8032-4667-6 and ISBN 10: 0-8032-4667-6

Reviewed by Captain James E. Collins, USN (Ret.)

Who would have thought, while watching the movie THE SOUND OF MUSIC, that Captain Georg von Trapp was not only a renowned U-Boat Commander for the Austro/Hungarian Navy, but also, in actuality, a beloved, warm-hearted father?

Elizabeth M. Campbell, the translator, happens to be the granddaughter of Captain von Trapp, and daughter of Eleonore von Trapp, the youngest of the seven von Trapp children. In researching and translating this book, she spent time talking with her mother and five living siblings about their lives. In the introduction to the book written by Georg von Trapp, originally published in Austria in 1935, she paints him as "a very fatherly father," who did everything for his seven children. Maria von Trapp, his daughter, remembered that, "Georg was the happiest when we were very young. We could turn his study upside down, turn the chairs over and put a blanket over them to make a house and totally mess up his room. He took us on trips and we'd make a fire and bake potatoes in the coals, and when we were sick, he would always be at our bedside. Every night he would come into our room and tell us a story that went on and on and on . . . [with] terrific imagination." He encouraged all of his children to play instruments as music was an important part of their family life.

As depicted in THE SOUND OF MUSIC, Georg did have a bosun's whistle, but he did not use it in the militaristic manner portrayed in the film. During the war he needed the whistle on the submarine to send orders when noise and smoke interfered. He gave each child a separate signal to call them because the grounds of his estate were so extensive. There was also a separate signal to summon all at once.

Georg Johannes Ritter von Trapp was born on April 4, 1880, in Zara, Austria, on the Dalmatian coast. The son of an Austrian Naval Officer, he graduated from the Naval Academy in Fiume. Following graduation, he and his class sailed around the world in a schooner, taking measurements for their charts. In 1908, Georg studied the design and construction of submarines and torpedoes at the Whitehead Factory in Fiume. There he met his future wife, Agathe Whitehead, who christened the U-5 in 1909, which later became Georg's first command during the First World War.

He started his wartime Naval career in coal-fired torpedo boats. His mission was to go out every night searching for targets. This would necessitate returning through mine fields every morning. He considered the mission of the torpedo boats *thankless and boring*. When offered a U-Boat, he immediately took it because "U-Boats were considered Austria's trump card." Taking command of U-5, he distinguished himself as a Naval hero, initially torpedoing and sinking a French cruiser. After other victories, he later commanded the U-14, the former French submarine CURIE which had been netted and sunk at the entrance of the harbor of Pola. The U-14 carried six torpedoes outside the hull which could be launched from inside while the U-5 had only one compartment and two torpedoes mounted on the hull. The U-14 had a bulkhead door separating the engine room from the one central control room, and had berths and even an officer's mess for the two watch officers and the commander. Captain von Trapp spent the rest of the war in command of the U-14 with many victories under his belt.

On the morning of the Armistice, at 0800 the Austro/Hungarian Flag was raised for the last time with a 21-gun salute. "Slowly and solemnly I personally raised the flag, wait for the gun salute, and take her down again. For the very last time! Tears streamed down every face. A sobbing is heard all around. Tirelessly, the U-Boats have held out to the end in their sworn duty. To the last salute of our flag."

As depicted in the movie, Captain von Trapp detested Hitler and his "muscling Austria and other European nations into submission to Germany." Twice refusing offers to join Hitler's Navy, and knowing the third time he would be taken, he and his family left Austria with their musical conductor and arrived in New York

penniless, and immediately started touring the U.S. as a concert group, to ever increasing acclaim.

I highly recommend this book. I was struck by how much was accomplished by these primitive and miniature boats in World War I – the U-5 manned by two officers and ten men. The men often endured such hardships as passing out at their stations because of noxious gasoline vapors. The boat had to surface to resuscitate the men by laying them on the topside deck. During one attack on a cruiser, only three men and the two officers were left to operate the boat, and even Captain von Trapp was woozy and had to sit at his periscope stand between looks. Often the periscope malfunctioned, and would be left in the up position while raising and lowering the boat to take sightings. It is interesting that the Austrians were so successful in these primitive boats, and were overwhelmed by the luxuriousness of visiting German U-Boats.

This most interesting description of World War I submarine duty, and reflections on the effect of the war from the side of the Central Powers, is complete with photographs. I purchased the book, signed by Elizabeth, at the Trapp Family Lodge in Stowe, Vermont.
(Editor's Note: It is now available also through normal book sales channels. I got my copy at Barnes & Noble. Jim)■

LIFE MEMBERS

CAPT. Charles B. Bishop, USN (Ret.)
Mr. James Avramis
Mr. Conrad Parker John
CDR Raymond C. Anderson, USN (Ret.)
ETCS(SS) Alvin Wayne Powell, USN (Ret.)

NAVAL SUBMARINE LEAGUE HONOR ROLL

Benefactors for Twenty Years

American Systems Corporation
Babcock & Wilcox Technical Services Group, Inc.
BAE Systems
Battelle
Booz Allen Hamilton, Inc.
DRS Power Systems
EG&G Technical Services, Inc.
General Dynamics Advanced Information Systems
General Dynamics Electric Boat
Kollmorgen Corporation, Electro-Optical Division
Lockheed Martin Corporation
Northrop Grumman Shipbuilding
Northrop Grumman Corporation - Sperry Marine Division
Planning Systems Inc., QinetiQ North America
Raytheon Company
SAIC
Systems Planning and Analysis, Inc.
The Boeing Company
Thornton D. & Elizabeth S. Hooper Foundation
Treadwell Corporation
Ultra Electronics Ocean Systems Inc.

Benefactors for More Than Ten Years

Alion Science & Technology
AMADIS, Inc.
American Superconductor Corporation
Applied Mathematics, Inc.
Cortana Corporation
Curtiss-Wright Flow Control Corporation
Hamilton Sundstrand Space, Land & Sea
Hydroacoustics, Inc.
L-3 Communications Ocean Systems
Materials Systems Inc.
Northrop Grumman Corporation - Marine Systems
Northrop Grumman Corporation – Undersea Systems
Perot Systems Government Services
RIX Industries
Rolls Royce Naval Marine Inc.
Sargent Controls & Aerospace

Sonalysts, Inc.
Vehicle Control Technologies, Inc.

Benefactors for More Than Five Years

Goodrich Corporation, EPP Division
L-3 Communications MariPro, Oceans Group
McAleese & Associates, P. C.
MICROPORE Inc.
OceanWorks International, Inc.
Oil States Industries/Aerospace Products Division
Pacific Fleet Submarine Memorial Association, Inc.
Pinkerton Government Services, Inc.
Progeny Systems Corporation
SSS Clutch Company, Inc.
SUPERBOLT, Inc.

Additional Benefactors

Burdeshaw Associates, Ltd.
Chesapeake Sciences Corporation (New in 2008)
Cunico Corporation (New in 2007)
Cydecor, Inc. (New in 2007)
Dresser-Rand Company
Drexel International Inc.
DRS Sonar Systems, LLC (New in 2008)
Dynamic Controls Ltd. (New in 2008)
Epsilon System Solutions, Inc.
ETTEM USA, Inc. (New in 2007)
Foster-Miller, Inc. - QinetiQ North America
IBM Global Business Services, Public Sector
IMES Strategi Support - Ltd. (New in 2007)
Nekton Research, LLC
Nuclear Fuel Services, Inc.
Oceaneering International, Inc. (New in 2007)
SteelCloud (New in 2007)
TSM Corporation (New in 2007)
VCR, Inc. (New in 2007)
Whitney, Bradley & Brown, Inc.
WSI Internet Marketing (New in 2007)

Support Your Naval Submarine League

The Naval Submarine League is supported by member contributions beyond annual membership dues. Your tax-deductible contribution will insure the NSL continues its leadership role as a professional advocacy association to educate the public on the importance of submarines in our Nation's defense.

( ) $1,000 Patron
( ) $500 Sponsor
( ) $250 Commodore
( ) $100 Skipper
( ) $ 50 Advisor
( ) Other _____ Associate

METHOD OF PAYMENT:
( ) My check made payable to **The Naval Submarine League** is enclosed.
( ) Please charge my: ( ) VISA ( ) MasterCard

Card No. _____ Exp. Date ____/____

Name_____ Amount_____

Card Billing
Address:_____

_____

Please indicate your NSL Chapter by checking one of the following:

☐ Aloha	☐ Atlantic Southeast	☐ Capitol
☐ Hampton Roads	☐ Levering Smith	☐ Nautilus
☐ Northern California	☐ Pacific Northwest	
☐ Pacific Southwest	☐ South Carolina	

Please mail your contribution to:
The Naval Submarine League
P. O. Box 1146
Annandale, VA 22003-9146

The Naval Submarine League is a Virginia-based non-profit 501(C)(3) corporation. It is dedicated to educating the public and promoting awareness of the importance of submarines to U.S. national security and the defense of our Nation.