WINTER 2012

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The FEATURES leading this issue are the presentations of three of those directly responsible for the future of this nation's submarine contribution to our National Security. Congressman McKeon spoke at the commissioning of USS CALIFORNIA (SSN 781) not only representing the State of California, but also as the Chairman of the House of Representatives' Armed Services Committee. His words were directed at the ship's crew, but stand as inspiration to all involved in the submarine enterprise. As importantly, his words also indicate his understanding, as the HASC Chairman, of the unique and vital place of the Submarine Force at the forefront of US defense.

Admiral Donald's speech to the League's Corporate Benefactors impressively covered the spectrum of work being done by Naval Reactors in support of the materiel, personnel and training needs of the nuclear navy. He also explained the challenges to be met in providing for those needs in the face of national funding constraints. He concluded that in order to meet those challenges and justify the funding support necessary, the submarine community has three vital "...areas where we need to sustain our alignment and focus:" (1) Continued operational excellence; (2) Importance of nuclear deterrence and the Navy's unique role and responsibilities; and (3) Excellence in program execution.

The third FEATURE is VADM John Richardson's speech to the NSL Corporate Benefactors. In this brief, the Submarine Force Commander describes his vision of the type of submarine warfare which we are entering. He again characterizes the first century of American submarine experience into three phases; pre WW II, WW II and the Cold War to set the perspective for a Fourth Phase. It is that new Fourth Phase which he sees as requiring new realizations and innovations, all superimposed on the excellence in performance traditional in the submarine community. His vision is an extended version of the *far-forward* posture familiar to most of us, is a sophisticated concept and may require a sharpening of focus by many of us.

In addition to these FEATURES this issue contains a wide range of interesting ARTICLES. Leading that list is RADM Jerry Holland's excellent summary of the technical and programmatic origins of Over-The-Horizon targeting which was undertaken as a provision for the extension of submarine warfare capability. Admiral Holland did that research in connection with the Submarine History Symposium, sponsored by the League and the Navy Historical Association, being held at the National War College on the 24th of April.

A fascinating history/mystery offering is Captain Fred Hallett's account of the French Navy's giant submarine SURCOUF in World War II. This is a long story, a complicated one, and a major revision to most of the old tales we had heard years ago. Another in our list of *history of submarine technology* articles is Dr. Monroe Jones piece on the evolution of submarine propellers. That evolution has been profound and its history has some surprising twists.

Dr Szaszdi, an academic expert on the politics of Eastern Europe with a specific interest in the Russian Navy has given us a very detailed and quite interesting look at Russia's 4th generation SSN. This appears to be a very capable submarine for which the future employment should be noted carefully.

Unusual for the magazine is the appearance of two *submarine-disaster* articles. Captain Jack O'Connell has some cogent comments on the oversight of THRESHER's deep dive. The other *submarine-disaster* article by Mr. Baker and Mr. Rule concerns the loss of two Soviet submarines.

Lastly, not to be missed is the interview across the ages of Admiral Nelson by our old friend Admiral Joe Callo.

Jim Hay, Editor

Correction: The following names appeared on the front cover of the Fall issue 2011, Dr. Jan Kalberg and Mr. Robert Aster, the correct spelling is Dr. Jan Kallberg and Mr. Robert Astur. The Submarine Review apologizes for the errors.

FROM THE PRESIDENT

2012 has already delivered some good news to the Submarine Force and the Naval Submarine League. Even though we have been given some budget challenges, we have also received tremendous support for the programs that have been developed with rigor and presented with firm support for their need. The continued funding of two VIRGINIA Class submarines a year for 2012 and 2013 gives the acquisition process time to reclama the delay proposed in 2014. The delay of two years in the start of the OHIO Class Replacement Program has affirmed the need for this program and has also opened a national debate on nuclear weapons strategic planning. You can rest assured that the League will be encouraging your participation in this process.

To that end, the League published 6000 copies of a booklet containing the first five articles in the FALL issue of ***The Submarine Review*** that has been mailed to members of Congress, State legislators, senior flag officers and the membership of the Submarine Industrial Base Council (SIBC). The SIBC met in Washington DC on 6-7 March for their annual briefing and visits with their congressional delegations. They were equipped for this process with copies of the booklet and a report from VADM Richardson, Commander Submarine Forces, reviewing the ***Design for Undersea Warfare*** that remains the focus of the Submarine Force. Additionally, I have completed traveling to brief nine of our chapters on the ***"Submarine Force Way Ahead"*** initially presented at the Annual Symposium. The briefing and the booklet are available on the League's website – ***www.navalsubleague.com*** – for you to download and give your friends and civic groups to encourage them to support these programs within their spheres of influence.

The Submarine Force leadership supported the 2012 Corporate Benefactor Recognition Days on 1-2 February with over 225 attendees at this annual event. ADM Kirk Donald, Director Naval Reactors, VADM John Richardson, RADM Barry Bruner, Director Submarine Warfare, RDML (Sel) Michael Jabaley, Program Manager for VIRGINIA Class Submarines, and CAPT Dave Bishop, Program Manager for OHIO Class Replacement Submarine provided concise reports on the needs of the Submarine Force and updates on the three main lines of effort for the Design for Undersea Warfare - ***Ready Forces:*** *Provide undersea forces ready for operations and warfighting;* ***Effective Employment:*** *Conduct effective forward operations and warfighting;* ***Future Force Capabilities:*** *Prepare for future operations and warfighting.* Congressman Joe Courtney also provided a good report on the Armed Services Committee reaction to the Defense Guidance promulgated just before this meeting. We now have 75 benefactors who provide significant support for our programs and operation.

This issue of the ***Review*** comes to you at the end of the current fiscal year. We just finished an Executive Committee meeting where we learned that we will provide all of our programs within budget for expenses and enjoy the substantial support from our Corporate Benefactors for the major events that resulted in a surplus in this year's financial performance. The annual audit results will be reported to you in our Annual Report, the Annual Symposium Business Meeting and published in the Fall issue of the ***Review***.

The Submarine Review continues to be a Submarine Force resource for disseminating information to a large audience. Additional opportunities to expand upon the submarine message includes the 2012 Submarine Technology Symposium on 15 - 17 May, now open for your registration, and the 30th Anniversary Celebration and Annual Symposium on 17 – 18 October at a new venue, the Fairview Park Marriott. Our next event will be the Annual Submarine History Seminar being held at the National War College on 24 April. This year RADM Jerry Holland has selected some outstanding speakers to address the theme "OUTLAW SHARK – The Beginning of Over The Horizon Targeting." There are advertisements for these three events in this issue. ***The Submarine Review*** provides you with a forum for discussing topics of interest to the Submarine Force. Seize the opportunity to express your views on subjects important to undersea warfare.

The Submarine League staff has upgraded our information technology infrastructure with the installation of broadband internet capabilities and a new Voice over Internet Protocol (VOIP) telephone system that has replaced our 30 year old system. With this change, the long promised permanent change of our email domain to **navalsubleague.com** will become the only address that will be available to our members. The **cavtel.net** domain will be cancelled on April 30. Please note these changes in your address books.

On behalf of all the Naval Submarine League staff I ask that you continue to expand the importance of the Submarine Force to our nation's defense posture to your family and friends. I look forward to continue representing you in this promotion. Please keep military personnel around the world in your thoughts and prayers.

John B. Padgett III
President

REMINDER

Then Naval Submarine League Email Address Domain is navalsubleague.com . The cavtel.net domain will be cancelled on 30 April 2013.

The following email addresses are in effect:
subexec@navalsubleague.com - Executive Director
subleague@navalsubleague.com - Administrative Mail
subtech@navalsubleague.com - SUBTECH Administration
nslemem@navalsubleague.com - Membership
nslops@navalsubleague.com - Operations Director
nslevent@navalsubleague.com - Symposia Coordinator
nsladmin@navalsubleague.com – Admin Assistant
nslguest@navalsubleague.com – Guest

NAVAL SUBMARINE LEAGUE - Box 1146 Annandale, VA 22003-9146
PH:(703) 256-0891 Toll Free (877) 280-7827 Fax: (703) 642-5815 E-mail: subleague@navalsubleague.com
Web Page: www.navalsubleague.com

30th Annual Symposium
SAVE THE DATE
17-18 October 2012
Fairview Park Marriott
Watch for August Invitation

Annual History Seminar
6-9 PM Tuesday 24 April 2012
National War College
"OUTLAW SHARK –
The Beginning of
Over the Horizon Targeting"

FEATURES

CONGRESSMAN HOWARD P. "BUCK" McKEON KEYNOTE ADDRESS AT THE USS CALIFORNIA COMMISSIONING CEREMONY

Thank you, Admiral Greenert, Mrs. Greenert, Admiral Willard, Mrs. Willard, Congressmen Rigell, Forbes, Wittman, and Scott, Commander Nelson, members of crew, family and friends.

Congratulations!
After six speakers, I can't help but to be reminded of the California's motto:
"Silence is golden."

I've had the honor of representing the golden state of California for almost twenty years now. But being invited here to the commissioning of this boat, and to pay tribute to this crew, is one of the great highlights of a long career in Congress. It's an honor I will never forget.

A few months ago, I had the privilege of visiting USS NEW HAMPSHIRE as she surfaced through the arctic ice. I saw the pride and the professionalism of the submarine community up front. It was the only night I spent with the Navy, by the way.

But that's why commissioning of one of our attack submarines is a momentous event. Submariners are a rare and special breed. All of us here today are witnesses to history. But through their service and stewardship of CALIFORNIA, this crew will make history. It is ironic that one of your boat's predecessors, the battleship USS California, was attacked at Pearl Harbor.

As members of our elite Submarine Force, you will be responsible for maintaining America's forward presence. That presence is America's natural bulwark against sneak attack and surprise. Like the months and years prior to the Pearl Harbor attack, the Pacific Rim is heating up. This vessel, and this crew, is our best defense against the volatility rising in places like the Far East. And should the unthinkable happen, and this nation finds itself tangled up in conflict, you will be our best offense against any enemy and any adversary.

In a few minutes, Mrs. Willard will order you to bring this ship to life. Members of the crew, **take that to heart.**

This wonderful vessel is a feat of American engineering and innovation. But without you men, it is simply a lump of wire and steel. A submarine does not have courage. Or cunning. Or determination. It is the crew that will be CALIFORNIA's brain, muscle, and lifeblood. You are the soul of this vessel. Crews will come and go. But the spirit that you instilled in this proud boat will ring eternal. That is the great responsibility of the plankowner.

You will be the ones who transform the California into a lethal weapon of war. But also understand that your mission is to be a lethal instrument of peace. As submariners, you are America's first line of defense. You are our powerful deterrent against aggression and chaos. The submarine is the quiet whisper in our enemies' mind, the doubt that gives them pause. They know that they cannot bring violence to our shores so as long as you are on our walls and beneath our seas. They know your mission is to take the fight to the enemy, so that the enemy cannot bring the fight to us. Understand that there is no higher calling, no greater duty, than to keep this nation **out** of war.

Ladies and gentlemen, this crew will help keep that peace. And ladies and gentlemen, this crew is elite. Our Submarine Force is the envy of every nation on earth. It is the pinnacle of centuries' worth of tradition, of skill, of pride, and of professionalism.

Today, this crew will man the pride of America's manufacturing capacity:

-a state-of-the art vessel that will quietly patrol beneath the waves, not only as the muscle and the backbone of our Fleet, but also its eyes and ears.

Members of the crew: always keep your eyes and your ears open. Remember your oath and your creed.

This nation depends on you, and your stewardship of the California.
Remember:

- You are the quiet warriors.
- You are the silent sentinels.
- You are the shield around us.
- You are the chosen few.

The sea favors the most capable sailors.

Gentlemen, take that expertise and push out from this safe port and into danger and glory.

Explore, dare, and discover.

May God watch over this crew, so that this crew may watch over us.

Thank you for your service.
Thank you for having me, God Bless the USS CALIFORNIA, and God Bless America.

NAVAL SUBMARINE LEAGUE CORPORATE BENEFACTORS RECOGNITION DAYS ADMIRAL KIRKLAND H. DONALD, U.S. NAVY DIRECTOR, NAVAL REACTORS 1 FEBRUARY 2012

Admiral Mies, thank you for that warm introduction. Admirals, Submarine League's Board of Directors, and friends of the Submarine Force—it is a pleasure to share this evening with you. To the Corporate Benefactors, thank you for your ongoing support of the Submarine Force, the Naval Submarine League, and this event.

Tonight I will take the opportunity to highlight some of the nuclear fleet's accomplishments over the last year. I will also give you an update on some of Naval Reactors' major projects as well as provide an outlook for those projects based on the constraints of the Budget Control Act. Finally, I will address how the new defense strategy relates to the Submarine Force.

Operationally, the Submarine Force performed well across a range of operations. Our SSBNs completed 35 strategic deterrent patrols; our SSNs conducted 37 deployments and professionally executed 57 missions of significance to national security; and on any given day two-or-three SSGNs were deployed, bringing strike, surveillance, and special operations capabilities to the most worrisome hot spots around the world. Demand from the Combatant Commanders remains high, and there was no better advertising for the Submarine Force's capabilities than our actions during the initial days of Operation Odyssey Dawn.

This past year, USS CALIFORNIA was added to the fleet, and with her christening in December, USS MISSISSIPPI is not far behind. However, as new submarines come online, we are making progress in the inactivation of the Los Angeles-class—having completed the defueling of USS MEMPHIS and USS PHILADELPHIA this past year.

Our shipyards have sustained the force with 14 major availabilities, to include refueling overhauls of USS PENNSYLVANIA and USS WEST VIRGINIA. Of course, I need to mention the significant work the industrial base accomplished to support the four CVN availabilities that occurred last year, including the efforts to complete the refueling overhaul of USS THEODORE ROOSEVELT (CVN 71).

Recruitment and retention for the nuclear Navy remained strong. This past year, we brought in 3,476 qualified officer and enlisted candidates, to include 17 women bound for our SSBN/SSGN force. For the women who started submarine training in 2010, 10 have already reported to their new commands. We continue to strengthen our relationships with the top engineering schools across the country. Last spring, Naval Reactors entered into a formal partnership with the University Engineering Alliance consisting of 11 schools across the Midwest with excellent engineering programs. This partnership has provided Naval Reactors with increased access to and enhanced visibility with the students at these schools, giving us direct interaction with university faculty, facilitated Navy nuclear presentations in the classroom, fostered the sponsorship of an annual summit, and allowed for curriculum reviews between Naval Reactors and the University Engineering Alliance schools. This partnership will give our future candidates a better foundation in nuclear education and do so cost-effectively by leveraging resources across the consortium.

Additionally in 2011, we were successful in leading strategic enterprise recruitment efforts that allowed our prime contractors, naval shipyards, and the Navy Recruiting Command to meet overall hiring demands of more than 1,800 engineers across the Program. Naval Reactors personnel visited over 70 percent of the Top 25 engineering schools across the country. Not only did we increase awareness of the entire spectrum of opportunities within the Naval Nuclear Propulsion Program, but we have seen improvement in the quality of candidates applying to various aspects of the Program.

Naval Reactors is entering a unique time in the Program's history, and recent changes in the Federal Budget climate will challenge us even more. We have a tremendous amount of work to do in the next few years, and we cannot do it without the support of many of the industries represented here tonight.

The complexity and simultaneity of this work has only been matched during the early years of the Program. In addition to nuclear design and construction programs such as VIRGINIA, OHIO-class Replacement, and GERALD R. FORD which are well known and receive significant press coverage, lesser known projects such as the ramp up for the new 688-class Moored Training Ship Conversions to replace our aging training platforms in Charleston, the S8G Prototype Refueling Overhaul in New York, and the much needed recapitalization of our spent fuel handling facility in Idaho are not far behind. The stakes involved in what we have planned are high; this is truly *bet the company* type work. While daunting, the prospects for setting the course for the Program for the next 30-40 years are equally as exciting for me and I hope for you as well.

Focusing first on construction, MINNESOTA, NORTH DAKOTA, and JOHN WARNER are progressing smoothly. We started building SSNs 786 and 787 last year and will continue to start 2-per-year in 2012 and 2013. However, VIRGINIA is one of the programs that may feel the pressure constraints of the Budget Control Act, and we are all familiar with the impact this could have on the already troubling Submarine Force structure picture in the future. On the other hand, we are hoping to receive funding for the design of the VIRGINIA Payload Module which would keep the Submarine Force consistent with the new Defense Strategy's recognition of the key role our undersea forces play in deterring our adversaries. While this is an important and needed capability, we would still need to be very focused on not only controlling costs, but reducing costs as we go down this road, because we cannot sacrifice hulls for added capability.

January 2011 marked the successful completion of Milestone A for the OHIO-class Replacement Program, which allowed for the transition into the Technology Development Phase. While we continue to tackle design challenges, I am confident that this future platform will deliver safe and effective combat capability while meeting warfighting needs in a cost conscious manner.

Similar to VIRGINIA, fiscal pressures could cause a construction start delay for the OHIO Replacement. Any delay in the construction start would cause a subsequent delay in the first patrol of OHIO Replacement, temporarily reducing SSBN force structure and challenging our ability to meet STRATCOM requirements.

To manage this risk, we must seek every innovation and efficiency to drive out cost and ensure OHIO Replacement ships are delivered on or ahead of schedule with the requisite warfighting capability. This will allow us to maximize the availability of these assets which will enable us to meet the nation's strategic deterrence requirements to the maximum extent possible.

Additionally, we are also in a teaming arrangement with the United Kingdom to share the design of a Common Missile Compartment. We must ensure that the design progression of the Common Missile Compartment remains on schedule to minimize impact to the United Kingdom's Successor Program.

In the propulsion plant, we are leveraging the work we have done in VIRGINIA and FORD to simplify the design and reuse components where it makes sense. In those areas where we are striving for significant improvement in capability—core life and stealth—we are taking advantage of the body of knowledge the Program has developed over the last two decades to manage technical risk while controlling cost. For example, to address production scale manufacturing challenges associated with different materials, the core we use for the refueling of the S8G land-based prototype will represent all key technologies necessary to satisfy ourselves that we can successfully manufacture and meet the stringent specifications for a life-of-ship core in OHIO Replacement.

Next, the construction of our next generation nuclear aircraft carrier is over 33 percent complete. Over two-thirds of the ship's structure has been erected and the first sections of FORD's flight deck will be landed in the next few months. All of the major propulsion plant equipment has been delivered and installed, and the propulsion plant test program recently got underway with the first fluid system tests. The next major milestone for GERALD R.

FORD will be christening and launch in the summer of 2013 with delivery in 2015. Delivery of FORD will restore the force structure to 11 operational carriers and when she deploys later this decade, she will embark over 1,000 fewer personnel than a NIMITZ-class carrier, saving the Navy over a hundred million dollars annually in operating costs.

As with all shipbuilding programs, affordability is the major focus area on FORD-class ships. In the past several years we have seen large per-ship increases in the cost of government furnished equipment, materials, and labor. We need to do better work across all areas—because we are our own bill payer, and we cannot afford the fleet we need.

As we all know, these great ships we are building cannot go to sea unless they have highly trained sailors to operate and maintain them. To this end, Naval Reactors is about to embark on a short duration, high intensity program that will convert two 688-class submarines into Moored Training Ships.

Last year, we completed most of the preliminary design work and have begun the necessary detailed design work in preparation to begin the conversion of USS LA JOLLA (SSN 701) in December 2014, making the platform available for student training at NPTU Charleston in late 2017. USS SAN FRANCISCO (SSN 711) will commence conversion in March 2017 with delivery in August 2019. Once converted, these former operational work horses will ensure our sailors develop early on the appropriate respect for our complex technology. In addition to the conversion program, Naval Reactors, for the first time, will replicate engineroom watch stations to assist in the training of students, as we begin our transition from four to three critical training platforms.

As I mentioned in my discussion of ORP, the new core for the S8G Prototype will test new technologies in order to reduce manufacturing costs and increase core life in support of future applications including a life-of-the-ship core for the OHIO-class replacement platform. The S8G Prototype is on track to begin her 31-month refueling overhaul in September 2018 with a return to student training in 2021.

The last major program I will speak about tonight deals with the transfer and storage of spent nuclear fuel. Naval Reactors is planning for a substantial increase in refueling/defueling workload in the near future, driven mostly by NIMITZ-class refuelings continuing toe to heel, the LOS ANGELES-class coming off-line in increasing numbers, and the ENTERPRISE decommissioning at the end of this year.

In the past, I have discussed how Naval Reactors is using a multipronged approach to address the challenges we are facing in meeting our commitments to the State of Idaho where our spent nuclear fuel is processed, and I would like to provide some updates on what we are doing.

The first approach involved moving our spent fuel out of wet storage into dry canister storage. This past year, we loaded the 50th spent fuel canister into permanent dry storage at the Expended Core Facility. This means about one-third of the Navy's existing fuel in Idaho is now in a spent fuel canister ready for offsite shipment to a permanent storage facility.

The second approach deployed the new M-290 shipping container system that increases efficiency because it allows fuel assemblies to be transferred directly from an aircraft carrier without intermediate processing in the surface ship support barge. So far we have delivered the first four of 25 planned M-290 spent fuel shipping containers on-time and within the almost $600M budget to support efficiency improvements at Newport News Shipbuilding for carrier reactor servicing.

The final approach recapitalizes our Idaho facilities. Although the Expended Core Facility continues to be maintained and operated in a safe and environmentally responsible manner, it no longer efficiently supports the nuclear Fleet. While key elements of the new design are being supported, we have been challenged in obtaining construction funding. Naval Reactors is reviewing the construction schedule and is developing mitigation plans. A primary goal of the mitigation plans will be reducing the additional cost the construction delay causes because we may be forced to procure additional M-290s each year the project is delayed.

Just like the aforementioned Program technical work represents both risk and reward for the Naval Nuclear Propulsion Program, the current strategic defense and fiscal environment represent both great opportunity as well as great challenge to our Navy, and more specifically, the nuclear fleet. As we have previously discussed in this forum, retrenchment from our ground wars coupled with a sustained desire of this country to remain influential globally calls out for flexible, forward, enduring naval capability as an arm of national power. Particularly in the Asia-Pacific region where the stakes of conflict are so high, the relevance of our allies so consequential, and the effects afforded by naval power so well suited, a strong Navy is, in fact, our asymmetric advantage. The recently published Defense Strategy clearly outlines a *pivot* toward the inherently maritime theater of operations, the Pacific, and provides the framework for shaping future budgets to address the needed force structure and capabilities. The Navy is very well positioned to address the Nation's strategic, operational, and tactical thinking to address both reinforcement of ally relationships and deterrence of potential adversaries around the globe, and particularly in the Pacific. Our Nation's senior leadership clearly recognizes this as it has been a very long time since the value of nuclear ships, both submarines and aircraft carriers, has been so broadly recognized and support for their construction and employment so deep. At the same time the challenges to get the resources we need to build, operate, and maintain our fleet cannot be underestimated. Pressure on defense spending will not subside and even the best supported programs will receive scrutiny and, likely, will pay some amount of "tax" as cuts are levied. We are no exception. As the FY13 budget is unveiled and subsequent congressional debate unfolds, I suspect you will see both of these phenomena in play. I also suspect that as the budget *pushing and shoving* gets more intense and timelines toward decisions get shorter, that is not the time to have anyone questioning our relevance or stewardship of our resources. Accordingly, here are a couple of areas where we need to sustain our alignment and focus:

• Continued operational excellence. As I mentioned earlier, our ships and sailors are doing some remarkable things in some very tough environments. You have provided them with superb capability and they have trained diligently to extract the most tactically from the ships and systems they employ. We have set the example of rapid, yet thoughtful deployment of technology. Our fleet leadership has set and maintained very high standards for operational proficiency. We cannot let up.
• Importance of nuclear deterrence and the Navy's unique role and responsibilities. Admiral Mies has spoken eloquently on this topic and there is significant churn as the Nation strives to sustain an aging stockpile, recapitalize an aging delivery platform, and define the role of nuclear deterrence in the security strategy. There is significant risk of making short term decisions, without full benefit of deep understanding of deterrence theory and strategy that will have long term, irreversible, negative consequences.
• Excellence in program execution. The support we enjoy is in no small fashion the result of competent program management and execution. We have a legacy of on time, on budget, on quality delivery. That must continue, and it is not a given. We have challenges in the VIRGINIA and FORD programs that if not addressed will have dire consequences on our ability to protect future force structure. Similarly, cost challenges in the OHIO Replacement Program must be collaboratively addressed. Nearly every day I see some example of poor quality of technical work or a failure to consider opportunities to eliminate waste in our designs, solutions, and processes, none of which were birthed in intent or incompetence, but rather in complacency, overconfidence, or arrogance. Inexperience also plays a role as we are in the midst of an unprecedented demographic shift throughout the Program where very talented, but inexperienced young folks are replacing our experienced veterans who are retiring at increasing numbers. Supervisory attention is being directed more to backstopping

the deckplate technical work of our increasingly junior workforce at the expense of effective overall oversight and strategic direction. These are all vulnerabilities that we must address or suffer the consequence of failure.

I thank you again for allowing me to be part of this great event. I look out and see the faces of many who stood the watch and held the standard for many years. Our nuclear navy is strong today and has a bright future. I know that with your help we will continue down a path of safety and mission accomplishment from the design and construction of ships to the execution of our mission. Thank you for your contribution to the Program and our Nation. With that—I will be happy to take questions.

REMARKS NAVAL SUBMARINE LEAGUE CORPORATE BENEFACTORS RECOGNITION DAY
VADM JOHN M. RICHARDSON
COMMANDER, SUBMARINE FORCES
2 FEB 2012

Thank you very much for that gracious introduction. I'm very happy to be here and I always look forward to this event. This Corporate Benefactor Recognition Day event was my first real speaking engagement after coming to this job. It was at that point that I knew this was the audience that could help develop the Force's strategy and ideas. If there's a north star in the constellation of engagement opportunities, this is that Polaris. Many of my mentors, my colleagues, my advisors are here. You all are the folks who have positively influenced my career for many years. Thank you.

At this venue last year, I rolled out the initial *shapes and shadows* of the Design for Undersea Warfare. The input we received from this group helped sharpen our vision and we successfully rolled out the Design that following July.

We've come a long way since July and our vision has become much more unified, comprehensive and coherent. We also know that there is much work to be done and in the spirit of meaningful interaction, I want to talk about those directions that are starting to form. We're putting together the first update for the Design for Undersea Warfare and we're expecting to release that update in the summer.

What I'm going to talk with you about today is all extremely current. In fact some of the ideas I'll talk about this afternoon were just unveiled and discussed in detail at the Submarine Flag Officer Training Symposium which we held on Tuesday.

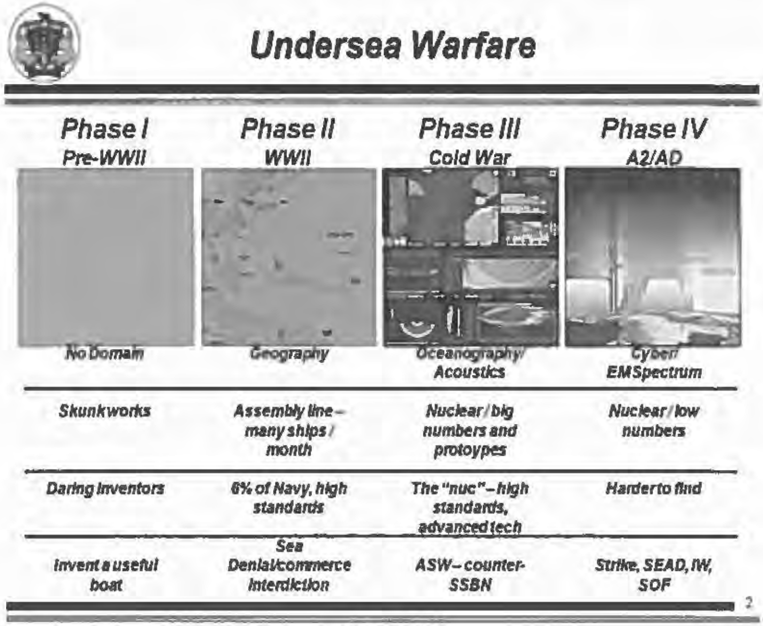

Figure 1

For those who were at the Symposium this past October, you heard me talk a little about the 4th Phase of Undersea Warfare and I think it could be argued that we've now entered this 4th phase. To recap very quickly, phase one would have been our experimental or exploration phase. The phase where we were trying to build something we could submerge and make it come back up again. Also this was the phase where we were trying to build an instrument that would become a useful warfighting application. Phase two was our World War II phase, where we really got our warfighting credentials. Phase three was, of course, the Cold War phase. By virtue of nuclear propulsion and nuclear weapons our domains were expanded and technology further enhanced our capabilities. Now, we're entering a new phase defined by area of denial, access of denial and the proliferation of long-range precision weapons. We're also entering the phase where cyber and *soft attack* requires us to have a deep understanding of many levels of the environment. I prefer to use the term *soft attacks* versus kinetic, non-kinetic. I think hard/soft is a little bit more descriptive. Using kinetic/non-kinetic is an abuse of a good physics term which never really sat well with me.

When I talk about these new missions, people often ask me what missions we'll stop doing as times get challenging. It would be great if we had the luxury to pick and choose missions that we would no longer execute, but the enemy gets a huge vote and in today's strategic environment it's like playing 3 and 4 layer chess.

We are building nuclear submarines in exquisite quality and sophistication, but we're building in low numbers. Our people are getting harder and harder to find. There are plenty of discussions about the economy, but the fact is our people are so highly qualified and desired that we're seeing some make the jump from the Navy to civilian opportunities.

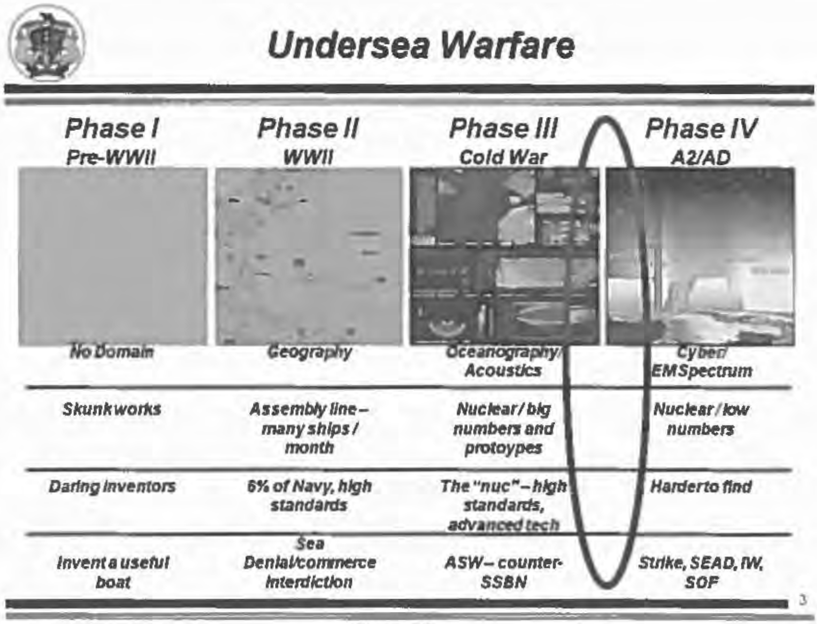

Figure 2

As we are transitioning into phase 4, I remain very optimistic. Having an appreciation of the 4 phases can give you a little bit of historical perspective. If you look back at those WWII and Cold War phases, those were existential crisis times—two went in and only one would come out. The stakes were incredibly high on a world-wide basis, but it was always the Submarine Force that led the way. We were the ones that would take the fight to the enemy in WWII and we certainly played a principal role in the Cold War—a decisive role. So the Submarine Force by virtue of our culture, our standards and the quality of our people will always have a tremendous responsibility and as always, we'll get through these challenging times. I remain very optimistic.

During this transition it is time to do some work. It is time to describe, even publish, the results of the Cold War. The contributions that the Submarine Force brought to the war that was won without starting a major world conflict. Where we can, we must declassify information and tell the stories of these undersea warriors. I've been working hard to make this happen in a controlled manner. Once we get a body of work declassified, our story can be told.

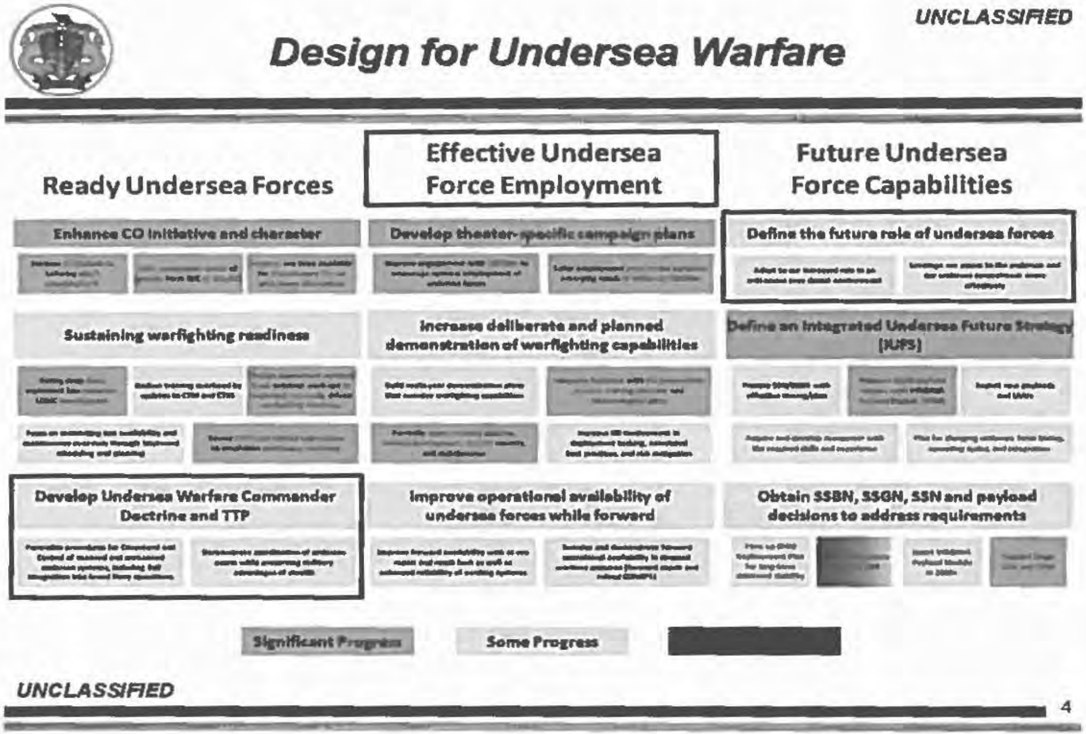
UNCLASSIFIED
Design for Undersea Warfare
Ready Undersea Forces
Effective Undersea Force Employment
Future Undersea Force Capabilities
Enhance CO initiative and character
Develop theater-specific campaign plans
Define the future role of undersea forces
Sustaining warfighting readiness
Increase deliberate and planned demonstration of warfighting capabilities
Define an Integrated Undersea Future Strategy (IUFS)
Develop Undersea Warfare Commander Doctrine and TTP
Improve operational availability of undersea forces while forward
Obtain SSBN, SSGN, SSN and payload decisions to address requirements
Significant Progress
Some Progress
UNCLASSIFIED
4

Figure 3

Figure Three is our report card on the Design for Undersea Warfare. We got our group of major commanders together and we decided it was important for us to grade ourselves in terms of executing the goals that we set in the Design. *(Ed. Note: Since we do not publish in color, the reader can easily visualize the character by the Admiral's stop-light description).* We can characterize our status in terms of a green-red-yellow stoplight. We can use orange-red for the two Virginia's per year. In light of some of the recent decisions, I would probably include the OHIO Replacement Program as orange-red as well. We need to go back and re-articulate exactly what we're after in terms of success for that program. Certainly we want to be superb in execution, but there's probably a little bit more that we can do to express that goal more succinctly.

The report card demonstrated a good effort by the whole team. Where we can grade a goal *green*, we're taking credit for being pretty much complete. We're not *done* here in that we'll stop paying attention to that goal—it's more like we've achieved a *new normal*, and we'll start to focus on the next challenge. We're going to move on to other goals.

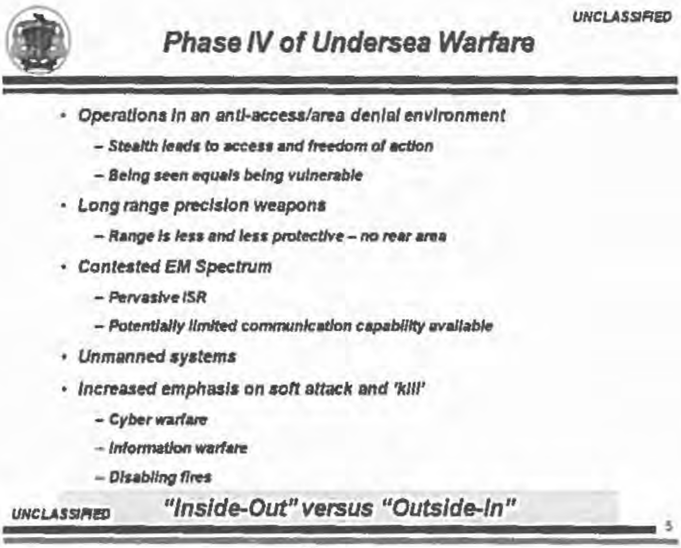

Figure 4

I want to come back to the topic at hand. Phase 4 and its implications for undersea warfare. In Figure Four, you see that many of these characteristics are ones you've seen before. Our stealth leads to access and once in there, freedom of action. Phase 4 will be a time where, more than ever before, being seen equals being vulnerable. With some of the newest long-range precision weapons, being imaged means being able to be targeted. While many forces will be working to break from the *outside-in* prospective, the undersea forces will be underneath the tents creating chaos, disruption, opportunity for the joint force from an *inside-out* perspective.

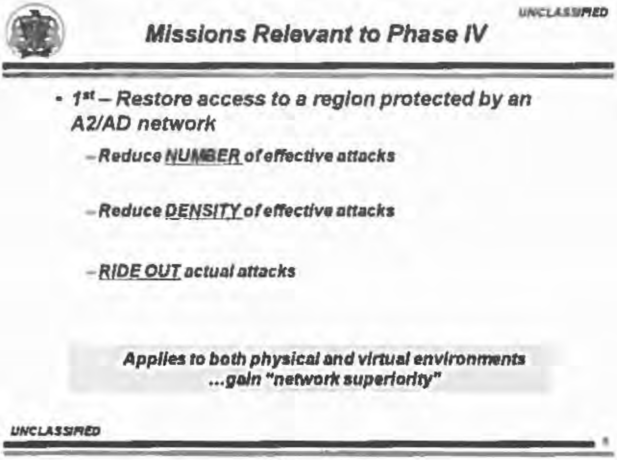

Figure 5

How do we define these disruptive opportunities that will enable the rest of the joint force and the Navy to get in? As we continue to define these roles, we know there will be a need to break down the anti-access force. A future conflict will require forces that can reduce the number and density of attacks. It will also require forces that can ride out attacks in both the physical and virtual environments. We already know how to define and gain maritime and air superiority...do we know how to gain network superiority so that we can dominate the conflict in that domain?

So, if you look at how undersea forces can play in terms of reducing the numbers of attacks, two ways come to mind. First, we can work to blind the enemy by disrupting the sensors network, and secondly, we can numb their nervous system—the command and control architectures. This is part of the *inside-out* approach that I spoke about a minute ago. These missions would be completely focused on allowing other forces to come in and fight from *outside-in*. In addition to sensors and C2, we would strive to strike the launchers to further reduce the attack density.

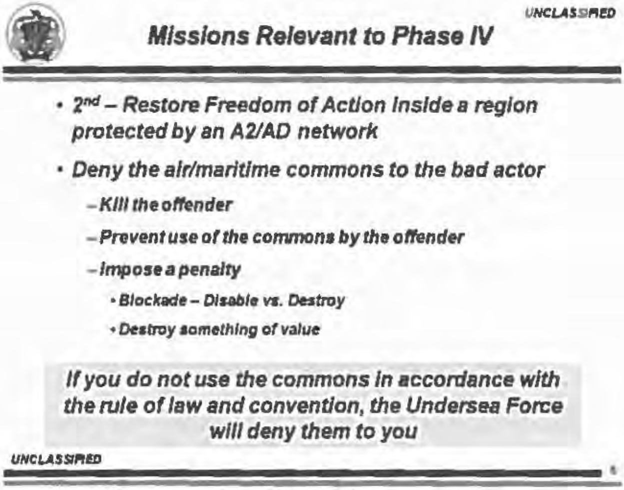

Figure 6

Another mission that will be intrinsic to undersea forces is that of restoring freedom of action, basically controlling the commons inside that formally denied area. This mission is an update that looks a lot like the fight we waged 70 years ago, in 1942. But our capabilities have moved far beyond those of WWII's. I'm really talking about stopping a ship, stopping his screw from turning, doing something in that *soft attack* way that will cause the enemy to be disabled and deny him from meeting his objective without sinking the ship.

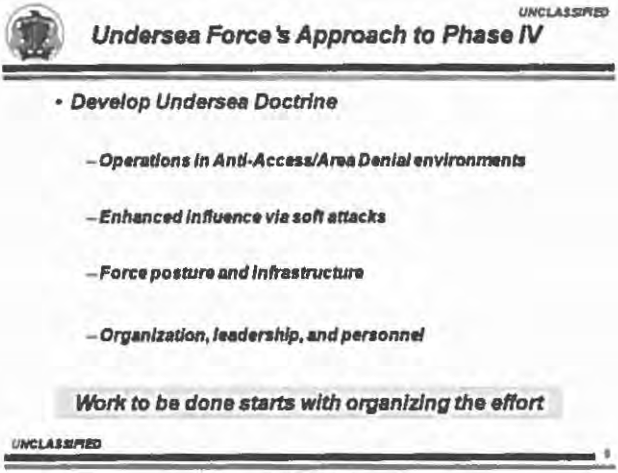

Figure 7

Figure Seven shows all the pieces that need to be done before we execute with precision. We need to establish the roles, the organizations and the undersea doctrine. We're working very closely with Naval Warfare Development Center on many of these initiatives. It has been a growing and rewarding relationship thus far and one that will continue to turn out meaningful results.

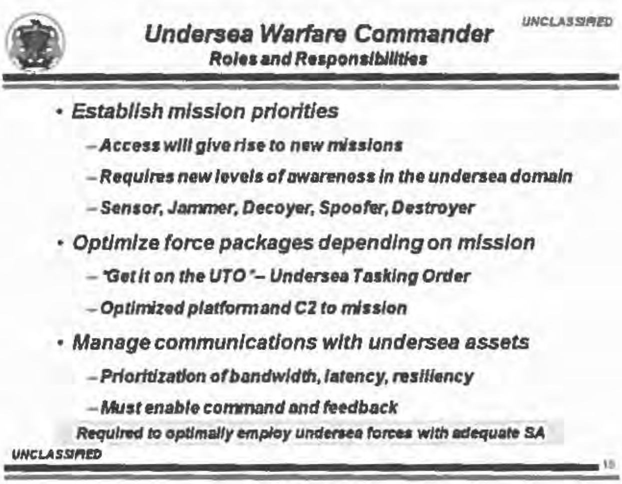

Figure 8

The last topic, or concept, I want to talk briefly about is the role of the Undersea Warfare Commander. As we think about the proliferation of systems that are being used in the undersea domain, commanders will require a much higher level of awareness and situational understanding in that environment. We can start by talking about our forces, the *blue* forces. We have our traditional manned submarines, our unmanned submarines and even our distributed sensors. There is also an awakening to the infrastructure undersea in terms of making use of natural resources. Mirror these same efforts and technological advances by the bad guys—they are getting better in this domain as well. Then there is the *white* contribution of sensors and systems. As you can see, driving and platforming in this increasingly complex environment requires a very high level of awareness and coordination. This Undersea Warfare Commander role needs to be taken to a higher level and one that is established before we enter the fight. It's a worthy discussion and one that we need to define soon.

Thank you again for this tremendous conference. I hope you found this discussion useful, and that it informs your strategies as well. The warfighting spirit and vision of the leaders before us... many in this room... has led to a force today that can go anywhere, capabilities that are enabling mind-boggling operations and Sailors that are unmatched.

ARTICLES

OUTLAW SHARK [1]
THE BEGINNING OF THIRD PARTY TARGETING AT SEA

by RADM Jerry Holland USN (Ret)

Jerry Holland is a retired officer who is a regular contributor to THE SUBMARINE REVIEW. He presently serves as Vice President of the Naval Historical Foundation.

OUTLAW SHARK was the first successful effort to use a combination of systems that working together had the ability to attack a target at sea that was beyond the range of the sensors carried by the individual shooters. OUTLAW SHARK created the setting in which development of Over-The-Horizon Targeting (OTH-T) at sea took shape. While some of the sensors and weapons that ultimately made up this ability were still in development at the time of the exercise, the concepts and methods were tested and proven. The results showed how to expand the attack opportunities by a single platform from its own limited horizon, (30 nautical miles for major surface warships, considerably less for submarines, 10 nm), to well beyond the limit of the sensors carried by surface ships or submarines.

Third party targeting was perfected in naval gunfire support for amphibious assaults during World War Two. Firing on targets that could not be sensed by the firing platform was executed through a naval gunfire liaison officer (NGLO) able to see a target requesting artillery fire on a specific grid coordinate or geographic location. The NGLO identified the target, its location and after ranging rounds would adjust the aim (*calling the fall of shot*) until satisfied the aim was correct when the order *Fire for Effect* would bring a barrage from the firing ship. In this mode, the firing ships never sensed the target. The operational technique was founded in visual sighting by an observer, two way radio and manual plotting on board the ship. These essential elements remain the basis for modern targeting beyond the range of sensors located on the firing platform.

In 1971 the deployments of surface elements of the Soviet Navy armed with long range tactical missiles in the Mediterranean Sea generated concerns about the vulnerability of aircraft carriers. Action to counter this new threat involved arming aircraft with air to surface missiles, and then creation of weapon systems that could counter enemy ships well beyond the range of existing guns and radar. By the late-seventies, technologies' had advanced the ability to attack effectively well beyond visual and radar ranges. The technologies that had to be developed to conduct such attacks included the abilities to:

- Determine the precise location of the firing ship.
- Conduct wide area surveillance over large bodies of water.
- Detect and classify potential targets in time and space and distinguish such from other objects in that area.
- Transmit this target and background locating data to a firing platform.
- Translate the received target location into weapon's orders.

All five of these steps had to be accomplished within a time period that would allow a weapon to be aimed, fired and arrive in the vicinity of the target before the target could escape.

Additionally, weapon(s) were needed that had the range to reach the potential target location, the speed to arrive there without excessive delay and devices to compensate for errors in the locating information and for the target's maneuvers during the period between sensing and weapon arrival. Central to meeting all of these specifications was computer equipment that was compact, reliable and fast. Fundamental to three of the five steps is a common time reference.

The first space-based navigation system, TRANSIT, went into operation in 1964 to support the Polaris Fleet Ballistic Missile deployment. This system relied on the Doppler shift of a radio signal from a known orbit. The Doppler was measurable because the receiver knew the position of the satellite and the timing of its signal. A single satellite pass was enough to provide a point fix but required long duration observation to obtain accurate measurement of the Doppler shift. Eventually TRANSIT had six satellites on orbit improving accuracy but still without the accuracy and timeliness necessary to support the Over-The-Horizon Targeting (OTH-T) mission.

In 1967 the Naval Research Laboratory (NRL) launched the first of two satellites that transmitted a unique radio signal, timed by a high precision clock. Any receiver tuned to the signal and knowing the satellite's position at a specific time would be positioned on a circle on the face of the earth. The center of this circle is under the position of the satellite and the circumference is calculated by the time interval between the transmission by the satellite and known to the receiver and reception of the signal. A second satellite was needed for a fix (intersection of two circles). As the number of satellites in orbit grew, so did the accuracy of the fix. Test satellites were launched in 1974 and 1977 with the first dedicated satellite, NAVSTAR 1, entering orbit in 1978. By May 1990 the Global Positioning System had 14 satellites on orbit and the daily anxiety of navigators from ages past on the probability of there being *morning stars* became history.

The second requirement, surveillance of large ocean areas, was met by a space-based sensor code-named Classic Wizard and the shore-based Ocean Surveillance Information System (OSIS). Since before World War II, the Navy had had an operational ELINT system, BULLSEYE, that could locate the source of high frequency radio/radar transmissions. That system depended upon triangulation using widely distributed ground stations. Calculations at first were done manually but by the 1960's were derived by computer. Though sensitive, the system was too slow and lacked the precision to serve as a weapons direction system.

The first experimental Navy ocean surveillance satellites, designed and manufactured by the Naval Research Laboratory, were launched in 1962 after years of development by NRL and the Defense Advanced Research Projects Agency (DARPA). These satellites, code-named POPPY, operated until circa 1971. The follow-on program in 1975 was a joint effort of NRL and the National Reconnaissance Office (NRO). The design consisted of clusters of satellites flying in near-circular low earth orbits at an altitude of almost 700 miles. At this altitude their detection horizon at any moment encompassed an area of 3500 miles diameter. Detection required the emission of an electronic signal. The contacts (ships, and later air and ground) detected by the satellites were then processed on the ground to calculate location, speed, and direction of movement. All of this required careful orientation of the clustered satellites and precise time common to all components.

The information thus derived went to OSIS (Fleet Ocean Surveillance Intelligence Centers/Facilities (FOSIC/FOSIF)) where it was combined with information from other sources and the resulting contact locations and predicted movements distributed to fleet commanders in the Atlantic, Pacific, and Mediterranean. While the emphasis was on Soviet ships, information regarding other contacts in their vicinity (background) was important in order to discriminate targets. The correlated locating and identification data went to the Shore Targeting Terminals (STT) at the Submarine Operating Authorities (SUBOPAUTH) where the data was tailored to a particular submarine. A sophisticated radio-computer combination then passed the information on the potential target to those submarines able to bring weapons to bear.

Hull-to-emitter correlation, HULTEC, associating specific radars to specific ships, began even before Classic Wizard was deployed. Maritime patrol aircraft with special collection equipment (EP-3) and detachments with similar equipment mounted in shelters on selected surface warships (Classic Outboard) or installed in submarines were deployed to measure the minute differences in radar characteristics associated with individual platforms. This information allowed OSIS to correlate the signals to specific platforms.

The communications paths connecting the satellites' earth terminals along the edges of the Atlantic and Pacific to the OSIS centers, between OSIS and the STT and from the STT to the submarine had to be able to pass a relatively large amount of data in a relatively short period of time. Two developments in communications techniques and theory were required to make these links possible. First was deployment of computers with the ability to allow both transmitter and receiver to access a common operating program at very high rates. While land-lines with adequate capacity could connect the space system's earth terminals to the FOSIC's and from there to the STTs, the historic communication paths to the fleet, operating in the high frequency (HF) band had neither the speed nor capacity for fast data transfer. Adequate bandwidth was available in the Defense Satellite Communications System (DSCS) developed in the sixties using satellites operating in the SHF band. But DSCS requires very large aperture antennae (6 to 7 feet diameter)—impractical for warships smaller than carriers and large deck amphibious ships.[2]

In the Tactical Satellite Program contracted in 1965, Lincoln Laboratory at MIT proved the concept of using a satellite-based radio operating in the UHF band. Though having a lower data rate than the SHF systems, a system in this frequency band was much less expensive, capitalized on the existing UHF infrastructure at sea, and most of all required a much smaller antenna that did not have to be aimed at the satellite. The first operational UHF satellites went into orbit in 1967 and 1968 allowing the Fleet Broadcast to shift from HF teletypewriter (75 bits/sec) to computer-to-computer links with consequent increase in capacity and timeliness (2400bits/sec). These initial units were followed by Gapfiller satellites and in 1977 by the Fleet Satellite (FLEETSAT) satellites.

For submarines, these UHF communications satellites were the basis for a system that allowed a new freedom of maneuver. They were half of the Submarine Satellite Information Exchange System (SSIXS). The other piece was the Integrated Submarine

Automated Broadcast Processing System (ISABPS, *Is a bips*). This computer at the Submarine Broadcast Control Authority (BCA) cataloged messages for specific ships, arranged them in order of priority and transmitted them on the existing VLF broadcast at a regularly scheduled interval (usually every two hours). But more than that, the system allowed the submarine to query the ISABPS computer through the satellite with an abbreviated signal at which time the computer would trigger the transmitter to send all relevant traffic via satellite to that particular ship—at the same time recording the time of the query. Developments in data compression allowed the outgoing messages to be sent and received in seconds. The results were dramatic; cutting the time necessary to expose an antenna from hours to minutes and even seconds and providing the SUBOPAUTH an exact knowledge of the state of information on board any particular submarine.

The next step was to turn the intelligence into action: getting the surveillance information to the launching ship. When budget managers in the Office of the Secretary of Defense refused to authorize funds for research into over-the-horizon targeting, RADM Guy Shaffer, Director, Navy Command, Control and Communications Projects, Naval Electronics Systems Command, found money to fund an experiment, OUTLAW SHARK.[3] For this experiment, a computer that eventually morphed into the Submarine Shore Targeting Terminal (STT) was set up at the Submarine Operational Authority Command Center in Naples, Italy and a companion computer was installed aboard a submarine. Similar terminals were installed on those surface ships planned to be equipped with Tomahawk anti-ship missiles.

The Naples headquarters copied operational intelligence data being collected for transmission to a Sixth Fleet aircraft carrier, condensed the data and relayed it to the submarine. The submarine's computer correlated the intelligence data with its own location and contact data in order to prepare search patterns for an anti-ship attack. In the exercise, the submarine received intelligence data in as little as six minutes after the detection.

In the beginning the target data, location and direction of movement, had to be entered manually into the Fire Control System (FCS). Eventually upgrades to the FCS (MK 117 and CCS MK1) made it possible to feed targeting data directly into the ship's fire control system.[4] The FCS then formulated the firing orders and sent them to the missile in the torpedo tube.

These sensors and the associated command and control arrangements provided the ability to use weapons with ranges beyond the range of the sensors carried aboard ship or submarine. The first, HARPOON, began in 1968 as an air-to-surface missile. By 1970 the HARPOON program had been extended to provide for launching from surface warfare ships. The first missile flew in 1972 and that year HARPOON replaced a proposed Submarine Tactical Attack Missile (STAM), with an encapsulated version of HARPOON capable of torpedo tube launch.

Early HARPOON missiles had a range of about 60 miles and made a nearly straight-in approach to the target homing on an ELINT signal with an optional pop-up-and-dive maneuver to dodge target defenses. When launched, the missile flew to a position near the target's reported location, turned on its seeker, located and attacked without further action from the firing platform. The concept relied on the short time of flight that permitted the missile to arrive in the target's vicinity before the target had moved very far from the location at which it had been detected or located when the weapon was launched. Over time the weapon guidance became more sophisticated to include mid-course guidance with a radar seeker but firing orders remained bearings only for short ranges or bearing and range for distant targets.[5]

In 1972, even before HARPOON was deployed, development of the TOMAHAWK Anti-Ship Missile (TASM) began. Originally planned to have a range of 140 miles, the Soviet anti-ship missiles range of 250 miles influenced Rear Admiral Walter Locke, the Cruise Missile Project Officer, to extend the missile's range. Replacing the missile turbojet with the turbofan engine used in the land-attack TOMAHAWK increased TASM range to over 300 nautical miles. Doing so made it necessary to create an end of flight search program that would account for the larger area of uncertainty that accompanied the extended range (i.e., longer time of flight allowing greater target movement). Admiral Locke used the actions of the scout bombers at the Battle of Midway as a model for this search program.[6] In 1975 the Johns Hopkins University Applied Physics Laboratory developed search patterns so that the TOMAHAWK anti-ship missile was capable of long range autonomous scouting and strike missions.

Three days after meeting with Admirals Holloway and Long, then Chief of Naval Operations and Deputy CNO for Submarines, in January 1976 to discuss creating an anti-ship missile in the TOMAHAWK program, Locke directed $700K to help fund OUTLAW SHARK. In December the first TOMAHAWK anti-ship missile flew 175 nautical miles toward the target and then began searching. The missile then flew another 173 nautical miles in a search pattern before finding the target that was 240 miles from launch point. This was the first long-range anti-ship cruise missile flight with no link between the missile and a controller. In contrast to the procedure for early TOMAHAWK land-attack missiles, the ship controlled all targeting and planned the entire anti-ship mission.[7]

The demise of the Soviet surface navy and the subsequent fame of the land attack version of TOMAHAWK (TLAM) has dimmed the memory and luster of the OUTLAW SHARK demonstration. But the lack of recognition has not diminished the significance of the event. This exercise was the ground work that lead to concepts for combining these systems and those of a similar nature for long range precision strike against targets ashore. OUTLAW SHARK was the model for Admiral Bill Owens' *System of Systems* that magnified visibility on the battlefield. Modern drone executed strikes are founded in these concepts and the systems that support them.

ENDNOTES

1. Except as otherwise noted, most of the historical material in this essay is developed from Norman Freidman, "Seapower and Space", Annapolis, US Naval Institute, 1990 and Norman Friedman, "Naval Institute Guide to World Naval Weapons Systems, 1997 – 1998", Annapolis,

Md. Naval Institute Press, 1998. The author is grateful for the review of the manuscript, corrections and advice from Rear Admiral Guy Shaffer, USN (RET), Rear Admiral Walter Locke, USN (RET) and Dr. Robert Hess, Captain, USNR (RET). The author alone is responsible for any errors and for all commentary.

2. During the Grenada invasion in 1983, SHF Vans borrowed from other services were piggy-backed onto the Second Fleet's command ship. Their antennae were neither stabilized nor trainable so their use was frustrating to commanders in the field and ashore as they lost signal during ship maneuvers. The commanders did not understand the limits of the equipment.
3. Friedman, Naval Weapons.
4. E.R. Hooton, ed., Janes Naval Weapons Systems, Janes Information Group, Coulsdon, Surrey, 1998.
5. Pieter Bakels www.navsource.org/archives/-1/57sl.ht, 11/12/08.
6. Rear Admiral Walter Locke to author, email, February 10, 2012.
7. Duncan Lennox, ed. "Jane's Strategic Weapons Systems", Issue 50, Surrey, Jane's Information Group, January 2009, pp 204-208.

TEAM SUBMARINE—PROVIDING UNDERSEA ASSETS TO THE WARFIGHTER

by Team Submarine Public Affairs

For more than a decade, Team Submarine has had an indelible presence at the Naval Submarine League's (NSL) Annual Symposium. Our flag officers have made numerous presentations and various staff members have manned a booth in the exhibit area. Team Submarine has even been honored by NSL with the 2009 NSL Submariner of the Year Award. Despite this recognition, the Team Submarine concept is not well known, as evidenced by the most common question asked to our booth workers - "What is Team Submarine?"

Team Submarine unites the Program Executive Officer for Submarines (PEO SUB); the Deputy Commander, Undersea Warfare (SEA 07); the Deputy Commander, Undersea Technology (SEA 073); the Naval Undersea Warfare Center (NUWC); and the Submarine Maintenance Engineering, Planning, and Procurement (SUBMEPP) Activity, once separate submarine-related commands and activities, into a single *submarine-centric* team. In doing so, Team Submarine eliminates traditional *stovepipe* structures and processes that previously created impediments and inefficiencies in the submarine research, development, acquisition, and maintenance communities. Team Submarine provides improved communication among the various offices that contribute to the overall success of the United States Submarine Force.

To provide greater visibility into Team Submarine, discussed below are a list of all the program offices, a description of what they do, and some of their recent accomplishments.

Program Executive Office for Submarines (PEO SUB)

Rear Adm. David Johnson is the Navy's Program Executive Officer for Submarines. As PEO SUB, Rear Adm. Johnson is responsible for a number of submarine research, development, and acquisition programs. PEO SUB consists of eight program offices, each tasked with the development and acquisition of specific submarines or submarine systems. These program offices are:

Virginia Class Submarine Program (PMS 450) – oversees the design, construction, and delivery of at least thirty Virginia Class submarines. The Virginia Class is designed and built to operate in today's challenging undersea environment across a wide array of littorals and blue-water operations. To date, eight Virginia Class submarines have been delivered, six are under construction and four more are under contract.

On Dec. 22, 2008, the Navy awarded a contract for eight Virginia Class submarines. The third contract for the Virginia Class, or Block III, covering hulls 784–791 is a $14 billion Multi-Year Procurement (MYP) contract that takes significant advantage of an increased procurement rate, enhanced construction processes, and design for affordability. As a result of the Virginia Class Cost Reduction effort, the Block III contract meets the Chief of Naval Operations 2005 mandate to remove approximately 20 percent of the per-hull cost by 2012. The Block III contract provides for one Virginia per year in Fiscal Years (FY) 2009 and 2010 with two per year in 2011, 2012, and 2013.

The Program Office is now working to further leverage its acquisition cost reduction successes into the ongoing Reduction in Total Ownership Cost (RTOC) initiative. The RTOC initiative seeks to reduce total ownership cost and increase operational availability through decreased depot maintenance.

Operationally, the Virginia Class has had several first-of-class successes. On Oct. 13, 2009, USS TEXAS (SSN 775) surfaced near the North Pole, marking the first Virginia visit to the Arctic Ocean. USS VIRGINIA (SSN 774) and USS HAWAII (SSN 776) recently completed successful full length deployments—the first for the Class—and maintained an operational tempo (OPTEMPO) of 84.6 and 84 percent respectively. USS TEXAS (SSN 775) completed its first deployment in August 2010 and maintained an OPTEMPO of 94 percent.

More recently, the Navy celebrated the commissioning of USS CALIFORNIA (SSN 781), the eighth ship of the Class, on Oct. 29, 2011 at a ceremony held at Norfolk Naval Station, Norfolk, Va. PCU MISSISSIPPI (SSN 782) was christened by Ms. Allison Stiller, Deputy Assistant Secretary of the Navy for Ships, on Dec. 3, 2011. Other Team Submarine milestones were the keel laying for PCU MINNESOTA (SSN 783) and the construction start for the next two Virginia (SSN 786 and SSN 787). The construction start for these submarines in 2011 marked the first time in 22 years that the Navy has begun construction on two submarines of the same class in the same year.

Ohio Replacement Program Office (PMS 397) – oversees the research, development, and acquisition of the replacement to the current Ohio Class ballistic missile submarines. Recent major program events include the Analysis of Alternatives (AoA) and the Gate 2 review. These were completed in preparation for Milestone A which was achieved on Jan. 10, 2011. As part of Milestone A, the program has begun its Technology Development Phase during which the Navy will establish requirements for the future class of submarines.

Team Submarine is prototyping components and certifying vendors for the Ohio Replacement today to ensure a smooth transition to design and construction in the coming years. The program office recently completed initial prototyping efforts on the missile tubes to prove the innovative modular build strategy.

Special Operations Forces (SOF) Undersea Mobility (PMS 399) – is responsible for the coordination of research and development initiatives, acquisition, test and evaluation, and in-service support of Dry Deck Shelters (DDS), Special Operation Forces (SOF) Host Submarines Systems, and future SOF undersea mobility systems.

In 2008, PMS 399 supported a significant milestone for the DDS when all six DDS were aboard submarines at the same time.

Five DDS were mated to SSGNs and one was installed on USS NORTH CAROLINA (SSN 777).

The program office recently stood up the Dry Deck Shelter Extension Acquisition Branch and Dry Combat Submersible Branch in advance of a planned effort to extend the pressure hull of the existing DDSs and explore the feasibility of a acquiring a new dry combat submersible, respectively.

Submarine Acoustic Systems (PMS 401) – is responsible for the development, acquisition, delivery and life cycle support of submarine towed and hull-mounted acoustic sensors as well as associated processing and support systems. The Acoustic Rapid COTS (Commercial Off-the-Shelf) Insertion (ARCI) program provides the submarine with regular hardware—Technology Insertion (TI) – and software – Advanced Processor Build (APB) – system refreshes based on *state of the practice* COTS Open Architecture (OA) components allowing ships to continuously deploy the most advanced warfighting capability available.

ARCI also supports processing for the Submarine Force's newest acoustic sensors. The TB-34 Fatline Towed Array and the Low Cost Conformal Array, which extends high frequency passive capability to near 360 degrees, have reached full rate production this year.

In fiscal year (FY10) and FY11, 14 submarines completed ARCI installations. Additionally, TI08/APB09 underwent operational tests on USS NORTH CAROLINA (SSN 777).

Undersea Weapons (PMS 404) – oversees the production, in-service support, and modernization of the Navy's Lightweight torpedoes (LWT) (MK46 & MK54), Heavyweight torpedoes (HWT) (MK48), and acoustic submarine emulators (targets) (MK30 Mod 1s & 2s).

The MK46 and MK54 LWT are the Navy's surface and aircraft launched anti-submarine torpedoes. Fielded with an expandable Open Architecture (OA) system, the MK54 combines software algorithms from the LWT and HWT programs with the latest commercial off-the shelf technology. The MK54 torpedo will replace the MK46 torpedo as the payload section for the Vertical Launched Anti-Submarine Rocket. Additionally, the MK54 is being fielded for rapid employment by surface and aviation assets. The High-Altitude Anti-Submarine Warfare Weapons Capability (HAAWC) program will provide an adapter kit to permit long-range, high altitude GPS-guided deployment of the MK54 by a P-8 Maritime Patrol Aircraft.

The U.S. Navy maintains a Joint Program Office (JPO) with the Royal Australian Navy for the development, testing, fielding, and post delivery support of the MK48 Advanced Capability (ADCAP) Common Broadband Advanced Sonar System (CBASS) torpedo.

The Undersea Weapons Program Office recently competitively awarded both the MK48 and MK54 contracts.

Undersea Defensive Warfare Systems (PMS 415) – conducts research, development, and acquisition of both submarine and surface-ship undersea weapons defensive systems.

These systems include acoustic countermeasures, acoustic intercept systems, towed torpedo defense systems, and acoustic augmentation systems.

At the direction of the Chief of Naval Operations (CNO), Surface Ship Torpedo Defense (SSTD) has been a main focus area for the program office. The program office is working to deliver a hybrid prototype SSTD capability to a high-value unit in FY13.

Another focus area for PMS 415 has been Submarine Acoustic Warfare Systems (SAWS). The program office recently awarded a contract for the Next Generation Counter Measure Developmental Contract which is designed to provide submarine defense from torpedoes employed by hostile nations.

Submarine Combat and Weapons Control (PMS 425) – develops and acquires combat and weapons control systems for both new construction and in-service submarines. Submarine combat and weapons control system utilizes information gathered by the submarine's sensors to localize and prosecute targets while maintaining situational awareness.

The program relies on Rapid COTS (Commercial Off-the-Shelf) Insertion (RCI) to provide regular hardware—Technology Insertion (TI) – and software – Advanced Processor Build (APB) – updates. TI's provide a submarine's hardware baseline allowing for the integration of future capabilities. *State of the practice* COTS OA components are updated every two years with a platform receiving a new hardware baseline every four years. APBs are provided to the latest hardware baseline every even year and provide improved capability over the previous baseline. Additionally, TI's provide proactive COTS obsolescence management of a submarine's hardware baseline with the added benefit of increased processing power allowing for the integration of future capabilities.

The Submarine Combat and Weapons Control Program Office is currently working to transition all SSNs and SSGNs to a common system, the AN/BYG-1. All legacy conversions are planned to be completed by end of calendar year 2013.

Similar to the office maintained by PMS 404, the U.S. Navy maintains a JPO with the Royal Australian Navy for the development, testing, fielding, and post delivery support of the AN/BYG-1 system.

Submarine Imaging and Electronic Warfare Systems (PMS 435) – designs, develops, and oversees the construction, modernization, and in-service engineering of Electronic Warfare (EW) systems, periscope systems, and photonics masts. Photonics masts, employed aboard Virginia Class attack submarines and Ohio Class SSGNs, replace traditional barrel periscopes with non-penetrating masts containing black and white, color, and infrared digital cameras located in an outboard sensor unit.

PMS 435 also procures the Integrated Submarine Imaging System (ISIS). ISIS provides visual and infrared imaging, integrated control and display and the Periscope Acquisition Tracking and Ranging with Improved Observation Techniques (PATRIOT) Radar on Los Angeles and Seawolf Class attack submarines along with the Ohio Class SSGN and Virginia Class Submarines. ISIS will be integrated into the Submarine Warfare Federated Tactical System (SWFTS) and will implement the TI/APB process utilized by ARCI and AN/BYG-1 starting with TI-10.

The program office is also pursuing the development of a Low Profile Photonics Mast and an Affordable Modular Panoramic Photonics Mast (360 degree imaging mast).

In addition to imaging programs, PMS 435 also procures and supports the AN/BLQ-10 Electronic Warfare (EW) and Improved Communications Acquisition and Direction Finding (ICADF) systems which are COTs based replacements for the legacy AN/WLR-8 and AN/BRD-7 systems.

Maritime and Surveillance Systems (PMS 485) – procures systems which provide tactical cueing and acoustic surveillance of the undersea domain. The program office is comprised of four main components—the Fixed Surveillance System (FSS), the Mobile Surveillance Systems (MSS), which includes Surveillance Towed Array Sensor System (SURTASS) and the Low Frequency Active systems, the Integrated Common Processor (ICP), and the Distributed System Group (DSG).

In July 2011, PMS 485 transferred from PEO Littoral Mine Warfare to PEO Submarine. Since then, the program office has participated in several successful demonstrations and certifications such as the installation and full system shakedown of the Compact Low Frequency Active (CLFA) Array on USNS Effective (T-AGOS-21).

Deputy Commander, Undersea Warfare (SEA 07)

Rear Adm. David Duryea, Deputy Commander, Undersea Warfare (SEA 07) is tasked with the total ownership of existing and emerging submarine platforms and systems. Aligned under SEA 07's purview are several program offices that conduct and support submarine maintenance, submarine rescue, deep submergence, and submarine safety.

Strategic and Attack Submarine Program (PMS 392) – provides oversight and management of submarine life cycle maintenance and modernization of in-service submarines; provides the process and conducts oversight on the NAVSEA certification of submarines at the end of each Major Depot Availability; monitors submarine operations and coordinates NAVSEA technical and logistics support for day to day Fleet operations; and programs and manages the planning and execution of submarine and nuclear powered surface vessel inactivations and disposals at the end of each hull's service life.

PMS 392's oversight and management of modernization includes the development of all ship alteration design packages covering all the submarine systems and equipment, and arranges installation by shipyards, field activities, or contractor teams. The program also provides technical validation and approval for Temporary Alterations (TEMPALTS), which provide vital, mission-specific capabilities for deploying submarines. In the past year, 123 alteration design packages were issued and 87 new TEMPALTS were approved for Ohio, Los Angeles, and Seawolf Class submarines.

During FY11, PMS 392 completed a highly-successful repair, and return to service, of USS HARTFORD (SSN 768). In support of Fleet requirements for increased Operational Availability and reduced total ownership costs, PMS 392, as part of Submarine Team One (ST1) conducted technical analysis to permit the reduction of the depot maintenance required for Los Angeles Class submarines, increasing their operational intervals from 48 to 72 months. This both reduces the ships' total ownership costs, and also adds, on average, one deployment per submarine over the ship's life.

Submarine Hull, Mechanical, and Electrical Engineering Management (PMS 392T) – provides superior, timely, and cost-effective life cycle maintenance, modernization, operations support, and systems engineering to ensure safe, reliable, mission capable submarines. Develops technically-acceptable alternatives and performs technical review/approval of any engineering changes and non-conformances.

Advanced Undersea Systems (PMS 394) – is responsible for the research, development, acquisition, test and evaluation, in-service support, and certification for advanced undersea systems. Assigned projects include submarine escape and rescue systems such as Submarine Rescue Chambers, Atmospheric Diving Systems, and the recently delivered Submarine Rescue Diving and Recompression System (SRDRS).

SRDRS is a three-phased acquisition program that delivers advanced submarine rescue and treatment assets to the Fleet. In 2008, SRDRS's Rescue Capable System (RCS) replaced the Deep Submergence Rescue Vehicle Mystic (DSRV-1) as the U.S. Navy's deep-submergence submarine rescue asset.

During the exercise Bold Monarch 2011, SRDRS conducted the first-ever U.S. Navy rescue system mate with a Russian Kilo submarine. During the exercise, SRDRS completed 10 dives on four foreign submarines, resulting in the *rescue* of 138 personnel.

PMS 394 is supporting the National Science Foundation and the Office of Naval Research in a major upgrade of the Deep Submergence Vehicle Alvin (DSV-2). In this upgrade, Alvin will receive a new pressure sphere and upgraded capabilities to support the scientific community.

Logistics Management Support (SEA 07L) – manages logistic functions for submarine platforms and systems during all phases of acquisition and throughout the life cycle providing modernization and maintenance support.

It takes an incredible amount of logistical support to put, and keep, our submarines at sea. This includes certifying that submarines are properly equipped with parts, technical documentation and other products that enhance operational readiness and ensuring the integrity of ships configuration information. SEA 07L also provides a face to the Fleet in tackling issues such as parts obsolescence and supportability concerns.

Recently, SEA 07L published 480 technical manual changes and facilitated material resolutions for approximately 743 parts on all in-service submarine classes.

Submarine Training (SEA 07TR) – is responsible for the systems and programs associated with training submariners. These systems include the state of the art Submarine Multi-Mission Team Trainer (SMMTT) that provides shore-based training for submarine combat control and sonar systems. Other systems, such as the Submarine Bridge Trainer, cover training for ship control and navigation.

On Sept. 17, 2009 the SMMTT Development Team received the Assistant Secretary of the Navy for Research, Development, and Acquisition's Innovation Excellence Acquisition Team Award for its innovative approach to bring together multiple partners to design and build a single, nearly all-encompassing, trainer.

Recent accomplishments include the installation of Virtual Tactical Labs in Groton, Conn. and San Diego, Calif. and the ground breaking of a Submarine Bridge Trainer in Groton.

Submarine Safety (SUBSAFE) and Quality Assurance Division (SEA 07Q) – is responsible for the implementation, administration, and coordination of the SUBSAFE, Deep Submergence Systems (DSS), and Submarine Fly-by-Wire (FBW) Ship Control System (SCS) Safety Certification Programs. The Division also enforces compliance with program requirements by conducting functional audits that assess the performance of activities engaged in SUBSAFE, DSS, and FBW work. In addition, SEA 07Q supports Team Submarine program offices, as well as both submarine Type Commanders, by performing SUBSAFE, DSS, and FBW certification audits and surveys of new construction and in-service assets. SEA 07Q plays an integral role in the U.S. Navy's Submarine and Deep Submergence Systems Certification processes.

Both the SUBSAFE and DSS Programs were created following the catastrophic loss of the nuclear powered submarine USS THRESHER (SSN 593) on April 10, 1963. While the exact cause of the loss is not known, the Navy investigation indicated deficient ship design specifications, deficient shipbuilding practices, and deficient maintenance and repair practices were root causes. To address these shortfalls, the SUBSAFE Program was established to provide maximum reasonable assurance of submarine watertight integrity and recoverability from a flooding casualty. The DSS Program was established to ensure manned submersibles are certified resulting in acceptable levels of occupant safety throughout each system's specified operating range when approved operating and maintenance procedures are followed. Finally, software and computers have replaced traditional electro-hydraulic and mechanical systems for ship control. Recognizing the importance of this new critical system, the Navy created the FBW SCS Safety Program modeling it after the SUBSAFE Program.

Among many other recent achievements, SEA 07Q completed 26 SUBSAFE, DSS, and FBW functional audits; 15 SUBSAFE Certification Audits; seven Unrestricted Operations certifications, and 30 DSS Sustaining and Certification Surveys in FY 11.

Submarine Maintenance Engineering, Planning, and Procurement (SUBMEPP) Activity – is responsible for the life cycle class maintenance planning, engineering, ship availability planning, material support, and maintenance instruction documents for the Submarine Force to ensure safe, reliable, and mission capable operations.

SUBMEPP, located in Portsmouth, N.H., participates in many initiatives to Reduce Total Ownership Costs and increase Operational Availability. Among these are the 48 to 72 month Operational Interval (OPINTERVAL) study of Los Angeles Class submarines with NAVSEA; Ohio Replacement Program design reviews for maintenance; and various individual ship engineering maintenance studies to support urgent Fleet needs and schedule changes.

Submarine Team One (ST1) – is responsible for improving the way the Navy conducts submarine maintenance and is comprised of personnel from Team Submarine's Strategic and Attack Program Office (PMS 392); the Submarine Maintenance Engineering Planning and Procurement Agency (SUBMEPP); the Naval Sea Systems Command's (NAVSEA) Logistical, Maintenance, and Industrial Operations Directorate (SEA 04); NAVSEA's Engineering Directorate (SEA 05); the Submarine Type Commanders; and the Naval Shipyards.

In 2011, ST1 won the Department of Defense Value Engineering Achievement Team Award for the Navy for its efforts on an engineering study that allowed the Navy to extend OPINTERVAL of Los Angeles Class submarines from 48 months to 72 months.

Deputy Commander, Undersea Technology (SEA 073)

Rear Adm. Thomas Wears, Deputy Commander, Undersea Technology (SEA 073) is responsible for near and long term research and development for submarine systems, autonomous undersea systems, and offensive and defensive undersea warfare weapons systems. Additionally, Rear Adm. Wears is the commander of the Naval Undersea Warfare Center (NUWC) in Newport, R.I.

SEA073 is actively pursuing advancements in undersea technologies such as advanced propulsion systems, submarine support systems, stealth, and undersea warfare payloads and sensors.

Additionally, Rear Adm. Wears serves as the Undersea Enterprise's Chief Technology Officer. In this capacity, Rear Adm. Wears has been tasked with developing the Undersea Enterprise's Science and Technology (S&T) strategy, maintaining a vibrant relationship with the Chief of Naval Research and the Defense Advanced Research Projects Agency (DARPA), and conducting periodic reviews to evaluate return on investment and rebalance the S&T portfolio as necessary.

Undersea Technology (SEA 073R) – is responsible for overseeing the development of advanced undersea warfare technologies for integration into surface, air, and submarine systems.

SEA073R is developing new technologies in several areas. One such technology is a new CO_2 scrubber system that utilizes solid vice liquid amine absorbent technology that is thermally regenerable, water tolerant, and non-caustic. Another area of research is in towed array reliability focused on Foreign Comparative Testing of systems and transitioning the Office of Naval Research's (ONR) Towed Array Reliability Future Naval Capability Project.

Naval Undersea Warfare Center (NUWC) – operates the Navy's full-spectrum research, development, test and evaluation, engineering, and Fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapon systems associated with USW and related areas of homeland security and national defense. NUWC provides S&T, development, acquisition support, and Fleet support, providing technologically advanced products and services to the Submarine Force.

Conceived to increase efficiencies within the submarine acquisition, maintenance, and modernization communities, Team Submarine has grown into the premiere design, development, acquisition, modernization, and maintenance directorate; ensuring that the U.S. Navy remains number one in the world.

RUSSIA'S FOURTH-GENERATION NUCLEAR-POWERED ATTACK SUBMARINE: A MISSILE DEFENSE NIGHTMARE – PART I

By Dr. Lajos F. Szaszdi

Dr. Lajos F. Szaszdi earned his B.A. in International Affairs at the Elliott School of International Affairs at The George Washington University. He obtained also at the Elliott School his M.A. in Security Policy Studies with a concentration on the Russian Armed Forces and the Russian Navy, graduating with distinction in the fields of Russia and the Russian Military Power, and Military History. He earned an M.A. in World Politics at The Catholic University of America, where he received his Ph.D. in World Politics. His book Russian Civil-Military Relations and the Origins of the Second Chechen War is an abridged version of his doctoral dissertation. Dr. Szaszdi worked as a Visiting Fellow on defense equipment and military technology at The Heritage Foundation. He is an independent open sources intelligence researcher and analyst, and a student of sea power, contemporary naval issues and naval history. In the 1990s he was invited several times to lecture on the Russian Navy and its Submarine Force at the late Professor Charles F Elliott's courses on the Russian military at The George Washington University. He is a Life Member of the U.S. Naval Institute and a member of the Naval Submarine League. Dr. Szaszdi has been attending the League's annual symposiums since at least 1995.

It was reported in the first week of October that Russia's first fourth-generation nuclear-powered multipurpose attack submarine, SEVERODVINSK, successfully conducted its first sea trials.[1] In naval terms, a fourth-generation submarine belongs to the latest and most modern generation of submarines. SEVERODVINSK is a Project 885 submarine of the YASEN (ash tree) class that has been described in Russia as "an undersea nuclear-powered guided-missile cruiser."[2] It is expected to be commissioned in the Russian Navy by the end of 2012. According to the director of the submarine's shipbuilder, Sevmash, the vessel's weapon systems will still need no less than six months of tests at sea in 2012 before SEVERODVINSK can enter service.[3]

SEVERODVINSK has been described by the U.S. Office of Naval Intelligence (ONI) as "Russia's first true multipurpose submarine," considered to be the successor of the *Akula-I* and *Akula-II* classes of nuclear-powered attack submarines (SSN) and of the *Oscar-II* class of nuclear-powered guided-missile submarines (SSGN)[4] The Project 885 submarines combine the SSN and SSGN types in a single class of multipurpose submarines. In addition to SEVERODVINSK, there is a second submarine under construction, KAZAN, with plans to begin construction in 2012 of five additional submarines of the improved *Yasen-M* class.[5] KAZAN, which is due to enter service in 2015, is being seen "as a prototype" of the *Yasen-M* class and compared to SEVERODVINSK, it will have "more advanced equipment and weaponry."[6] SEVERODVINSK's "estimated cost reached $1 billion" according to the Russian press.[7]

SEVERODVINSK has significant characteristics and capabilities. It has a full load submerged displacement of 13,800 tons, a hull length of 120 meters and a beam 15 meters wide, a maximum operational depth of 600 meters, and a top underwater speed of 35 knots—or between 35 and 40 knots.[8] The new submarine's maximum acoustic speed (the speed in which it still remains silent and is thus able to listen clearly through its passive sonar) was expected in 1996 to have been 20 knots, but it could actually be as high as 25 knots.[9] SEVERODVINSK has a crew of 90 including 32 officers.[10]

SEVERODVINSK's armament allows it to engage targets on the sea surface, underwater and on land. Reportedly its armament includes 24 sea-launched cruise missiles (SLCM), including "supersonic cruise missiles."[11] The submarine carries torpedoes, rocket-propelled torpedoes and anti-submarine warfare (ASW) missiles, and it can deploy sea mines.[12] The torpedo tubes weapon compartment would hold at least 40 weapons and probably 50 weapons if not more (such as 60 weapons),[13] including torpedoes and ASW missiles. In addition to its eight 21-inch (533 mm) torpedo tubes, SEVERODVINSK carries eight large missile launch tubes abaft the submarine's sail, probably angled.[14] The reported arsenal that these missile launchers may carry is formidable and includes: the supersonic P-800 (3M55) Oniks/Yashma (NATO designation: SS-N-26) anti-ship/land-attack SLCM, the supersonic P-900 (3M51) Alfa anti-ship/land-attack SLCM, the subsonic land attack RK-55 Granat (NATO designation: SS-N-21 SAMPSON), and the SS-N-27 SIZZLER SLCM.[15]

SEVERODVINSK's eight missile tubes might have each a diameter similar to that of the four launch tubes of the Virginia Payload Module (VPM), intended to be inserted in future U.S. Navy Virginia class nuclear-powered attack submarines (SSN). Each payload tube of the VPM has a diameter of 87 inches or 2.2 meters that can accommodate seven Tomahawk cruise missiles per tube.[16] The Virginia Payload Module tubes will have the same dimensions as the missile tubes of the Quad Pack quadruple missile launcher module for the Ohio Replacement next-generation nuclear-powered ballistic missile submarine (SSBN). These missile tubes will be capable of launching the Trident II D-5 submarine-launched ballistic missile (SLBM), with four Quad Pack modules planned to be fitted to the Ohio Replacement.[17] Missile tubes with a diameter of 87 inches or 2.2 meters would fit comfortably in the hull of SEVERODVINSK, which has a beam of 15 meters, compared to the Ohio Replacement SSBN's projected beam of 13.1 meters (43 feet) or the Ohio class SSBN/SSGN with a hull beam of 12.8 meters.[18]

It may be that the dimensions of SEVERODVINSK's missile tubes are the same as those of the missile launchers of Russia's fourth-generation nuclear-powered ballistic missile submarines of the Borey class. This level of commonality would be similar to the level of modularity between the missile tubes of the Virginia

Payload Module and those of the Quad Pack for the Ohio Replacement submarines. One indication of this may be that the first Borey class, Project 955 submarine, YURI DOLGORUKY, would be fitted with missile tubes with a diameter of approximately 2.2 meters, since it has been reported that the ballistic missile they would carry, the Bulava 30 (NATO designation: SS-NX-32), has a diameter of 2 meters while the missile's launch canister has a diameter of 2.1 meters.[19]

Each of SEVERODVINSK's launch tubes may carry at least three SS-N-26 missiles.[20] It is also possible that each missile tube may be able to hold four SS-N-26,[21] for a total of 32 missiles in the submarine. The SS-N-26, which is dubbed Yakhont in Russia,[22] has a diameter of 670 mm (26.4 inches) while its missile canister has a diameter of 710 mm (28 inches).[23] Four SS-N-26 in their launch canisters would occupy a space with an overall diameter of 84 inches (2.1 meters), which would fit inside an 87-inch (2.2 meters) missile tube.

Yakhont missile has a cruise speed of Mach 2.6 and a maximum range of 300 km flying at 14,000 meters, and a cruise speed of Mach 2 and maximum range of 120 km when flying 5 meters to 15 meters above the sea surface. The missile has a conventional 250 kg high explosive and semi-armor piercing warhead (HE SAP). Although essentially an anti-ship missile, the SS-N-26 can attack land targets through satellite navigation and a planned imaging infrared (IIR) seeker.[24] In addition, the missile could potentially be armed with a tactical nuclear warhead. There may be also a follow-on missile to the ramjet-powered SS-N-26 with a scramjet engine to *double* the speed of Mach 2.6 at altitude of the original weapon. This new missile may be similar to the Russo-Indian BrahMos 2 missile under development.[25] Another report describes the hypersonic BrahMos 2 as "a kerosene-based cruise vehicle capable of speeds in the Mach 5-8 range," and the land-attack version of the weapon would likely be designed to have twice the range of the current BrahMos missile, which is 299 km.[26] The BrahMos missile, which has a maximum speed of Mach 2.8, was developed jointly by Russia and India and is based on the

Yakhont. In terms of upgrades, there have been proposals to extend the range of the BrahMos to 1,000 km.[27]

The submarine's launch tubes could carry instead at least three P-900 Alfa ramjet-powered SLCM, each of which has a 550 mm (21.7 inches) diameter and reportedly uses the same missile canister of the SS-N-26.[28] Hence, it may be able to carry four Alfa missiles per launch tube for a total of 32 missiles. The Alfa SLCM has a cruise speed of Mach 3, a range of 300 km, and a 300 kg conventional warhead, although it could probably be armed with a nuclear warhead. The air-launched version of the P-900 is estimated to have a maximum range of 500 km.[29]

SEVERODVINSK may be able to hold at least 32 SS-N-21 land attack cruise missiles in its missile tubes if only four are contained in each launch tube. The SS-N-21 has a 510 mm (20.1 inches) diameter and it can be launched from 21-inch, 533 mm torpedo tubes.[30] The SS-N-21 has a launch canister that is 650 mm (26 inches) in diameter, which may be used to launch the missile from the SEVERODVINSK's "vertical weapons bay."[31] In such case each of the submarine's launch tubes would be able to contain only four SS-N-21. However, each missile tube could potentially hold up to seven of these SLCM if they are arranged the same way as seven Tomahawk TLAM (Tomahawk Land Attack Missile) are carried in the Virginia Payload Module.[32] Thus, SEVERODVINSK may have the potential to carry 56 SS-N-21 in its eight missile tubes. The *Sampson* missile could have a 100/200 kiloton nuclear warhead or possibly a 410 kg conventional warhead. It has a maximum range of 2,400 km to 3,000 km.[33] There may be a version of the SS-N-21 with an electromagnetic pulse (EMP) generator of a *high-power microwave* pulse "to disrupt electronic circuits."[34] The missile could also be equipped with a radar stealth active cancellation system. In the active cancellation system "the incoming...radar wave is sampled by a receiving antenna. Having predicted the aircraft's reflectivity at this frequency and angle, the avionics create and transmit a false echo (mauve), a signal designed to cancel out the genuine reflection...from the aircraft's skin."[35]

Other SLCMs that could be carried in SEVERODVINSK's missile tubes are three members of the Klub-S (submarine-launched) family of missiles, which are similar in design to the SS-N-21. One candidate is the Klub 3M54 (SS-N-27A) anti-ship missile, which cruises at subsonic speeds until the weapon's radar seeker locks-on to the enemy ship, when the SS-N-27A's third stage with a 200 kg high explosive warhead detaches and flies zigzagging towards the target at Mach 3. The maximum range of this version is 220 km.[36] There is a version of the 3M54 developed by 1998 "in which the forward part of the weapon becomes a supersonic rocket-propelled pay-load stage,"[37] presumably for different types of warheads and loads that may include an electromagnetic pulse (EMP) generator against the phased array radar and electronic systems of a ship.[38] A second anti-ship missile version is the Klub 3M54M1 (SS-N-27B), a subsonic SLCM with a 450 kg high explosive warhead and a maximum range of 300 km.[39] Then there is the Klub 3M14 (SS-N-30A), the land-attack version of the 3M54M1 missile. Like the SS-N-27B missile, the SS-N-30A is also subsonic, and has a range of 300 km and a 450 kg high explosive warhead, but it is equipped with a satellite guidance system.[40] There may also be a version of the land-attack 3M14 missile with an EMP generator. The Klub-S missiles have a 21-inch, 533 mm diameter, but they are contained in canisters with a 26-inch, 650 mm diameter.[41] The SS-N-27 may be kept inside the missile canisters when carried in the submarine's missile tubes, which would allow for only four missiles per vertical launch tube. In addition, the SS-N-27 can be launched from SEVERODVINSK's 21-inch torpedo tubes.[42] The SS-N-27 and SS-N-30A missiles, including perhaps the subsonic stage of the SS-N-27A, may be fitted with an active cancellation system for radar stealth.

Moreover, each missile launcher may fire a new generation of long-range cruise missiles (LRCM). It has been widely reported that the SEVERODVINSK will carry SLCM with a range of 5,000 km or about 3,100 miles, armed either "with conventional or nuclear warheads."[43] The reported sea-launched LRCM could be a submarine-launched variant of the new stealthy land-attack Kh-

101 and Kh-102 subsonic air-launched cruise missiles (ALCM). The Kh-101 has a 400 kg conventional warhead and the Kh-102 a 250 kiloton nuclear warhead, and both missiles are reported to have a range of 5,000 to 5,500 km.[44] The Kh-101 and Kh-102 have a diameter of 550 mm,[45] and the SEVERODVINSK's missile tubes could thus carry up to four or just three of these missiles. The Kh-101 (and Kh-102) has a stealthy design, with a reported radar cross-section of 0.01 square meters. The missile has "a variable flight profile, cruising at altitudes from 30-70 m to 6,000 m," with a circular error probable (CEP) of between 12 meters and 20 meters.[46] The LRCM carried by SEVERODVINSK may have an active cancellation system to achieve a lower radar cross section (RCS).

Another possibility is that the design concept of the Meteorit LRCM project of the late-Soviet period—which reportedly was cancelled—has been pursued secretly as another missile. There may be a new missile replacing the cancelled supersonic Meteorit-M (NATO designation: SS-NX-24 Scorpion) submarine-launched LRCM. In the 1990s, research continued with Kh-90, a successor to the Kh-80 or Meteorit-A (NATO designation: AS-X-19 *Koala*), the air-launched equivalent of the SS-NX-24.[47] The ALCM version of the Meteorit had a 1.2 meter diameter, a length of 10.5 meters, a cruise speed of Mach 2.5 to Mach 3 and a maximum range of 5,000 km.[48] Comparatively SS-N-24 had a diameter of 1.2 meters, a length of 12.5 meters, and a speed of Mach 2 – Mach 3.[49] More ominously, the Meteorit missile could carry two independently targeted 90-kiloton nuclear warheads, capable of attacking targets up to 100 km apart.[50] Interestingly, Jane's reveals that according to experts, the Kh-80 and Kh-90 "ramjet-powered platforms were used as testbeds for the plasma-stealth technology (codename Marabou) touted as being developed in Russia over the last decade."[51] This *plasma-stealth technology* would refer to the *stealthogenic*, cold plasma cloaking device Russia has reportedly been developing to make its combat aircraft stealthy against enemy radar.[52] In such active stealth system a plasma cloud engulfing the missile would absorb incoming radar waves or these would *pass around [the] plasma cloud* as if there would not be any missile present.[53] Each launch tube of SEVERODVINSK could carry one missile belonging to this class of large LRCM if it becomes operational.

SEVERODVINSK also has the potential to be armed with a submarine-launched version of the land-based Iskander-M Tender (NATO designation: SS-26 *Stone*) short-range ballistic missile (SRBM), if it is developed. Such an idea would imitate intermittent plans to deploy in U.S. Navy submarines (SSN and SSGN) the Navy TACMS (Tactical Missile System), a navalized version of the ATACMS (Army Tactical Missile System) "tactical semiballistic missile."[54] The U.S. Navy showed interest in the proposed TACMS-P (Tactical Missile System Penetrator), which would have a range of 300 km that could be extended to close to 500 km.[55] Russia could follow up this idea and thus develop a naval version of the SS-26 for use against land and sea targets. Since the SS-26 has a 920 mm (36 inches) diameter,[56] each of the eight missile tubes in SEVERODVINSK could hold at least one and up to two missiles inside canisters. The SS-26 equipping the Russian Army has a maximum range of 400 km to stay within the limits of the INF Treaty, but a submarine-launched version of the missile could have a range of 500 km. This would not be improbable, since the Iskander-M is a *direct* descendent of the 500 km-range land-based SS-23 SRBM, which was eliminated by the INF Treaty.[57] And a tactical sea-based SRBM is not covered by the INF Treaty.

The SS-26 can carry 480 kg or 700 kg warheads, which include according to Jane's "tactical HE [high explosive] earth penetrator for bunker busting, an EMP [electromagnetic pulse], and an anti-radar blast/fragmentation warhead." Moreover, "the missile can fly a depressed trajectory below 50 km altitude, and that the RV [reentry vehicle] can make evasive manoeuvres up to 30 g during the terminal phase, to prevent interception by a surface-to-air missile."[58] With a guidance system that includes an inertial navigation system (INS), satellite navigation, and TV or imaging infrared (IIR) for digital scene matching area correlation (DSMAC), the SS-26 has a CEP ranging between 10 meters and 30 meters.[59] Like the shorter-range Tochka-U (NATO designation:

SS-21 *Scarab*) SRBM, the SS-26 could be fitted with an *anti-radar blast warhead* to be used against *ship radar targets*. Like the SS-21, the SS-26 might be armed with tactical nuclear warheads with yields of 10 kilotons and 100 kilotons.[60] With inclined missile tubes the submarine could launch the SRBM while underway, without having to stop to launch the missiles.[61] Launched from Yasen class submarines, the SS-26 could be used to attack land-based radars and command and control centers. A submarine-launched Iskander-M could be employed as an anti-ship ballistic missile (ASBM) against AEGIS cruisers and destroyers to breach the defenses of an aircraft carrier battle group, in preparation for a saturation anti-ship cruise missile attack. Moreover, an attack aimed at AEGIS ships armed with the SM-3 missile would be intended to destroy elements of the sea-based leg of the European missile defense system.

Incidentally, the new land-based Iskander-K tactical missile system uses an Iskander SRBM road-mobile transporter-erector-launcher (TEL) to carry and launch two rounds of the R-500 ground-launched cruise missile (GLCM), a weapon which reportedly has a maximum range of 500 km.[62] Needless to say, this range of 500 km would constitute a violation of the INF Treaty. The R-500 GLCM, designed by the KBM missile design bureau, might be the ground-launched equivalent of the Kh-SD medium range air-launched cruise missile, developed by the Raduga (rainbow) design bureau. The Kh-SD ALCM has a reported maximum range of 600 km when flying at 15,000 meters, and a subsonic cruise speed of Mach 0.75. The Kh-SD shares with the 5,500 km-range Kh-101 the same *mission planning system* and a common guidance system.[63] Moreover, the new Kh-SD missile was apparently developed from the earlier Kh-65SE ALCM, which was designed as an anti-ship cruise missile.[64] Kh-65SE, which has been displayed with a stealthy design, has a range of 500 km to 600 km flying at Mach 0.48 to Mach 0.77, it cruises at an altitude of 40 meters to 110 meters and it has a 410 kg warhead. There was reportedly a land-attack version of the Kh-65SE missile, which has a CEP of 18 meters to 26 meters.[65] In comparison, the R-500 GLCM during trials cruised at a speed of about 250 meters per second, equivalent approximately to Mach 0.74, at a height of 100 meters, and conducted "several maneuvers" on its way to the target. Its CEP may be "less than 30 meters."[66] Such a missile may have an active cancellation system for greater stealth.

There could be a submarine-launched equivalent of the R-500 GLCM and the Kh-SD ALCM with a 500-600 km range for anti-ship and land-attack operations. Such a missile would be armed with a conventional or a nuclear warhead. It may have a diameter of 770 mm (30.3 inches) in the forward part of the missile, like the Kh-65SE appears to have.[67] If this type of missile is ever developed and deployed in the Yasen/Yasen-M class submarines, two could be carried in each of their missile tubes.

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[9] Wertheim, *The Naval Institute Guide to Combat Fleets of the World: Their Ships, Aircraft, and Systems*, p. 604. With regard to the Russians' progress in achieving greater acoustic stealth in their nuclear-powered attack submarines, see Polmar and Moore, *Cold War Submarines: The Design and Construction of U.S. and Soviet Submarines*, p. 319; RIA Novosti, "Nuevo submarino nuclear ruso 'Severodvinsk' completa con éxito primeras pruebas de mar;" Office of Naval Intelligence, *Worldwide Submarine Proliferation in the Coming Decade* (Washington, D.C.: Office of Naval Intelligence, 1995), pp. 5-6. The U.S. nuclear-powered attack submarine *Seawolf* can sustain an acoustic speed of 25 knots. See Funnell, *Jane's Underwater Warfare Systems 2008-2009*, p. 99.

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[11] RIA Novosti, "Russian Navy to receive new nuclear attack submarine by yearend," January 31, 2011, at http://en.rian.ru/mlitary_news/20110131/162394984.html (October 28, 2011); idem, "Run silent, run deep: Russia boasts most silent nuclear attack submarine."

[12] RIA Novosti, "Nuevo submarino nuclear ruso 'Severodvinsk' completa con éxito primeras pruebas de mar;" idem, "Russia to float out new nuclear submarine after delay;" Funnell, *Jane's Underwater Warfare Systems 2008-2009*, p. 24.

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THE LOSS OF SURCOUF: Solving an old Mystery
Part I of II

by CAPT Frederick H. Hallett, USNR(Ret.)

Before beginning this bizarre story, let me say a few things about my own peculiar background. I served as a gunnery officer aboard the heavy cruiser USS ROCHESTER during the Korean War and left her in December 1952 for Submarine School in New London. After graduation and reporting aboard USS TIRU (SS416) in Japan, I received the gold dolphins of a qualified submariner a year later at Pearl Harbor. When I left active duty I remained in the Naval Reserve and worked for 16 years at Electric Boat building submarines, concurrently serving during the last few years as Commanding Officer, U.S. Naval Reserve Submarine Division 3-11 at the Submarine Base, New London. I was privileged to know and work with some of the finest submariners of the day as well as nuclear and missile experts of great distinction. I was particularly close to Hal Shear and Bob Long, both later Admirals, and Captain Cy Young, having made shakedown cruises with them aboard Polaris submarines PATRICK HENRY and THOMAS A. EDISON. A lifelong sailor, I have sailed across the Atlantic three times, two of them in my own 35-foot boat, and have sailed to Bermuda many times. So I bring some knowledge of nautical matters relating to this story.

Almost every submariner of my vintage (commissioned 1951, qualified in submarines 1954) has heard some version of the story of SURCOUF, the giant French submarine which visited New London just before World War II began, tying up at State Pier because she was too long to fit the Sub Base piers. The most common version had her posing as Free French while secretly refueling and reprovisioning U-boats at sea, and the story recounts how the Navy became suspicious after several visits and arranged for one of our subs to tail her, catching her alongside a U-boat and sinking them both. Since we were not yet at war with Germany, the story usually ends with "We were told never to talk about this." There's just one problem with this fascinating tale.... almost nothing about it is true except that SURCOUF came to New London in November, 1941. The true story of this French floating fiasco is far more fascinating.


SURCOUF in 1939

There is an old cliché about history being written by the winners, and that is often true. But sometimes the losers get their chance—and sometimes neither winners nor losers prefer to talk about what really happened. This is one of those stories. It concerns what was then the largest submarine in the world—the French Navy's SURCOUF (NN3). She was a creature of 1920s strategic thinking and became a subject of controversy even before she was commissioned in 1934, having been specifically designed to evade international restrictions. This was the era of the Washington Naval Limitation Treaty of 1922 and the London Conference of 1930 which were intended to inhibit warship construction. By 1942 she was caught up in a web of pure incompetence, deceit, disinformation, and treason which threatened to disrupt relations between the U.S. and its allies in the nascent war against the Nazis. There are six key facts upon which an understanding of SURCOUF's true fate depends:

1. There was distrust between the Royal Navy and the French Navy of long standing, with deep roots in their history as adversaries. One of the most obvious manifestations of this distrust was the reality that when France surrendered to the Nazis

in 1940, of fifty admirals in the French Navy only one (Vice Admiral Emile Henry Muselier, **winner of an American Navy Cross during WWI)** came to fight on the British side. The new chief of state of what came to be known as Vichy France was Marshal Henri-Philippe Petain, who expressed his government's position in clear terms: "*The Axis powers and France have an identical interest in seeing the defeat of England accomplished as soon as possible. Consequently, the French Government will support, within the limits of its ability, the measures which the Axis Powers may take to this end.*"* This distrust, in the case of SURCOUF, was aggravated by the circumstances of her arrival in England and the manner in which she involuntarily came under the command of the Royal Navy's Flag Officer, Submarines, Admiral Sir Max Kennedy Horton, GCB, DSO, during Operation CATAPULT. Combined with Gallic pride which habitually balked at accepting help from outsiders, particularly Englishmen, this visceral lack of trust prevented both officers and crew from getting the benefit of any submarine training offered. Eventually, her short but totally dysfunctional career under British operational command convinced senior officers of the Royal Navy that she was not only politically unreliable but, because of her mechanical limitations and the repeatedly demonstrated incompetence of her crew, of no use to the Allied cause. During the same period, the officers and crew of SURCOUF became increasingly convinced that they were distinctly unwelcome both in the U.K. and in the U.S. to the point that their British operational commander was determined to rid himself of them by any means, fair or foul.

2. The design and physical configuration of SURCOUF was ill-suited to WWII-style warfare. Displacing 3257 tons on the surface (almost double the displacement of U.S. submarines of WWII) and 361 feet long, she had reduced stability because of the topside weight, particularly a (sometimes) watertight 185-ton rotating turret sporting two 203 mm. (8") guns in the forward superstruc-

*Page 815 – The Rise and Fall of the Third Reich: A History of Nazi Germany by William L. Shirer, Simon and Schuster, New York 1960.

ture and a watertight capsule aft to house a tiny Besson MB.411-ANF monoplane with twin floats and a rudder on the bottom of thefuselage. Also topside were two 37 mm. cannons, two Hotchkiss machine guns and two quad- mounted torpedo tube arrays on the after deck- one each for 15.7" and 21.7" torpedoes - which could only be fired while on the surface. She also had four 21.7" bow torpedo tubes which could be fired while submerged. Conceived by one of France's premier naval strategists, Admiral C.J.A. Drujon, and designed by naval engineer Jean-Jacques Leon Roquebert, she had two large Sulzer 3800 h.p. diesel engines and two propeller shafts, each driven by two 850 h.p. C.G.E. electric motors, giving the vessel a theoretical surfaced speed of 18.5 knots and a submerged speed of 10 knots for one hour on battery propulsion. SURCOUF was launched Nov. 18, 1929 in Brest and delivered to the French Navy July 11, 1931. Her maximum design depth was 80 meters (262'). She had no radar.

3. Almost all of the pre-war operating experience of SURCOUF's crew was lost shortly after she arrived in England. How that happened will be covered later, but only one officer, Yves Daniel, and about fourteen crewmen remained from a crew of more than 147. Reporting aboard in Britain was Capitaine de Corvette Georges Louis Nicolas Blaison, who was an experienced submariner recently retired for medical reasons. He had previously commanded the French submarine SIBYL. Capitaine de Fregate Paul Ortoli, a gunnery expert who had spent 1930 through 1932 as a lieutenant aboard SURCOUF trying to get the turret and weapons to work as designed, was senior to Blaison. After SURCOUF, Ortoli had gone off to other assignments and in 1940 commanded a flotilla of trawlers during the evacuation of Dunkirk. Although he had never commanded a submarine, he had commanded LA FLORE, a small destroyer. Admiral Muselier, who had been appointed by General de Gaulle to command the Free French naval and air forces, decided to appoint him to command SURCOUF, with Louis Blaison as his executive officer. This decision was a major factor in the unfortunate course of events of the next year. Capitaine de Corvette Georges Alphonse Rossignol was third officer and also an experienced submariner.

Beyond that the submarine experience was very thin, for the rest of her existence, SURCOUF would be plagued by frequent and serious operational problems stemming from lack of submarine skills, not helped by a lack of willingness to accept training or criticism from the British submariners aboard. Captain Ortoli himself found it impossible to accept any advice from the first Royal Navy liaison officer, Lieutenant John Greene, a submariner since 1935, or from his successor, Lieutenant Francis Boyer, also a submariner, each with valuable experience and fluent in French. Both were very critical (*appalled* might be a better word) at the state of training and discipline aboard and they described it in their reports to Admiral Horton. Each of them reported gross incidents like submerging with the conning tower hatch open, (resulting in flooding and chlorine gas in the battery compartments and living spaces), as well as diving without a proper trim with resulting loss of control and serious depth excursions. Even Sub-lieutenant Roger Burney, the third and last British Navy Liaison Officer (BNLO), not a submariner by training, reached the same negative opinion after a few bad frights. In normal times, the responsible submarine skipper would have been relieved in disgrace and a new team sent in to restore conditions for safe and reliable operation. But these were not normal times.... and there was no new team.

4. There were powerful political forces at work in the U.S. in 1940. A large portion of the American public was determined not to get involved in another *European War* and had also managed to both deplore and ignore Japan's rampages through Asia. Modern readers may have trouble understanding the strength of movements like the America First Committee. With roots in the mid-West and intellectual support from Yale Law School, funded by wealthy and influential businessmen and led by national hero Charles A. Lindbergh, more than 800,000 members advocated building up U.S. defenses and staying out of war. Political leaders like President Franklin Roosevelt had to cope with this political reality in setting national policies. One of the consequences was U.S. recognition of the Vichy regime as the legitimate government of France despite its pro-Nazi leanings. The U.S. government entered into negotiations with Vichy to guarantee the neutrality of

French colonies in the Western Hemisphere. Vichy's negotiator was pro-German French Navy Admiral Georges Robert, the "High Commissioner of the Republic to the Antilles and Guiana and Naval Commander in Chief for the Western Atlantic".
Later convicted and punished for collaboration with the Nazis, he would play a key role in SURCOUF's fate.

5. The U.S. Navy was completely unprepared for anti-submarine warfare in 1941. In a navy focused on long-range offensive operations, the standard U.S. destroyer had only one QC sonar set and two depth charge racks with five Mark 7 depth charges on each rack. Its main mission was anti-aircraft screening of capital ships, with a secondary mission of shore bombardment. The Army Air Corps was supposed to defend American waters. ASW aircraft as such did not exist, and almost anything that could fly (including civilian aircraft and blimps) was thrown into the hunt for U-boats. There was no ASW organization, no experts, no tactics, no training facilities and few weapons. The Germans exploited this weakness in what U-boat commanders later called *the happy time*", *the golden days* or the *American shooting season*. They launched 'Operation Paukenschlag' (Drumbeat) in December 1941 with five Type IX U-boats which ranged at will up and down the U.S. east coast. In February, 1942, just when SURCOUF was leaving Bermuda, four more U-boats entered the Caribbean to conduct coordinated attacks on oil refineries at Aruba, Curacao and Trinidad on the 16th. U-502 alone, operating near Aruba, sank six ships between 16 and 23 February. By July, there were 70 U-boats operating in American waters and by October this had grown to 105. During America's first year of war, 1027 Allied ships were lost to U-boats, mostly in the American defense zone, at a cost of only 86 U-boats sunk.

6. For reasons which will become clear, neither the British government, the French government nor the U.S. government wanted to admit the truth about SURCOUF. The Germans who knew what had actually taken place were few, and most of them departed this life on 17 February 1943 with the loss of U-69. That is how the loss of SURCOUF came to be associated with the story

found in all the official history books, that she was sunk in a collision with the American freighter THOMPSON LYKES. It was a plausible and convenient fiction which embarrassed no one. But that is not really what happened.


SOUCUF

From what I have discovered in doing the research for this article, this was a French submarine crew which could barely keep their own boat operating, much less carry out the difficult task of resupplying another submarine in the open sea. During her entire existence, she never fired a single shot in anger—neither guns nor torpedo tubes. Plagued with problems from the start, she rolled in heavy seas, sometimes far enough to spill acid from her batteries. She was slow to dive (two and a half minutes to 40 feet) and hard to control while submerged, with recurrent hydroplane and rudder problems. The aircraft could only be launched and recovered on the surface in a flat calm, and then it took 30 minutes. The turret leaked.

An unbiased observer would judge SURCOUF to have been a failed experiment, but despite her technical shortcomings, she was considered to be an important symbol of French seapower. Since Napoleonic times, the French had been unusually devoted to symbols of military prowess, even though their symbols had not served them well as military technology rapidly advanced. (The Maginot Line was such a symbol, along with the symbolic courage of the French infantryman, who, if properly led, was believed to be able to overwhelm lesser men armed with machine guns, Stukas and Panzers.) But even symbols, if they are complex machines, must be maintained. That requires trained technicians and a steady supply of repair parts, but most of SURCOUF's machinery had been custom-built in Cherbourg, and during the German occupation, spare parts were simply not available.

After a very short time trying to operate her as a Free French vessel under his command, the Royal Navy's Flag Officer, Submarines, Admiral Horton, decided that she could be of no help to the Allied cause as well as being very vulnerable to radar-equipped ships and aircraft. (Horton was described by military historian Charles McCain as "not the nicest man in the world...ruthless, indifferent to anyone's feelings, hard as nails and close as a clam" but also as "perhaps the greatest fighting admiral produced by Great Britain in the 20th Century"). But for political reasons (to avoid alienating the Free French), he was directed to keep SURCOUF in commission, and to find something useful for her to do.

Admiral Horton

It was very late in my research that I read the excellent book by James Rusbridger titled *WHO SANK SURCOUF? The Truth about the Disappearance of the Pride of The French Navy*, published in 1991 by Random Century Ltd., London (ISBN 0-7126-3975-6). The author exhaustively documents the strange story of this unlucky ship which sprouted legends and rumors from the moment it first arrived at Devonport in the British port of Plymouth. Of all that has been written about SURCOUF, a great deal of it clearly incorrect, Mr. Rusbridger did the most careful sorting of fact from fiction. His extensive research produced the most reliable and definitive account of SURCOUF's short career as part of the Royal Navy... right up to the moment of her departure from Bermuda in February, 1942. I genuinely regret that he did not live to see the military and diplomatic correspondence, logbooks, war diaries and action reports recently declassified and available at the National Archives and Records Administration facility in College Park, Maryland. It would have been a great experience to work with him to develop the surprising conclusions I have reached, which differ so markedly from any previous accounts.

When France declared war on Germany on 3 September 1939, SURCOUF was in Martinique. From 26 September to 18 October, she came slowly home as a convoy escort to KJ-2, a 25-ship convoy (including 11 tankers) from Jamaica to Brest. Picking up her story after the French Army collapsed under the German onslaught on June 12, 1940: Britain stood alone. Most Europeans, having seen the Nazi war machine in action, believed England was doomed. Like a cornered bulldog, Churchill was determined not to go down without a fight. His first task was to rescue the British army trapped at Dunkirk by the German advance to the sea. Hailed as *the miracle at Dunkirk* (officially it was called Operation DYNAMO), in only nine days, more than 338,000 troops were brought back to England from Dunkirk harbor and nearby beaches. Before they were even safely ashore, the British launched a new operation called AERIAL with three major objectives:

- to evacuate from western France all remaining British and Allied troops (which numbered more than 190,000)
- to keep the Germans from gaining control of the French Navy
- to demolish all French port facilities which might be useful to the Nazis.

The British were determined to ensure that the ships of the French Navy did not fall into German hands. On 17 June, Operation AERIAL was already underway as the new French premier Marshal Petain petitioned the Germans for an armistice. In Brest, the evacuation began that same day. At 4 p.m., all French naval ships began departing. Many of them turned west and south and made for Mers-el-Kebir in Algeria, or Dakar, with only a few heading across the Channel to England. On 18 June, among the last to leave was the largest submarine in the world, the pride of the French Navy, with the dull booming echoes of demolition charges following her out to sea as British military engineers systematically blew up the harbor facilities.

SURCOUF had been undergoing a refit with much equipment disassembled for repair. Both of her big Sulzer diesels were out of commission, but Captain P. M. H. Martin decided she could get to Plymouth, 122 nautical miles to the north, using her storage batteries to drive the four electric propulsion motors while steering with a hastily improvised system.

At sunrise the morning after her hasty departure from Brest, SURCOUF's bridge watch sighted the port of Penzance on the south coast of Cornwall. Her enginemen had been working all night to reassemble the diesels, finally getting the starboard engine running. From the radio room came two conflicting messages. The first one, sent at 1145 on June 18, was signed by Admiral Jean-Francois Darlan, Minister of Marine of the temporary French government at Bordeaux, ordering all French warships to cease engagement and head for the nearest French port. The second message, at 1420 the same day, was from the senior French Navy officer at Brest, Capitaine de Vaisseau Le Franc-Guyader of the battleship PARIS, who counter-manded the 1145 order, correctly deducing that it had been sent by the Germans since it lacked proper authentication.* Le Franc-Guyader ordered SURCOUF to any English port. Given her location and state of disrepair, Captain Martin thought it prudent to ignore the first and obey the second. She entered Plymouth harbor at 0200 on 20 June, 1940, and was assigned a downstream mooring. It turned out to be a bad location. At low tide she was on the bottom and heeled over. It was a bad beginning but things were going to get worse.

Admiral Darlan was a supporter of Marshall Petain. He would eventually become the *de facto* head of the Vichy government. Like many upper class Frenchmen, his politics tended to the right, favoring the Fascist regimes of Franco, Mussolini and Hitler, while the French working classes leaned to the left and tended to support the Communists in the government which had fled Paris as the Nazi army approached. Darlan initially found favor with the German sympathizers who controlled that part of France not yet occupied by Germans. Along with Marshall Petain, Darlan helped set up a government in the city of Vichy after France surrendered on June 22, 1940. Petain and his associates detested Charles de Gaulle, a French Army officer who almost singlehandedly built a competing *Free French* government-in-exile in London. Although sophisticated Englishmen like Sir Winston Churchill, writing in his splendid history of WWII, might express some sympathy and even admiration for French leaders like Petain or Darlan, among the French and British working classes, the general attitude was simply mutual loathing. The Royal Navy enlisted men assigned to SURCOUF to assist the British Navy Liaison Officer (BNLO) with communications felt isolated, rejected, and at times even threatened by their French shipmates. According to their letters home, they had seriously considered what they would do if the crew mutinied and defected to Vichy France.

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*The Road to Oran: Anglo-French naval relations, September 1939-July 1940 by David Brown, Routledge 2004 ISBN-0714654612 p. 62.

The French Navy had traditionally been anti-British. (Darlan's great-grandfather had been killed during Nelson's victory at Trafalgar). More recently, the French had contested British domination of the sea at every turn, designing and building a whole series of capital ships to match or exceed whatever Britain produced. SURCOUF herself had been built as a submarine with the firepower of a cruiser because there were treaty limits on cruisers but not on submarines. The relationship between the Royal Navy and the French Navy could have been described as formal correctness tinged with distrust and suspicion. Free French Navy units in Britain were commanded by Admiral Muselier, while across the water Admiral Darlan was directly and publicly cooperating with the Nazis. Ironically, they had been classmates at L'Ecole Navale in 1899.

Fearful that French warships would either be surrendered to or captured intact by the Germans, on 3 July, 1940, the British launched Operation CATAPULT to make certain that did not happen. After a failed attempt to negotiate with the local French commander, the Royal Navy attacked the French ships at Mers-el-Kebir in Algeria, destroying one French battleship, seriously damaging five other ships and killing 1,297 French sailors. That same day in Plymouth at 0415, a British boarding party of submariners and Royal Marines clambered aboard SURCOUF to announce that she would henceforth be under British control. By a strange quirk of fate, Captain Martin had just received another radio message from Darlan directing him to scuttle his ship, but before this order could be carried out, shooting broke out and a French officer, two British officers and one British enlisted man were mortally wounded. Captain Martin and the rest of the crew surrendered and were marched up the pier to Hamoaze barracks to stay until tempers cooled. The British offered to return them to France if they wished to go. Most of the officers and crew accepted. Those being repatriated may have been lost en route*.

*On 25 July 1940, French passenger liner MEKNES, 6,127 tons, left Southampton carrying 1,277 French naval personnel who were being repatriated to France to continue the fight. At 10.30 pm the ship was hit by a torpedo from the German motor torpedo boat (Schnell-boot) S-27 off the coast of Brittany. Some 383 Frenchmen were lost.

Perhaps Ortoli and Blaison had an impossible task before them—to meld the new officers and crew into a competent, smoothly functioning team. They needed to quickly teach people who had never before served aboard (or in one case even seen) a submarine how to perform dozens of essential functions efficiently and safely. But when the three English veteran submariners aboard, the British Navy Liaison Officer and his two assistants, Leading Telegraphist Bernard Gough and Leading Signalman Harold Warner, offered their help and advice, the French crew followed the lead of their officers and refused to listen. On 15 September 1940, Captain Ortoli hoisted the French colors and readied his ship for sea. She had been officially assigned to the 3rd Submarine Flotilla and ordered to report to HMS Titania for training. Titania was a base on the Clyde in Greenock, Scotland, very near Holy Loch. The British had gathered all French Navy personnel there to organize and train crews for Free French ships. Admiral Horton's orders read *"In view of circumstances which have rendered it necessary to man this submarine with many officers and ratings without submarine experience...the period of working-up shall be of sufficient duration which will enable it to proceed on service with complete confidence."* In simpler terms, "You should keep training as long as it takes to learn what you need to know."

According to a TIME magazine article from November 10, 1941, XO Blaison recalled of this period that "With a small nucleus of veteran submarine men, we built up a crew, we transformed fishermen into gunners, peasants and college boys into electricians, firemen and soldiers into mechanics...." Subsequently it would become obvious how unsuccessful this on-the-job training had been.

On 20 December 1940, Ortoli took his new command to sea for the first time, and two days later, performed his first trim dive (a normal submarine routine of compensating for weight changes by pumping water in or out, forward or aft, as necessary to adjust the vessel to neutral buoyancy). With a good trim, the boat can come to a complete stop submerged and remain at the same depth with no up or down angle. On most submarines this is done daily since it is an important part of being able to dive quickly and remain in control when threatened.

On 1 February, 1941, SURCOUF sailed for the Clyde. A few days later, while conducting a trim dive in Loch Fyne, she went completely out of control because of a gross error in *filling* a trim tank which should have been *emptied*. This was an unforgivable demonstration of incompetence by both officers and crew. Admiral Horton concluded she could never be relied upon to take any part in the war he was fighting every day. He terminated all efforts at submarine training in Scotland and ordered her to go to Canada to operate on the surface as a convoy escort.

On 19 February, she left Scotland for Halifax. Two days later she submerged and lost depth control again, reaching a depth of 65 meters before recovering. Five days after that, storm conditions forced a change of course because she was rolling so heavily that acid spilled out of the batteries. She also had a fire in the main propulsion switchgear. Considered overdue on February 25th, she did not arrive until March 3rd.

In early April she sailed as a convoy escort for an eastbound convoy called HX-118. One week into the voyage, the dissatisfied convoy commander asked that she be recalled by Admiral Horton to Devonport. Upon arrival, Lt. Greene was delighted to find his relief, Lt. Boyer, ready to take over as BNLO. On April 22nd, while SURCOUF was in Devonport, the Luftwaffe launched a weeklong series of air raids nicknamed the *Plymouth Blitz*. These raids killed one crewman who was ashore and damaged SURCOUF's aircraft. Taken ashore for repairs, the little plane was never returned aboard.

On April 24, 1941, Horton decided to reassign SURCOUF to Bermuda. His message to the Commander in Chief, American and West Indies Station, Vice-Admiral Sir Charles Kennedy-Purvis at HMS MALABAR said "**After arrival on your station, SURCOUF is allocated to you for operations against enemy supply ships and raiders. It is intended that she should normally operate from Bermuda but could fuel from Gibraltar or Freetown as desired. It is expected SURCOUF will be borne on the books of HMS Malabar as an independent command.**"

On June 30 she set off to sink or damage some enemy ships. Instead she managed to damage and nearly sink herself. A few days out, she had a major electrical problem which left her drifting without power for several hours. On the 18th she had a cascade of casualties starting with diving with an open conning tower hatch. Sea water reached the batteries, generating chlorine gas and sickening several crew members. With the added weight of water aboard, she was out of trim, plunging to more than 100 feet and causing the gun turret to begin taking on water, making her even heavier. Captain Ortoli ordered the ballast tanks blown without remembering to close the ballast tank vents first, but fortunately the added buoyancy was enough to get them to the surface. They started the diesels, pulling fresh air in to ventilate the boat and dilute the chlorine fumes. It had been a really close call, and they had not handled it well. Fifteen crew members were disciplined for misconduct and several more were hospitalized when she returned to Bermuda at 0800 on 20 July.

Then, for a change, there was some good news. As part of the new U.S. Lend-Lease program for supporting the Allied cause, the Americans had agreed to overhaul SURCOUF at the Portsmouth Naval Shipyard (PNSY) in Kittery, Maine. She left Bermuda with alacrity just five days after her aborted patrol, making a speed run on the surface in summer weather to an America still at peace, arriving on 28 July and entering Dry Dock No. 2. The executive officer met shipyard engineers on the morning of August 4th with a 70-item worklist and shortly afterward thought of about 70 more. The yard was hampered by a lack of drawings and technical manuals which had been destroyed along with many other documents by SURCOUF's crew during the British boarding in Devonport. There was also a problem with understanding French technical and nautical terms, and, in those days, metric dimensions. In many cases, the yard could proceed only by copying old parts to make new ones. This refit was to be neither quick nor easy. A week later, PNSY estimated the work at $800,000 plus $10,000 more for reconditioning ammunition which had been stored aboard for years. On 15 September, the Navy Yard Industrial Manager (CAPT Henry Davis) and Planning Officer

(Commander A. I. McKee, whom I knew many years later at Electric Boat as "Admiral McKee"), met with SURCOUF's second-in-command, Louis Blaison, to explain that, "*...the condition of your ship is much worse than we thought it would be. Every time we have started on a work item, we find more things that need repair. We may not be able to finish everything that needs to be done in the time we have. You were supposed to be out of here by October 4th but if we have to replace the main bearings, we can't finish until at least October 22nd, and work on SURCOUF is already delaying work on new construction. We need you out of that dry dock!* " (Content authentic, but dialogue imagined.) So ready or not, SURCOUF vacated Dry Dock No. 2 on 29 October.

Captain Ortoli, having presided over a year of near-disasters, had been relieved of his command on 20 September 1941. His executive officer, Louis Blaison, became the new C.O. While at Portsmouth, the BNLO, Lt. Boyer, who had been aboard since April, reported to his superiors that he was "*extremely concerned about the state of morale on board and that I had confirmed evidence from U.S. Navy intelligence there was a lot of talk around the town about what the crew were going to do and how they were not going to take the submarine to sea again. And there was talk about whether, if they did take the submarine to sea again, they should try to go back to Brest and turn their submarine over to the Germans for which they thought they would get very high praise and be forgiven for having served with the Free French and allowed to go back to their families. I also felt the boat was unsafe and should not be allowed to go to sea again because the captain and crew were incapable of operating it satisfactorily....the boat is valueless to the allied side, and we're just wasting our time.*" In Sanford, Maine, just to the north of Portsmouth Navy Yard, there were many French-Canadian families who had come to the area to work in the textile mills. Many of them opened their homes and their hearts to the sailors of SURCOUF. I suspect that some of this intelligence might have been gathered in warm and friendly kitchens after a few glasses of wine. *In vino, veritas, in aqua, sanitas,* the Romans used to say.

Truth may indeed be found in wine, but there was some doubt whether for SURCOUF sailors, health would be found in water.

Lieutenant Boyer's frank assessment of SURCOUF's situation earned him some displeasure with at least one senior officer, and on November 5, he was relieved as BNLO by Sub-lieutenant R.J.G. Burney. Warner and Gough remained aboard but only because they were ordered to. In letters to family, they told of their shunning by the French crew and their gloomy predictions for the future. Pressed by shipyard officials who badly needed to focus on production of new U.S. submarines, on 10 November Captain Blaison signed the paper accepting the shipyard's work, officially ending the refit. SURCOUF departed the next day to conduct sea trials at the U.S. Naval Submarine Base, New London, Connecticut.

Being too large to safely maneuver at the Sub Base piers, she moored on the north side of State Pier. On 21 November, she got underway with a Navy escort for the local operating areas to commence sea trials. The following day, she collided with her escort, damaging No. 3 and 4 ballast tanks. The resulting decision to terminate the sea trials allowed the U.S. Navy personnel to enjoy their Thanksgiving holiday. Temporary repairs to the ballast tanks were completed quickly and she departed for Bermuda on 27 November, arriving on 30 November. The collision in New London had caused a new flurry of communications between Bermuda and London headquarters relating to the desirability of decommissioning SURCOUF.

When Captain Blaison told Admiral Purvis-Kennedy that he had been summoned to Halifax by Admiral Muselier "*to take part in a naval review*" (which was nothing but a subterfuge), permission was quickly granted. She left on 7 December and had a strange surface encounter with a tanker which Captain Blaison had decided to stop for questioning about why he was flying a distress signal. Apparently he was flying the distress signal and radioing for help because he was being chased by a giant submarine.

SURCOUF took Admiral Muselier aboard in Halifax and told the British Navy representative they were going to sea on 20 December "*to conduct exercises.*" Instead they headed north, encountering Atlantic winter seas which rolled her to extreme angles and again spilled battery acid. She entered the St Lawrence estuary and transported the Admiral to Quebec City. Apparently during this time, Muselier was in communication with General de Gaulle, who informed him that the proposed *liberation* of the French islands off Newfoundland had been vetoed by the Americans. Despite this veto, de Gaulle directed Muselier to proceed with the operation just as they had planned it.

On 24 December, flying a distinctive *Cross of Lorraine* ensign in place of the traditional tricolor, and in company with Free French corvettes MIMOSA, ACONIT and ALYSEE, she entered the harbor at St. Pierre, where Admiral Muselier declared that the islands of St. Pierre and Miquelon were now under Free French control and that the Vichy government was ousted. With naval guns in the harbor and armed sailors and marines at the town hall, the transition was quick and bloodless and sealed with a plebiscite. The vote was about 900 to 30 in favor of the Free French. The British were probably quietly pleased, but the Americans were furious with de Gaulle, Muselier and SURCOUF. Secretary of State Cordell Hull, feeling that his carefully crafted strategy built around neutrality for France's possessions in the Western Hemisphere was imperiled, tendered his resignation, but President Roosevelt talked him out of it. However, relations between the U.S. and the de Gaullists were at a low point. After this episode, the British stopped supplying intelligence information to the Free French.

SURCOUF received secret orders from Admiral Horton while she was still in St. Pierre directing her to proceed to Tahiti and New Caledonia via Bermuda and the Panama Canal. Later, in his 16 January report to Admiral Horton, Sub-Lt Burney reported that the Admiral's *secret orders* had been known on the streets of St. Pierre the day after they arrived.

But those orders would never be carried out. SURCOUF and her crew had endured too many breakdowns, too many close calls and too much anguish about the fate of their country and their families left in France to be enthusiastic about going halfway around the world to fight under British command. In the next issue, the rest of the story.

THE FIRST INSTALLMENT of this article described the strange set of circumstances which brought the giant French submarine SURCOUF in 1940 to England and then to America before taking part in the *liberation* of the north American French colony at St. Pierre and Miquelon. Almost the entire experienced crew had left her immediately after arriving in Britain, and from late 1940 onward she had been operated by a crew recruited from available French Navy men who had escaped from France just before the surrender to the Germans. This experiment in *on-the-job* training had not gone well.

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A CENTURY OF AMERICAN SUBMARINE PROPELLER DESIGN

by Edward Monroe Jones, Ph.D.

Dr. Monroe Jones is an Industrial Psychologist consulting in Organizational Development and Labor Relations. He is also the Director of the Submarine Research Center in Bangor, Washington. He qualified in Submarines twice: as an enlisted man on STERLET and as an Officer on SIRAGO. He is a frequent contributor to THE SUBMARINE REVIEW.

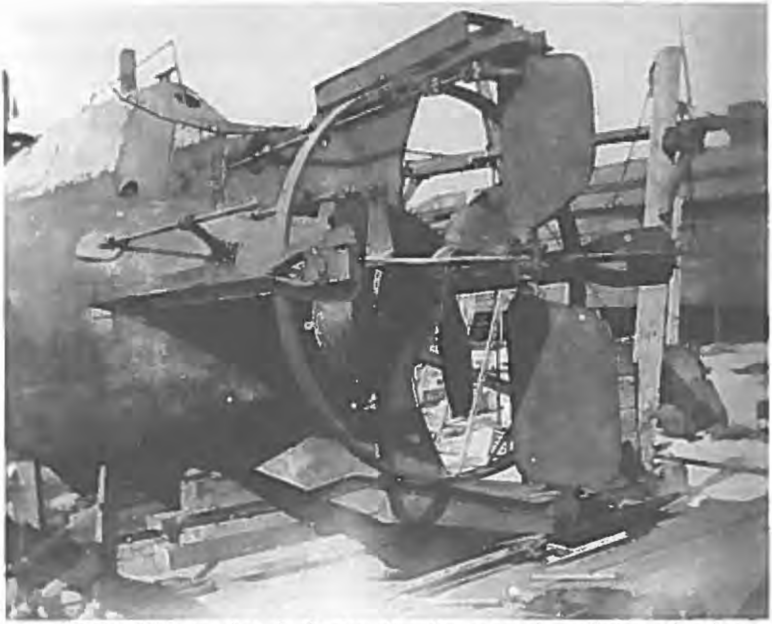
As the paddle wheel was replaced by the screw type propeller in the 19th century the 20th century brought submarine propulsion design from the bladed propeller to the ducted impeller propulsor. That journey was marked by milestones in mathematical applications, feats of engineering, and trial-and-error experimentation. It is worthwhile to review this fascinating aspect of American submarine history.

In the latter part of the 19^{th} century pioneering naval engineers such as William Froude, David W. Taylor and Stefan Drzewiecki determined the basic behavior of propellers.

In its simplest form, as viewed from the perspective of John Holland and Simon Lake, a submarine's propeller was made up of a rotating hub with radiating paddle-shaped blades angled to the axis so as to bite into seawater and thereby push the water rearward with resultant vessel forward advance. The straight paddle shaped, two-bladed propeller was replaced by elliptically shaped blades in two and three bladed variations. As submarine designs improved, so did propeller design and both men attacked the problem of blade efficiency by mathematical formulae and experimentation. The shape of a blade's pressure side, or face, changed from a flat surface to a variously– curved shape depending on the desired rotation speed. Propeller efficiency was plotted on a graph where pitch variation was compared to ship's advance through the water. Graphic plots illustrated a propeller's slip ratio or wasted thrust.[1]

John P. Holland concentrated his efforts on a single screw submarine and by the turn of the 20th century was in negotiation with the Navy Department to build the first United States submarines. His major competitor was Simon Lake who also competed for Navy submarine construction contracts. Lake introduced certain worthwhile concepts in submarine design which included twin screws and variable pitch propeller blades. Holland stuck to his single, centerline propeller concept despite Lake's argument that such a design meant poor maneuverability and unwanted torque.[2]

The Navy Department saw merit in Lake's arguments and insisted that Holland redesign his submarine to include twin shafts and propellers. In frustration, some of Holland's initial designs submitted to the Navy Department included triple screws since he still believed that a single, centerline screw would provide the greatest efficiency.[3] On April 11, 1900 the U.S. Navy bought Holland's final design which became known as USS HOLLAND. It incorporated his first concept of a single propeller extending aft along the centerline axis of the submarine.



The HOLLAND in dry dock showing its control surfaces aft of the 3 bladed centerline screw. Naval Historical Center.

Subsequent submarines included the Fulton and the Adder series, all of which incorporated the single centerline propeller design. Simon Lake continued to compete with Holland and produced a reliable adjustable pitch propeller which continued to be a concept ahead of its time. He switched to a fixed pitch design because of cost and manufacturing complexity. Lake's boat performed less favorably than those of Holland and he blamed the performance on compromised propeller design.[4] He introduced a twin, four bladed propeller with exaggerated blade tip width and won the Navy Department's contract to build USS PROTECTOR. The succeeding Viper class of submarine was equipped with Simon Lake's variable pitch propellers. These were used to advantage when maneuvering in restricted waters. The recently organized Electric Boat Company built the OCTOPUS which was the Navy's accepted twin screw submarine.[5] At the same time, improvements were made to propeller shaft glands and thrust bearings. Improved thrust bearings were constructed of segmented pivotal shoes which butted against a revolving thrust collar.

The twin screw with three bladed propellers became the standard design of the U.S. Navy through the 1920s. It adopted a four bladed screw design with improved blade curvature efficiency prior to the Second World War. At the close of the Second World War the Navy acquired the German Type XXI advanced-design submarine. The Navy's new Tang class, fast-attack submarine appeared in the 1950s and was the result of concepts taken from the German design including retention of the basic twin screw. The Navy's first nuclear powered submarine, USS NAUTILUS (SSN-571), retained the fast-attack hull design and twin screw, four bladed propeller. The submarine was a truly revolutionary phenomenon. It could out-run ASW surface ships with ease, but its major problem was noise. BuEng and civilian engineers renewed their efforts to solve problems of propeller efficiency and noise-producing cavitation.

Some basic concepts may serve to outline the problems. The purpose of the propulsor is to develop thrust to overcome resistance to motion of the submarine. The delivered power of the propulsor is defined as thrust times speed.[6] Propeller efficiency is output energy divided by input energy. Less energy is expended if a large mass of water is given a small change of velocity. Hence, for propulsor efficiency there is benefit in having a large diameter propeller.[7] Also, when the propulsor is close to the hull, certain effects arise. As water passes around the hull it changes velocity. At the bow it comes virtually to a standstill, then accelerates around the hull shape. As the stern-form reduces in diameter the fluid again slows. Therefore, at the stern there is an area surrounding the tail of the hull where there is slow moving water with an accompanying efficiency advantage in placing the propeller in the low-velocity wake. The initial conclusion is that a large diameter propeller located close to the submarine's stern can be expected to give higher efficiency; however, the wake is limited to a slim region around the stern, so a very large propeller diameter may extend beyond the wake resulting in rather poor overall efficiency. There is a limit to the hydrodynamic gain with a large diameter propeller. Also, a large propeller introduces an augmented drag which requires a greater input thrust to overcome. By moving the propeller farther astern the associated loss of efficiency can be reduced, but to do so may lose the advantage of the wake. To make the problem even more complicated, the wake is not uniform because the hull has upstream appendages such as the sail and these cause interfering wake turbulence.[8]

The above considerations represent simplified explanations of the complex problems faced by naval engineers. Experimentation was needed to test engineering principles. This was tentatively achieved using tanks such as the David Taylor Basin.

Although efficiency can be largely defined in terms of axial acceleration of the fluid, the action of a screw type propeller also imparts rotational motion or swirl to the downstream fluid which constitutes a waste of energy. The design of a large diameter propeller leads to the requirement for high torque on the shaft and low speed of rotation. These requirements not only pose problems for the propulsion machinery design, but also require that the hull resist the torque reaction of the propeller.

One way of combating large propeller torque is by use of coaxial contra rotating propellers. The combined action of the double propellers cancels out the rotational energy loss so that a greater propulsor efficiency can be obtained. However, there is a substantial penalty of complexity in the design of the coaxial shafting with its bearings and the need for elaborate gearing or secondary power source.[9]

Another method of combating torque is the use of stator blades mounted on the hull to introduce a counter-swirl to that produced by the propeller. While such mountings produce the desired straight thrust, the drag of such stators reduces the advantage while introducing undesirable engineering problems.

It may be seen by the description above that propeller design and placement entails compromises and engineering innovation that could best be tested by a vehicle such as the ALBACORE (SS-569)[10]. The resulting hull shape and propeller design of USS BARBEL (SSN-580) and USS SKIPJACK (SSN-585) incorporate the findings from experimentation by ALBACORE. American submarines produced in the 1970s and 80s had advanced propellers that were not only more efficient, but quieter in terms of cavitation.

Cavitation is the formation of gas bubbles in a flowing liquid where the pressure of the liquid falls below its vapor pressure. It may be visualized as the formation of low pressure resulting from fluid acceleration around propeller blades.[11] The faster the blades move, the lower is the downstream pressure. As it reaches vapor pressure the fluid evaporates and forms small bubbles of gas. When the bubbles collapse they typically cause very strong local shockwaves in the fluid which are audible to sonar. The noise produced by this cavitation is somewhat higher in frequency than the machinery noise in the interior of a submarine. For example, a five bladed propeller turning at 300 RPM has a blade rate of only 25 Hz, whereas electrical machinery such as a turbo generator often spins at some multiple of 50 or 60 Hz.[12] Nuclear submarines are particularly vulnerable to sonar detection.

The problem of machinery noise, reduction gear whine and cavitation was attacked in the Navy's submarine silencing program and was incorporated in the THRESHER design. Engineering efforts to reduce cavitation focused on the shape of the propeller. Submarine propeller engineers attempted to improve propellers by skewing rearward the tailing edge of each blade. A mean hydrodynamic pressure was used in calculations by assuming normal operating and transit depths.[13] Large scythe-shaped propellers alleviated the problem.

Rotational force in the slipstream vortex distributes rearward-trailing bubbles radially. Vapor-filled bubbles collapsing within this corkscrew-like trail do so in rhythmic patterns that reflect the particular construction of the propeller and correspondingly, the probable type of submarine housing the propeller. Experimentation revealed that blades could be radially pitched in three dimensions to include a rearward bend. This variance gave a propeller a complex shape resembling an open umbrella.

The three-dimensional skewed propeller with up to seven blades had the positive effect of producing thrust at lower rotational speeds. Lower spindle speed meant minimized blade vibration with a commensurate reduction in cavitation. Manufacturing such a complicated propeller was a challenge for American industry and could only be accomplished using computer-controlled milling machines. This type of propeller became America's standard nuclear- powered submarine propulsive device in the latter decades of the 20^{th} century. The design was held in great secrecy by the Navy, but Toshiba sold propeller milling machinery with accompanying computer programming to Kongsberg Ltd. of Norway which in turn sold it to the Soviets. That government used the computer data to rapidly begin a program to imitate research of the US Navy. As a result American submarines were faced with Soviet opposites difficult to detect.[14]

While cavitation bubbles collapse violently and thereby produce unwanted noise emission, air filled bubbles collapse at a slow rate and produce virtually no noise. Air bubbles introduced alongside a metal surface softens the sonar reflection. Fluid density is essentially unchanged in an air bubble cloud. It remains that of water, but the rigidity is that of air. The result is that the speed of sound in a cloud of air bubbles in water is a factor of almost 10 times slower than in water. Sounds within a submarine hull which would otherwise propagate for a long distance are reflected back into the hull and eventually dissipated therein. In the case of a propeller, the leading and trailing edges of the screw having small holes that emit air bubbles can dampen cavitation bubbles. Noise generated by submarine propeller blades is substantially reduced when forced air bubbles mix with cavitation bubbles.

Such a system is called the Prairie-Masker and was used on some GUPPIES in the 1960s. It was particularly effective when the submarine was snorkeling since it is necessary to either pull air from the surface or to use compressed air needed for other purposes within the submarine. Keeping a set of small holes in propeller blades clear from fouling while running submerged for lengthy periods can present an additional problem.[15]

USS BARBEL purges its Prairie-Masker with water spewing from its propeller blades. The Ralph Chatham collection.

A submarine propeller project of the 1990s was the innovative idea of using an external ducted propeller with multiple blades. This idea resembled in many respects the primary intake stage of an aircraft jet engine. Despite the difference between air compressibility and the non-compressibility of seawater, engineers examined the possibility of using a multi-bladed fan within a ducted ring to produce greater thrust. This type of propulsor has the advantage of a power-efficient slow rotation speed with accompanying reduction in cavitation. The circular duct which surrounds the impeller is shaped so as to accelerate fluid velocity through the impeller blades. The rotating element is protected by the ducted ring. Disadvantages include the cost of the propulsor installation, difficult mounting requirements, higher maintenance and greater weight at the extreme stern of the submarine. The American submarine Seawolf (SSN-021) and the Virginia class submarines are equipped with ducted impeller propulsors.[16] The Royal Navy's Trafalgar and Astute class submarines are equipped with pump-jet type propulsors similar to those of American design. Wikipedia reports that both the French and Russian navies also have submarines with impeller type propulsors.[17]

One must ask what the next generation of submarine propulsive device might be. In the case of Tom Clancy's Red October a mysterious *caterpillar* propulsor is located inside the fictional Soviet submarine. Internal propulsor's may have a place in the future of American propulsion design since anticipated advantages might include better noise emission control and well-anchored stator blades that could produce smooth rearward thrust at the submarine's stern. In the meantime the Virginia class submarine will continue to represent the best in American propulsion design.

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OPERATIONAL REQUIREMENTS FOR CONVENTIONAL SUBMARINES IN THE FUTURE

Commander Frank Thiede, German Navy

Commander Frank Thiede joined the German Navy in 1984 as a Seaman. First serving as NCO (only on submarines), he became an Officer in 1993. He was the Commanding Officer (CO) on U18, a 206A class submarine and for more than four years the very first CO on U31, first of its class U212A submarine. He sailed her during all sea acceptance trails. CDR Thiede also served as Staff Officer Operations in the German Submarine Flotilla, as Deputy Commander in the Submarine Training Centre, as Senior Instructor Underwater Warfare Operations in the German Navy Tactics Centre and as Subject Matter Expert in NATOs Centre of Excellence for Operations in Confined and Shallow Waters (COE CSW). Today CDR Thiede is working at the Supreme Headquarters Allied Powers Europe (SHAPE) in Belgium as a Strategic Planner.

The role of conventional submarines

In World War II conventional submarines provided an impressive demonstration of their unique capability to disrupt maritime sea lines of communication and the ability to operate independently. With the rise of the nuclear powered submarine after the war, the operational focus of conventional submarines (SSK) concentrated closer to coastal areas.

As a Submariner I have often been asked the same question: "*how are conventional submarines used today in confined and shallow waters* and *what will their role be in the future? And, what capabilities will these valuable assets require?* The prevailing operating conditions, shallow water, increased shipping density, complex sound propagation—makes detection but also counter detection of submarines often very difficult. In these waters the geography, the proximity to the shore and shallow waters limit the freedom of maneuver for all kinds of sea traffic.

In the past, the operational focus of maritime warfare was on the blue water. Today we are concentrating on the fact that the main maritime traffic routes intersect in waters close to the shore. Everything starts and ends in confined and shallow waters. Consequently it is this area, a subset of the littoral theatre, which, from a naval perspective, has to be successfully controlled in order to safeguard global trade, prosperity and peace.


Commander Frank Thiede

Nuclear powered attack submarines (SSN) are operated as hunting submarines, eavesdropping off hostile coasts or acting as most powerful and valuable assets in strike operations (SSN and SSGN). Due to their comparatively large size, their suitable area of operation is the open ocean—in other words—blue water. It has often been done, but I doubt it to be feasible—and certainly unsafe—to operate even a smaller nuclear boat in the confined and shallow waters, when it is probably continuously nailed to periscope depth. The maximum size of submarines to operate unimpeded in such a challenging area is limited and depends on the required minimum water depth and maneuverability in shallow water. Due to its size the conventional submarine has an unbeatable advantage in this domain. Unfortunately this comes with its own limitations. SSKs, in the main, operate independently and alone. Integration into a maritime task group or force is difficult; the relatively slow speed of a SSK does not make it the first choice for being an integral part of a force.

Technically, the capabilities of conventional submarines have significantly improved since the 1990s. The introduction of air independent propulsion (AIP) is one important example. Conventional submarines operating air independently (SSK-AIP) have a decisive tactical advantage against SSKs or SSNs, the capability to operate stealthier. Stealthiness is closely followed by a commitment to remaining undetected in order to execute highly sensitive missions. Any submarine must prevent counter detection. Even if an SSK-AIP is not able to match the speed of an SSN, it provides a serious threat due to its capability to remain almost undetectable over a certain period of time.

U31 leaving the Harbor

Before the dissolution of the Warsaw Pact, the focus was on Anti-Surface Warfare, simply to sink surface vessels, and on Anti-Submarine Warfare. The wartime mission of submarines was sea denial in order to render a sea area inaccessible for an opponent. Since the end of the Cold War, the requirements for the use of conventional submarines have changed significantly. Their core mission has evolved from the protection of own and disruption of enemy sea lines of communication, to the fight against surface vessels and Anti-Submarine Warfare. Submarines are now increasingly operating in regional high intensity conflicts or fast developing conflicts and crises. Thus potential areas of operation shifted from the open sea into the coastal waters. In today's maritime influenced or supported operations, the SSK's—much like the SSN's—are primarily used for (a) Intelligence, Surveillance and Reconnaissance, the collection and pre-analysis of information by acoustic, electromagnetic, optical and optronic sensors, (b) for Indication and Warning, (c) the selective use of a submarine for obtaining essential, time critical information for an operation and (d) for support of Special Forces, including the covert deployment of personnel. But SSKs can perform these tasks a lot closer to the shore than the SSN. The variety of scenarios today includes not only missions covering the classic warfare areas but also, for example Maritime Interdiction Operations, Counter-Piracy or Counter-Drug Operations. A surface Critical Contact of Interest for example will notably mask its suspicious behavior when sighting or detecting an approaching Navy or Coast Guard ship, helicopter or aircraft. It will probably not, when a submarine approaches at periscope depth, collecting all kinds of data and evidence, reporting to a higher authority, ordering and coordinating follow on actions.

Much better than their non-AIP predecessors, future SSK-AIP's will be able to operate efficiently in blue waters; however, the required capabilities of tomorrow's submarine must be based on the requirement to conduct operations in confined and shallow waters.

The role of a conventional submarine has to be understood less as a *lone wolf* and more as an integral part of a Task Force or Task Group. To be as effective as possible in these missions, certain capabilities for submarines are required, which will be determined now. The submarine is the ideal advanced and covert sensor. Submarines are able to operate in hostile waters and prepare a battle space prior to major operations. To contribute as much as possible to a maritime operation, the submarine has to act in direct support; in other words, all movements are ordered and controlled by a Task Force Commander, specified tasks are given directly. If the submarine is operating in associated support, all tasks have to be requested via a Submarine Operating Authority.

Direct support requires two major capabilities for submarines: (1) two-way communications at almost any time and (2) speed.

Experience shows that the success and benefit of a submarine deployment in a maritime operation depends on the ability to communicate large amounts of data in near real-time in order to operate as a part of a Team, participating in network-centric operations. The availability of current and comprehensive information is a prerequisite for all successful military operations. The rapid dissemination of all information enables the Area or Force Commander and the political decision-makers to make sound decisions. On the other hand, for a Submarine Commander, easy access to intelligence information is often essential to operate the submarine as effectively and safely as possible in order to accomplish its mission. Furthermore, the control of a submarine to prevent mutual interference and to coordinate the water space management, to enable action against an enemy submarine in a friendly submarine operating area, requires the capability of secure, stable two-way broadband communications and the ability to participate in both above and underwater networks. The decision to expose the submarine's position by using hoistable masts like periscopes or antennas or by acoustic and electromagnetic transmission will always be made by the submarine commander. His decision will be based on the tactical situation and the prioritization of his given orders.

SSK technology and challenges

The acoustic signature of state of the art SSKs has been reduced significantly. During the submerged transit modern electric motors are driven by energy from advanced, powerful batteries and/or air-independent power systems, such as fuel cells. Additionally, these boats are hybrid, i.e. still require diesel engines/generators to charge the batteries and of course a snorkel. But whenever speed is required, AIP-propulsion is not yet the perfect solution due to the relatively low speed attainable with fuel cells or Stirling engines. The conventional lead-acid or very soon the lithium-ion battery will—for the foreseeable future—be indispensable for high speed.

U31 on the Surface

And it is *speed*, that is essential for everything that has been discussed in this paper. A modern conventional submarine in the future must be able to shift its focus or the focus of its operations in a relatively short time by a few hundred nautical miles and it must be able, at least partially, to keep up with the speed of advance of a Task Force in order to act in direct support.

For supporting Special Operation Forces Missions, certain available sensors and effectors are of particular importance. Prior to deploying the forces, a valid, detailed and accurate operational picture must be provided. In addition to the information of acoustic, electromagnetic, optical and optronic sensors, the use of small UAVs in coastal areas extends the capabilities and the horizon or the line of sight of a submarine. The submarine must be able to deploy a certain number of personnel safely and covertly within minutes. Additional payloads, sometimes in larger size like delivery vehicles or canoes, have to be transported. The ability to provide limited fire support for Special Forces, for example with small missiles capable of attacking land targets, would complete the mission profile.

The basic design of submarines and the *classic use* of this system have changed only slightly in history. SSKs are mainly designed to fire heavy weight torpedoes, either wire-guided or as a fire-and-forget weapon. These weapons are configured to attack submerged and surface targets. The necessary data collection and target motion analysis is done by passive and active sensors in combination with a modern highly sophisticated fire control system.

From open sources it is evident that since the end of the Second World War, only three surface vessels have been sunk by submarines in war or close to war scenarios. Conventional and nuclear-powered submarines have successfully executed sea denial during the Cold War and several local conflicts. These assets tied down extensive maritime forces, which had to be used for Anti-Submarine Warfare and for protection of own forces and thus were not available for other operations.

There is no question about it, that the capability for Anti Surface Warfare is still mandatory for future conventional submarines. This applies equally to the capability of detecting and fighting other submarines and to sustaining operations in a conflict. However, we have to consider whether in future operations an SSK equipped with usually six or more torpedo tubes and a corresponding payload of heavyweight torpedoes is required, or an additional capability can be achieved by equipping the submarine with other components at the expense of a large torpedo load. The same applies to the question, how much effort has to be spent in the future on close to zero signatures. The challenge is to keep required capabilities but reduce the number of torpedoes whenever feasible.

Conclusions

Since the area of operations in confined and shallow waters limits the maximum size of the submarines, efficient use of space is paramount! What modern navies need are highly-sophisticated and flexible conventional submarines with the respective sensors and effectors. The capability to participate actively in network-centric operations, the capability of gathering intelligence, and to conduct surveillance and reconnaissance is mandatory. A submarine can provide, depending on the tactical situation, very valuable information as a covert advanced sensor and integral part of an Information Network. Additionally, the submarine is always capable of switching from Intelligence, Surveillance, Reconnaissance or Indication and Warning to Anti-Surface or Anti-Submarine Warfare, depending on the current situation, requirements and orders. The heavy weight torpedo as the *classic* main armament is still required for self-defense and for achieving or implementing sustainable sea denial. However, it is the number of torpedo tubes and the load of additional torpedoes which could be limited to use the space on board more efficiently. Potential solutions, like pressure-resistant modules, feasible for different payload like torpedoes, missiles, divers or other payloads tailored to specified missions are already available on the market.

It is clear that conventional submarines will have a place in the fleets of the future. This shows the disposition of modern units worldwide. Even if the purpose of these assets is often described in the *classic* way, it is reality that these submarines have changed from an offensive, lone weapon carrier to a precious and valuable platform, supporting or being an integral part of a maritime Task Force, but still combined with the capability for immediate offensive action.

Future scenarios need to be analyzed carefully in order to define the required skills and capabilities. Further technical solutions need to be developed and implemented. Navies as users and industry as manufacturers of conventional submarines must be encouraged to work together in close cooperation to share their experience, concerns and their ideas.

At the beginning of this article I raised the questions, *how modern conventional submarines will be used in current and foreseeable future operations and what are the required capabilities for conventional submarines derived from this*. I see the role of future SSKs or SSK-AIP as flexible and versatile assets that are adaptable to the evolving maritime security environment. Their stealthy character makes them ideally suited for a variety of missions like Maritime Security and/or Interdiction Operations, Intelligence Surveillance and Reconnaissance, Indication and Warning, Counter Piracy or Counter Drug Operations and to support Special Forces—and Land Operations. The capability to execute sea denial, Anti Surface and Anti-Submarine Warfare requiring an adequate number of torpedoes and or missiles, will be mandatory. It is still valid to assume that 10 Anti-Submarine Warfare assets are required to counter one submarine. From my perspective a future conventional submarine requires the capability to act as a flexible asset, tailored to the given specified mission. At first glance, modules for mission dependable payloads could be a solution. The ability to participate in above—and underwater networks, to communicate in real time and to move at high speed with longer endurance is a must. Submarines are gaining increasing importance in maritime and joint operations in the littorals and, if required, in the blue waters as well. There is no doubt that for the foreseeable future the focus will be on conventional submarine operations in green and brown water.

Winter in Norway

THE NELSON INTERVIEW
JOURNAL OF THE 1805 CLUB

by RADM Joseph F. Callo, USNR(Ret)

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People who write about history and particularly those who write about noteworthy personages face a challenging question: What is the real relevance of the subject at hand? If only we could talk directly with larger-than-life figures from past history there would be much to learn from them that lifts us beyond a mere narrative of events. For example, what might we discover from a modern-day television interview with arguably the world's most famous naval hero?

Well, suspend disbelief for a while and imagine that break-through scientific and technological advances actually made it possible to communicate with those who have left his world. Imagine what it would be like to witness a person-to-person interview with Lord Nelson by a twenty-first century television host. The transcript of the interview could run along the following lines.

Host: Good evening ladies and gentlemen. Welcome to an historic television event. The interview you are about to witness has been made possible by truly historic advances in paranormal communi-cations, breakthroughs that have provided the means of speaking in person with individuals who have passed on from this world. This will be the first interview based on this amazing capability and the first of our new series. 'Speaking with History's Heroes'. We are pleased and proud to have arranged for Vice Admiral Lord Nelson to be with us here in our studio this evening. Welcome Lord Nelson.

Nelson: Thank you, I'm sure.

Host: Admiral, let me begin at the very end of your amazing career and the Battle of Trafalgar, when you said in your last moments: 'Thank God I have done my duty'. Why did you pick those particular words at such a significant time?

Nelson: There was of course the fact that I didn't have time for a long statement. But in a more serious manner, it was the plain truth, spoken from the heart of an officer in His Majesty's service. And as I observed early in my career, *duty* is indeed the great business of a sea officer. It was at the core of everything I did as a serving officer of His Majesty's Navy.

I wrote on the subject in a number of different ways at a number of different times. You may recall, for example, my letter to Captain Thomas Bertie in 1798. I wrote at the time, somewhat tongue in cheek, about one aspect of doing one's duty: "I would have very man believe, I shall only take my chance of being shot by the enemy, but if I do not take that chance, I am certain of being shot by my friends". I was of course alluding to the fate of Admiral John Byng who was shot by a firing squad of six marines on the quarterdeck of HMS MONARCH in 1757.

But to continue, at times determining one's real duty can be devilishly hard. Duty goes well beyond written orders, which usually cannot take into account what is happening in a singular circumstance. That is why I always placed my attention on the greater object at hand. When circumstances change, the specifics of aged orders from afar usually do not suffice.

Host: But in a sense weren't you interpreting your duty based on your personal view of matters?

Nelson: Exactly! But my personal view was the product of my experience and circumstances at the time.

Host: But didn't that make you unpopular with your fellow officers and with many at the Admiralty?

Nelson: Admittedly so, and I certainly got into my share of scrapes with the Admiralty. For example, my inclination to determine my duty as something beyond written orders when I was in command of HMS BOREAS on the Leeward Islands station almost cost me my career. But in the course of much of my service, I relied on my anchor to windward at the Admiralty.

Host: Who was that?

Nelson: Earl St. Vincent. He supported me on important occasions. He encouraged me for instance during my days of black despair and terrible suffering from my wound after my defeat at the Battle of Santa Cruz, which by the way I have always thought of as a pivot point in my career. And of great importance, the Earl repeatedly favored me for the challenging assignments that allowed me to prove my worth in combat against England's enemies.

Host: But Admiral, if I may persist, isn't a naval service based on obedience to orders, rather than leaders who want to go their own way in crucial situations?

Nelson: To be sure. But there sometimes is a difference between strict obedience to an order and the idea of duty, and as one advances in the service, one is increasingly expected to be able to think and react in terms of circumstances. And I would point out that in your modern times there has been increasing importance placed on the concept of small tactical units, with leaders who must make at-the-moment decisions as situations arise. The United States Marine Corps uses a thought-provoking term in this regard: 'the strategic corporal'.
There is, however, always grave risk to one's career, even for the most senior officers, when one acts contrary to specific orders. The American sea power visionary, Admiral Mahan, expressed the dilemma well when he wrote about my difficulties in enforcing the Navigation Acts in the Leeward Islands. In his biography of my life, he wrote: 'It is difficult for the non-military mind to realize

how great is the moral effort of disobeying a senior'. The Admiral also goes on to emphasize the special danger of such disobedience for an officer when he said: "[I]t" is, justly and necessarily, not enough that his own intentions or convictions were honest: he has to show, not that he meant to do right, but that he actually did right, in disobeying in the particular instance'.
So we see that the leader who is willing to make informed judgments in combat faces double danger. First there is the physical peril of injury or death, and the second danger is potential disgrace for making an aggressive but ultimately wrong decision in the heat of the fight.

Host: It seems to me that, by your standards, it must take a special personality to develop and retain a resolute sense of duty.

Nelson: It requires a willingness to risk one's career that is something apart from the courage to face death in combat. As I said earlier, the idea of duty is not easy to define and it involves a particular mental state.

Host: Admiral, I would like to go back for a moment to something you mentioned earlier about the Battle of Santa Cruz. Why did you refer to it as a pivot point in your career? That seems an unusual term for an action that most historians consider to be of limited historical consequence.

Nelson: The disaster at Santa Cruz cleared my mind. Following my efforts at the Battle of Cape St. Vincent, I became a hero to my countrymen, and even the Admiralty leaders in London saw me as one who could triumph in battle. One might say that I had begun to grow an exaggerated opinion of my capabilities. In your modern speech, I believe you call it hubris. That special overconfidence caused me to make serious mistakes at Santa Cruz. I lacked an adequate understanding of the difficulty of the terrain, and I refused to be deterred when I had lost the advantage of surprise. Worst of all, I underestimated my opponent, General Antonio Gutiérrez.

Actually since moving on to our current existence, Antonio and I have become good friends, and we discuss aspects of the battle from time to time. Only a few decades ago we were enjoying a bit of cheese and beer, and he chided me on leading like a stubborn mule during the action. I of course felt compelled to remind him that, notwithstanding, it was I who had a boulevard in Santa Cruz named in his honour, not he. In his usual manner, he roared with laughter. But then he quickly turned serious and gave me pause with his suddenly restrained demeanor and a subdued admonishment: 'Horatio, we both know that a boulevard in your name was not worth the horribly excessive butcher's bill for the day's business'. He was without doubt correct, and it was that bitter truth after the Battle that had cured me of my excessive pride, my hubris.

Host: How did you manage to get past the mental and physical pain of that defeat? That had to be an extraordinary accomplishment.

Nelson: In truth it wasn't something I accomplished. It was my mentor and friend the Earl St Vincent and my wife Fanny who dragged me past my despair. The Earl pointed out that no matter our exertion and the justice of our motives, we cannot always succeed in battle. His unshakable confidence in me was the best medicine I could have received. And it was Fanny who nursed me tenderly until the ligature fell away from my arm stump, and my wound healed. It was then that I reconciled to my 'fin' as a substitute for a right arm. In passing and with more than a bit of remorse, I would observe that that period was when Fanny and I were closest. I truly needed her and she responded handsomely. Sadly I must also say that Fanny never understood my commitment to my duty.

Host: Admiral I would like to move ahead and ask for your reaction to some questions about the current Royal Navy. For example, what do you think of women serving in Navy assignments that had been traditionally reserved to men?

Nelson: Well now, I wonder if I should answer as a plain sailor might or as a senior office must. Let me say this: it's not something I would have considered for a single second. When I was serving, the idea would have been considered foolish, idiotic. But god knows the times have changed.

In some ways, however, the question is irrelevant for me, and not because of the different way of thinking between my lifetime and today. It's irrelevant because when all is said and done, on an issue such as that, it's the civilian leaders of the service who decide. Once that sort of decision is made, the only recourse for people like me is to either conform or resign. I would say, however, that the service seems to have made the adjustment in good order. In fact I would say, they have done a good job of it. Women are serving in many roles formerly limited to men, not without attendant difficulties, but they are serving well.

Host: Admiral, while we are on a contemporary subject, may I ask you a question about a current government budget policy?

Nelson: My sense of your tone is that I couldn't stop you with a broadside.

Host: What do you think of the ongoing cutbacks of the size of the Royal Navy that have marked recent years?

Nelson: Madness! I know government doesn't care about the Navy, but doesn't it know what it means to be an island nation? Please excuse my outbursts, but I don't think people realize that it's Britain's survival that is at issue.

There are three things that should influence these crucial decisions by government about our Navy. The first is what are our ambitious as a people? Second is what are the potential dangers faced by our country from beyond our shores and not just now but in the foreseeable future? Third is the state of the treasury. It seems to me that the current planning by government starts with the last and ends with the last. Government and most of what you now refer to as the media are suffering from what those who still have the capability to think strategically are calling 'sea blindness'. That blindness has, in the language of a plain seaman, put our country on a lee shore in a tempest. Madness!

Host: But many in government say we simply can't afford to spend the money that it takes to build and maintain a large navy.

Nelson: Let me put it to you this way. The first obligation of government is to protect the people and the country. Once that is accomplished with surety, then government can think about other spending. I must confess to you that I don't understand why it should be so difficult an idea to seize. When it comes to the country's future safety, government should look past the ledgers to what history informs us. As I wrote when our people were under great threat in 1801, 'our country looks to its sea defence, and let us not be disappointed.'

Host: I can see that my question has agitated you so let's turn to a more pleasant subject: What were the things that attracted you most to Lady Hamilton?

Nelson: Sir, you cannot be serious with that question! Well, never mind, I will give you a serious answer. There was her beauty, her charm, her grace, all expressed in her attitudes, and her devotion to England. Most important to me, however, she understood my attachment to duty and supported that commitment with considerable enthusiasm. That is what set her above all other women for me. I tried to capture that quality when I said to her at Merton: 'If there were more Emmas, there would be more Nelsons'.

Host: Yet at the time there were many, including those at court, who were reluctant to accept her as you did, as if she were your wife.

Nelson: Looking back, expecting Lady Hamilton to be accepted in the same light I saw her was not realistic. I loved her dearly; others were ruled by convention. In truth, if I had kept her as a mistress, no one would have given it a second thought, probably not even Fanny. But even in the eyes of many of my friends, I was flaunting our relationship, and that was unacceptable in many places. Both Lady Hamilton and I—to a greater degree Lady Hamilton—paid a price for that rashness.

Host: For our remaining time, I would like to return to your final day at Trafalgar. What are your most vivid recollections of that historic day?

Nelson: One of my lasting recollections was how calm the morning was. At first light there was the faintest of breezes, accompanied by swells from the west. VICTORY's motion in those conditions was almost hypnotic. The overcast skies added to a restrained mood. Even in the early light we could clearly see the thirty-three ships-of-the-line of the Combined French-Spanish Fleet. They were a mere nine miles away. Immediately it was apparent that the Combined Fleet was, without question, on a course to join battle. But in the light airs it was a slow-motion evolution. No matter what else might be said about our enemies that morning, there was no reticence concerning combat action.

Host: What was the mood in VICTORY?

Nelson: The attitude in VICTORY was one of the quiet intensity. The contrast between the morning's gentle aspect and the quiet intensity of our officers and men created a unique tension. We all knew what we had to do, and there was a restrained mood about the decks. There was little conversation. And what talking there was had to do with our preparations for battle.

At 06:00 I signaled to form the order of sailing in two columns, one column with fifteen ships-of-the-line led by Admiral Collingwood and the other with twelve ships-of-the-line led by myself. At 06:30 and again at 10:00, I signaled to prepare for battle. At 11:45 I ordered the 'England expects' signal and ten minutes later I signaled for the fleet to make all sail possible. At noon I ordered for the fleet to anchor at the close of day, because it was clear from the swells rolling in from the west that a serious storm was imminent. Finally, at 12:15 I ordered the signal to engage the enemy more closely. Those eight flag orders were all that were needed during the entire morning in order to launch the business of that fateful day.

Host: Was there a sense of fear that morning?

Nelson: All fears for bodily safety were suppressed. These were veteran, well-drilled sailors. There was a shared—and quiet—understanding that we were sailing into an action that would be recorded in flame and cannon smoke across the pages of history. There was, however, one special kind of fear I could sense: the fear that each man felt that he might fail to do his duty to the fullest. Failure to do one's duty to the utmost was the real spectre to be dreaded.

Each man wanted to show a good example to those about him, and from my second-in-command, Vice Admiral Collingwood, to my band of brothers, to the lowest seamen in our fleet, I had absolute confidence that we would all do our duty. That was what I tried to express with my now-famous 'England expects' signal. The greater part of my duty was to demonstrate the utmost of confidence to the fleet, and in fact, there was little in the way of direct orders needed from me during the morning or the following action.

Host: What's most memorable about the actual fighting?

Nelson: As we approached the Combined Fleet at roughly right angles, we were pounded with shot for what seemed like an interminable period of time. Then finally, we crossed under the stern of the flagship of the Combine Fleet's commander, Admiral Villeneuve, who was embarked in the French 80-gun ship BUCENTAURE. As we passed, we fired a 68-pound carronade loaded with round shot and a keg of 500 musket balls through BUCENTAURE's stern. That was followed immediately by a double- and triple-shotted broadside fired in sequence from our port guns.

I clearly remember a brief mental image of the horrible killing and maiming effect of those raking blows, as they howled along the lengths of BUCENTAURE's gun decks. After that and until the French marksman's musket ball found its mark, things were blur of canon fire, smoke, wreckage, and the chaotic images and sounds of mortal combat.

Host: Clearly there was a great deal of courage demonstrated by both sides at the Battle of Trafalgar, but what in your opinion were the greatest differences between the fleets?

Nelson: We were superior in leadership. We were confident in one another and in the justice of our cause against Napoleon's France. In contrast there was significant distrust between the French and Spanish captains, and Admiral Villeneuve fought with a determination founded on his knowledge that his relief had been dispatched by Napoleon to replace him. We fought with conviction; they fought to avoid disgrace.

But I am compelled to admit that it was the fighting quality of the honest seamen of our ships that was, to use a more recent term, the 'force multiplier' that made the difference. We officers get the public's attention, but it is the training and raw courage of the lower decks that settle matters in the mortal combat. And as I wrote from *Agamemnon* to my wife in 1795: 'Nothing can stop the courage of English seamen'.

Host: Historians like to talk about the turning point in a battle. What was the turning point at Trafalgar?

Nelson: There was no turning of the tide of battle at Trafalgar. I would add, however, that the outcome was determined—the turning of the tide if you will—in the series of meetings with my captains before the action began. During those meetings we established a plan with winning tactics, and then the victory was sealed with a winning combat doctrine.

Host: Just what do you mean by combat doctrine?

Nelson: In plain terms, that's the attitude that takes over in the chaos and horror of combat. It's the over-arching approach that drives the situation, and at Trafalgar it was summarized in my memo to my captains of 9 October, just before the battle. At that time I wrote: 'No captain can do very wrong if he places his ship alongside that of an enemy.'

Host: Admiral, I have a final question: given the bodily wounds and mental suffering you went through in your 35 years of naval service, would you do it all over?

Nelson: To employ one of your popular phrases: in a heartbeat.

Host: Thank you and goodnight.

THE FATAL THRESHER DEEP DIVE: DIFFERENT OCEAN, *DIFFERENT OUTCOME?*

By CAPT John F. O'Connell, USN (Ret.)

Captain John F. O'Connell, USN (Ret.) was commissioned from the United States Naval Academy. He served in USS BON HOMME Richard (CVA-31) and USS ROCHESTER (CA-124) before attending Submarine School. He served in USS PERCH (ASSP-313), USS CAIMAN (SS-323), GMU Ten, Squadron One staff, USS BARBERO (SSG-317), XO USS PICKEREL (SS-524), and ComSubPac staff. He commanded USS SPINAX (SS-489) and Submarine Division 41. He was a Branch Head in the Submarine Warfare Division of OpNav (OP-31) and Chief Staff Officer of Submarine Flotilla Seven. He served as ComSubPac N3, and then as Defense and Naval Attaché Tokyo. He has published five books, three dealing with air power and two with submarine operational effectiveness in the 20th century.

On 9 April 1963 USS THRESHER (SSN-593) got underway from Portsmouth Naval Shipyard and proceeded to sea for Post Shakedown Availability (PSA) sea trials. She rendezvoused with her sea trial escort, submarine rescue vessel USS SKYLARK (ASR-20), and completed a shallow dive that day. They separated and headed for the deep test dive area. The maximum depth capability of SKYLARK's McCann Rescue Chamber was 850 feet. The assigned area for THRESHER's deep dive was approximately 200 miles east of Cape Cod with a depth of water of about eight thousand feet. THRESHER's design test depth, the deepest depth to which the Navy Bureau of Ships (BuShips) authorized her to descend was 1300 feet.[1] Test depth is based on hull thickness and material. THRESHER's hull was constructed of HY 80 steel, used previously only in diesel-electric USS ALBACORE (SS 569) and SKIPJACK (SSN 585) class SSNs. Improved hull welding techniques allowed THRESHER to operate as deep as 1300 feet compared to the Skipjack class test depth of 700 feet.

THRESHER began her descent from periscope depth to test depth at 0747. Norman Polmar asserts in Death of USS THRESHER that SKYLARK had not been provided an agenda by the commanding officer of THRESHER for its first PSA deep dive. I have made certain assumptions based on normal submarine practice for test depth dives during sea trials, and has drawn on material developed during the Naval Court of Inquiry proceedings into the loss of USS THRESHER on 10 April 1963.[2]

There was a sub-surface communications channel available between THRESHER and SKYLARK during the sea trial. It was the AN/UQC underwater telephone, referred to as *Gertrude* in the Navy. Submarines are equipped with Gertrude, as are antisubmarine warfare vessels and submarine rescue ships. Gertrude is similar to tactical radio in that the originator voices a message and ends with *over* or *out*. The former implies that an answer or acknowledgement is expected from the other party, while a message ending in *out* does not require a reply. Unlike a radio message being transmitted through air, the Gertrude message travels through water. Both air and water are fluids but the speed of transmission in them differs significantly.

THRESHER and SKYLARK established Gertrude communications while THRESHER was at periscope depth. THRESHER indicated that she was beginning her dive to test depth. The normal procedure would be to go from periscope depth to test depth in a series of steps, leveling off at each new depth level and checking throughout the boat for leaks. Flooding would be reported immediately.[3] Flooding, depending upon its severity, might call for emergency surfacing of the submarine. In order to avoid a possible collision between the submarine carrying out an emergency surfacing operation and the ASR, they would operate offset horizontally from each other. About half way to test depth THRESHER would probably have *rigged for deep submergence*, setting certain valves and fittings for increased safety at deeper depths.

Within the THRESHER all compartments were connected by sound powered telephones, with the control center phone talker acting as controller for the circuit. Given the importance of the sea trial, an officer in the control center might have been monitoring the circuit also. At each level of submergence depth the control center telephone talker would poll all compartments to check for leaks or any other problems. As THRESHER proceeded deeper her hull compressed with increasing sea pressure and that action normally brought forth a series of mechanical creaks and groans, somewhat alarming to crew members who had spent the past nine months in the shipyard. During builder's trials of a new class of submarine, a telescoping rod is positioned in the interior hull of the submarine at its greatest breadth, and the actual hull compression is measured as the submarine proceeds to test depth.

At 0752 THRESHER reported being at 400 feet. At 0809 THRESHER reported being at 650 feet, and at 0835 at 1,000 feet. At 0853, THRESHER reported she was descending to her test depth of 1,300 feet.

Events apparently proceeded normally until about 0913. At that time THRESHER reported "Have positive up angle...attempting to blow up". SKYLARK's commanding officer recalled the transmission from THRESHER as "Experiencing minor problem...Have positive angle...Attempting to blow." At 0917 a further garbled report was noted. The SKYLARK officer of the deck later testified that he heard the words *test depth* followed by *breaking up* sounds similar to ship sinking sounds he had heard during WW II.

At about 1058 SKYLARK began attempting to establish radio communications with the Submarine Operational Control Authority in New London, Connecticut to report to Commander Submarine Flotilla Two about the problems with the THRESHER sea trial. There were difficulties in getting the message through, including the relatively low priority assigned to the message by SKYLARK.[4] Finally at about 1256 SKYLARK's alarming information reached Captain J. S. Schmidt, USN, and subsequently the world including Assistant Commander Submarine Force Atlantic Fleet (New London), Commander Submarine Force

Atlantic Fleet (ComSubLant) (Norfolk), Commander in Chief Atlantic Fleet (Norfolk), the Chief of Naval Operations, the Secretary of the Navy, and President John F. Kennedy were informed that there was a very serious problem with one of the most advanced nuclear-propelled submarines in the U.S. Navy.

SUBMISS was declared indicating an overdue and unaccounted for submarine. It was followed by *SUBSUNK* when it was clear that THRESHER had gone to the bottom during the course of her sea trial and was lost forever, along with her entire crew of officers and enlisted men, plus a contingent of officials, navy and civilian, from Portsmouth Naval Shipyard, the Bureau of Ships (BuShips), and SubLant staff, some 129 men in all.[5]

A Court Of Inquiry was rapidly convened under the leadership of Vice Admiral Bernard L. Austin, USN as President of the Court. It included five senior submarine officers of ranks from Vice Admiral to Captain. It began its proceedings on 13 April 1963 and took testimony from a number of individuals connected with the PSA and subsequent sea trials. The Court of Inquiry Report totaled 1700 pages. In summary it concluded that the loss of THRESHER was due to three factors:

- Failure of a silver-brazed fitting in the engine room, with immediate flooding, and subsequent emergency shutdown of its nuclear reactor (scram) due to spray in the engine room affecting electrical control panels (*Portsmouth Naval Shipyard*)
- Freezing of entrapped water in blow valve strainers. This blocked air from the flasks going in to the main ballast tanks to expel their water and push the submarine hull to the surface (*BuShips Submarine Design section)*
- Inability of the engineering watch to restore the reactor to normal operation from its *scrammed* status to provide normal propulsion power within a short time period (*BuShips Code 08-Naval Reactors Branch*)

The author has indicated in parentheses and italics, after each factor—the responsible organization in the train of events that led to the loss of THRESHER.

- Portsmouth Naval Shipyard had clear evidence a full year before the loss of THRESHER that the qualities of its silver braze joint work was suspect, when at 600 feet USS BARBEL (SS 580) had a silver braze joint in her engine room break loose. BARBEL conducted an emergency surface operation and reached the surface safely but with her engine room flooded up to the deck plate level.[6] The Court of Inquiry Report, Part II, item 111 noted that "...prior to THRESHER's post shakedown availability, there had been reports of serious failures of sil-braze joints in BARBEL, SKATE, SNOOK, SCULPIN, ETHAN ALLEN and THRESHER."

- THRESHER's main ballast tank blow system was a new design by BuShips. It had not been tested as a complete system in a simulated emergency situation. The valve manufacturer had added a strainer to the valves. When the emergency blow started, the flow of air became very cold due to adiabatic effect and the strainer orifices were rapidly blocked with ice. Subsequent to loss of THRESHER, a dockside test of an identical system was conducted in USS TINOSA (SSN 606) and the exact same circumstances were observed. The blow started, and then stopped because of ice formation.[7]
- Reactor plant operation was rigidly governed by the Reactor Plant Manual issued by Admiral Rickover's branch of Naval Reactors within BuShips. It allowed for no discretion or individual judgment in procedural matters. Once the reactor *scrammed*, that is the control rods were automatically inserted to moderate neutron flow and slow the reactor down, the specified restart procedure was lengthy—too long to allow THRESHER to regain normal propulsion power before she sank below crush depth, given the flooding in the engine room.

Subsequently Portsmouth Naval Shipyard paid much more attention to the quality of silver braze joint work, coupled with BuShips' new found interest in welding rather than silver-brazing certain fittings. The Submarine Safety (Sub Safe) program was instituted at great expense and delay in delivering new submarines to ensure that a loss like THRESHER would never occur again. Presumably BuShips submarine system designers learned a lesson about thoroughly testing newly designed systems before sending them to sea where people's lives are at stake. Admiral Rickover quickly issued modifications to the Reactor Plant Manual to allow a much quicker *restart* of naval submarine reactors in emergency situations.

However there was another factor involved in the complete loss of THRESHER that has not previously been reported or explored, at least publically. It was the failure of Commander Submarine Force Atlantic (ComSubLant), the submarine operational commander in the Atlantic Fleet, to specify that deep dives conducted after new construction, post shakedown availability or shipyard overhaul—be conducted in specified *safe* deep dive areas.

In 1963, the year of THRESHER loss, Commander Submarine Force Pacific Fleet (ComSubPac) had a standing requirement in effect, specified in its ComSubPac 301-Year operation order, that initial deep dives after completion of new construction, conversion or overhaul, would be conducted only in approved areas.[8] There were separate areas specified for each class of submarine by its test depth limitation.

The first, shallow dives to periscope depth or several hundred feet would be conducted in 200—300 feet of water, as was THRESHER's initial shallow dive. Most of the diesel powered Guppy and Fleet Snorkel boats that made up the main part of the ComSubPac inventory were 400 foot test depth boats, although there were a few 300 foot *thin skin* diesel-electric boats left in service.[9] The post-WW II TANG (SS 563) and Barbel class diesels were 700-foot boats, as were the later nuclear powered Skates (SSN 578) and Skipjacks.[10]

For a 400-foot boat, the deep dive area would probably have been no deeper than 500 feet. The relationship of crush depth to test depth is roughly 1.5.[11] Thus a 400-foot boat's crush depth would be conservatively estimated at 600 feet.[12] The existence of a bottom at 500 feet ensured that if the submarine conducting a deep dive had a flooding casualty and sank to the bottom, it would be at a depth above the estimated crush depth of the hull—and thus the submarine would not automatically be lost forever. The McCann Rescue Chamber could operate as deep as 850 feet. In theory at least, a 400-foot boat, with several compartments flooded and on the bottom at 500 feet and unable to surface, might still have survivors of the flooding rescued by the ASR.[13]

For THRESHER, a 1300-foot boat, its crush depth would be estimated at 1,950 feet. Using the same logic that motivated ComSubPac in its standing operations order, the assigned ComSubLant deep dive area for THRESHER should have been no deeper than a 1500-1700 feet range. **Instead, THRESHER was sent to an area so deep, about 8,000 feet, that she was doomed to be crushed by sea pressure if she sustained a major flooding casualty and could not surface.**

The Court of Inquiry Report did not make any statements about test dive area depths at all. If ComSubLant had no restrictions in effect, that omission is understandable. What is less understandable is the failure of the Court of Inquiry to take note of the different practices of the two Submarine Force Commanders in force at that time, and to recommend to ComSubLant that it adopt the same practice as its Pacific counterpart.

Apparently OPNAV, presumably the Submarine Warfare Division (OP-31), took note of the difference. During the hearings of the Joint Committee on Atomic Energy, on Wednesday July 1, 1963, Vice Admiral Ramage, Deputy Chief of Naval Operations for Fleet Operations and Readiness (OP-03) testified, "...some new requirements include the following: Test dives are made in depth of water limited to 1 1/2 times the test depth..."

If THRESHER had been a unit of the Pacific Submarine Force and had undergone sea trials off San Francisco, after a PSA at Mare Island Naval Shipyard, she would have been assigned a deep dive area in the 1500 – 1700 foot bottom range. Assuming the same tragic sequence of events, she would have flooded her engine room and gone to the bottom, but would still be intact at say 1600 feet. TRIESTE could have surveyed her off San Francisco and reported on her condition.

She would not have been crushed and laid strewn about the bottom as scrap metal at 8,000 feet. It is possible that a salvage effort might subsequently have raised THRESHER's hull allowing a factual determination to be made of the exact cause of her flooding rather than educated conjecture about possible causes.

What might have come next is in the realm of speculation. At 1600 feet the sea pressure is approximately 726 pounds per square inch. The engine room would have flooded almost completely except for a small volume of compressed air (at 726 psi) in the upper part of the compartment.

If a few engine room personnel remained alive in the air bubble in the overhead of flooding compartment, they would soon be breathing air at 726 psi and consequently they would be poisoned by the toxic effects of oxygen and nitrogen at high partial pressures. They would be quickly rendered unconscious and then die.

In any case the spray and flooding would have disabled all electrical equipment and circuits in the engine room. The maneuvering room, located in the forward starboard part of the upper level of the engine room, would not be capable of directing steam to the propeller shaft. All motor-generator sets would be shorted or flooded out, and the unflooded compartments forward would be left with only battery-powered emergency lighting.

Carbon dioxide removal equipment would be unable to operate. In addition to the existing air in them, the forward compartments would have whatever pure oxygen was stored in tanks, which could be bled into the compartments, as well as carbon dioxide removal chemicals which could be spread around to limit the natural increase of CO_2 as surviving personnel breathed. However, asphyxiation would inevitably ensue as the O_2 supply was exhausted and CO_2 removal chemicals were used up.

Presumably all engine room personnel evacuated forward. Attempts to limit flooding of the engine room by admitting high pressure air from the main air flasks using internal salvage air valves might have encountered the same freeze up that prevented THRESHER from blowing its main ballast tanks to get the surface. In this alternative scenario THRESHER then sits on the bottom in 1600 feet of water, possibly still in Gertrude communication with her ASR escort, and that escort is informed about her situation. Without the nuclear reactor plant in operation, THRESHER's sole power source is her battery, with about half the power of a standard diesel-electric Guppy submarine battery.

THRESHER was not designed with enough reserve buoyancy to flood a large compartment like the engine room and still surface. With the engine room flooded, she would be stuck on the bottom. Even if the ice that had formed to block the main ballast tank blows, melted—and the main ballast tanks blew dry, there would probably not be enough buoyancy to lift the hull to the surface.

The end result would be the death of all on board due to asphyxiation. At 1600 feet in early 1963 there were no rescue assets available that could have taken any of the surviving crew off THRESHER.

However, and this is a big difference, THRESHER would not have been torn apart. She would have remained intact on the ocean floor until such time that Navy salvage efforts might have raised her, using large flotation devices and external salvage air connections.

As the title of the article implies, the final outcome of THRESHER's deep dive, if conducted in the Pacific instead of the Atlantic, would have been different from the actual outcome, albeit her crew were doomed by the advances that submarine operating depth technology had made over rescue depth capability.

ENDNOTES

1. Polmar, Norman, *The Death of the USS Thresher* (hereafter Polmar: *THRESHER*), p. 38. THRESHER had been to test depth some 40 times prior to her post-shake down availability. See also *Cold War Submarines* by Polmar, Norman and Moore, K. J. (hereafter Polmar and Moore: *Cold War*), p. 150. See tables 4-2, 6-2 and 10-2 for test depths of post WW II U.S. SS and SSN.

2. Polmar, THRESHER, p.p. 36-37, but Bentley, John, *The Thresher Disaster*, pp. 6-7, indicates that SKYLARK had received a copy of the test depth dive agenda by mail (THRESHER Notice 9080 of 2 April 1963).

3. The author's experience in the Pacific Submarine Force in five submarines and two Submarine Force staff billets was that there were no Force-level directives laying out a prescribed agenda for post-overhaul deep dives. The matter was left to the discretion of the commanding officer of the individual submarines.

4. SKYLARK assigned precedence designator PRIORITY to her messages. Above that was FLASH reserved for enemy contact messages and the like. Next

was IMMEDIATE, used for immediate operational problems, including search and rescue. Below PRIORITY was ROUTINE for administrative traffic. No one would have faulted SKYLARK for using IMMEDIATE vice PRIORITY precedence, given the circumstances.

5. THRESHER wreckage was finally located on the ocean floor at a depth of 8,400 feet on August 28, 1963 by deep submergence vehicle TRIESTE.

6. Hearings of the Joint Committee on Atomic Energy, Wednesday June 26, 1963, p. 16, Exchange between Chairman Pastore and Admiral Brockett (Chief, BuShips). See also Admiral Rickover testimony of Tuesday, July 23, 1963, pp. 85-86 concerning BARBEL's silbraze joint failure.

7. Bentley, THRESHER, p. 216 and p. 324. See also Hearings of the Joint Committee on Atomic Energy, Thursday June 27, 1963, p. 32, footnote 1; and Wednesday July 1, 1963, p. 112.

8. The author was Assistant Operations Officer on ComSubPac staff from late 1963 until early 1966, and one of his responsibilities was maintaining that operations order and updating it as required.

9. In January 1963 USS PICKEREL (SS 524) completed her seven month long conversion to a Guppy III submarine. She went out and conduced sea trials in accordance with what the author recalls as ComSubPac Op order 301-YR, which laid out deep dive areas near each shipyard location. The author was executive officer of PICKEREL on that occasion.

10. The author, then ComSubGru Seven Chief Staff Officer, was Officer in Charge of USS GRAYBACK (SSP-574) sea trials in 1974 after completion of an overhaul at Ship Repair Facility, Yokosuka, Japan. A deep dive area that met her test depth requirement (700 feet) was selected outside Tokyo Bay.

11. Hearings of the Joint Committee on Atomic Energy, Wednesday, July 1, 1963. Vice Admiral Ramage, Deputy Chief of Naval Operations for Fleet Operations and Readiness remarks on p. 93, noting that "...some new requirements include the following: Test dives are made in depth of water limited to 1 ½ times the test dive depth... See also Polmar and Moore *Cold War*, p. xx which states that in the U.S. Navy collapse depth for submarines is calculated at 1.5 x test depth.

12. Polmar and Moore, Cold War Submarines, p. 11 USS CHOPPER (SS 342) exceeded her 400-foot test depth off Cuba in 1969 after a stern plane casualty, plunging to 1,050 feet before emergency surfacing. Post dive examination by submarine engineers indicated that plastic deformation of the hull had begun. Chopper never dove again.

13. Hearings of The Joint Committee on Atomic Energy, Wednesday, July 1, 1963, p. 93. Vice Admiral Ramage, Deputy Chief of Naval Operations for Fleet Operations and Readiness, testified about actions taken to improve submarine safety These included "...changes in our operating procedures...Test dives are made in depth of water limited to 1 ½ times the test depth..."

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ETERNAL PATROL

Mrs. Jeanine McKenzie Allen

CAPT Charles E. Armitage, USN(Ret)

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TWO SOVIET SUBMARINE DISASTERS

by Mr. Charles. J. Baker and Mr. Bruce Rule

Chuck Baker is a veteran US Navy submariner who served on fast attack submarines in the 1980's and later served as a surface warfare officer in the early 1990s. Chuck's background is in applied engineering and he holds a Master's Degree in Mechanical and Aerospace Engineering. He currently works at NASA's Jet Propulsion Laboratory as a senior systems engineer and is a team member on NASA's Mars Science Laboratory project.

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

The MIKE Class Soviet SSN K-278, lost on 7 April 1989

Fire at Sea, The Tragedy of the Soviet Submarine Komsomolets (Nato: MIKE) is a remarkable book about a remarkable submarine. Written by D. A. Romanov, the deputy chief designer of the MIKE, and copyrighted in 2006, the book (hereafter ROMANOV) provides detailed technical information on the design characteristics of the MIKE that could not have been published during the Soviet era.

It is not the purpose of this article to review ROMANOV but to discuss several important conclusions that are based on information in the book but which were not specifically addressed by the author.

As discussed in ROMANOV, MIKE was lost when a fire in the aft-most compartment (seven) melted non-metallic connections in the high pressure air and hydraulic lines allowing their release into that compartment which resulted in a (quote) blast furnace (end quote) with estimated pressures 20 times normal and combustion temperatures at least as high as 1600F (ROMANOV, pp. 103). Those conditions caused the titanium pressure-hull to recrystalize and burn through (breach) to permit flooding. Sea water near the stern was observed boiling.

The resulting flooding had progressed from compartment seven as far forward as compartment three when the MIKE sank down by the stern at 1708 local on 7 April 1989 in the far northeastern Norwegian Sea (73-43-17N, 13-15-51E).

When the MIKE sank, five men were still onboard. Four entered the escape sphere in the sail which could not be released, probably because of the stern-down attitude which would have prevented the sphere from rising from its vertically-mounted containment area. According to the single survivor, that stern-down attitude increased sharply before lessening as the MIKE sank toward the bottom at a depth of 5530 feet.

The survivor from the sphere stated (ROMANOV, pp 171) that "suddenly there was a shock beneath us, like a bomb exploding, followed by a second vibration." Although, as discussed in ROMANOV, there are alternate explanations for these two events, the most likely (not discussed in ROMANOV) is bottom impact, first by the stern and then by the rest of the submarine pivoting on the grounded stern. This sequence of events, which leveled the submarine - as confirmed by subsequent imagery and observations from Soviet MIR submersibles—released the escape sphere.

If the MIKE impacted the bottom 10-degrees down by the stern and sank at about 13-knots, a value determined for USS STERLET (SS-392) during an instrumented sinking on 31 January 1969, then the two MIKE bottom impact events should have been separated by two to three seconds.

The released sphere—designed to hold the entire crew of 64—rose to the surface in "one to two minutes" where the pressure-seated topside hatch blew open permitting the survivor to escape. (A weight displacement analysis suggests about three minutes.) Another man, who also was ejected, died from his injuries while the other two in the sphere were either moribund or dead. They had failed to connect their emergency breathing systems and were overcome by toxic fumes and atmospheric over-pressure within the sphere which increased the toxicity of the fumes. The sphere, which then flooded and sank, was subsequently located about 300-feet from the MIKE wreck after rising and then sinking 5500-feet.

If the MIKE sank at 1708 local and had the same measured 13-knot sink-rate as STERLET, bottom impact would have occurred at about 1712, a value consistent with then Soviet press reports of the surfacing of the sphere at about 1715.

The normal maximum operating depth for the titanium-hulled MIKE (test depth) was 1022m (3350-feet) with a never exceed depth of 1250m (4100-feet) and an estimated pressure-hull collapse depth of 1500m (4900-feet).

Page 175 of ROMANOV shows the photograph of a clock recovered from the MIKE wreck-site in 1992 and now on exhibit in the Russian Naval Museum in Saint Petersburg. That clock stopped at 17:22:30 or about 10-minutes after the probable bottom impact by the MIKE. This circumstance indicates the area within the MIKE pressure hull where the clock was located did not collapse until subjected to a pressure of 2,460 psi for those 10-minutes. Although the design pressure limit of the MIKE bulkheads (specifically those contiguous to compartments six and seven was 142 psi) (ROMANOV, pp. 102), the clock provides clear evidence that one bulkhead survived temporarily at about 17 times that pressure.

During the instrumented sinking of STERLET, the torpedo room bulkhead (the only sealed compartment) collapsed at a depth of 1200-feet, three times the test depth of the pressure-hull. The energy released by that event was equal to the explosion of 840 pounds of TNT at that depth.

Chapter 2 of COLD WAR SUBMARINES by Norman Polmar and K. J. Moore states that "the end (torpedo room) compartments of WWII US diesel submarines were rated at 1100-feet to fascilitate the use of the McCann rescue chamber" mated to the escape trunks in those compartments. See Note (1) The STERLET keel was laid down on 14 July 1943.

During a 1993 Russian survey of the MIKE wreck-site, a 20-

foot hole was noted in the starboard-side of the first compartment, the torpedo room.

These circumstances indicate the clock was recovered either from the torpedo-room through that hole in the pressure hull or was ejected through the hole and recovered from the bottom. It is concluded the MIKE torpedo room bulkhead could withstand the same pressure as the pressure hull for the same reason as the STERLET design: to provide a refuge for those crew members unable to enter the escape sphere who might then be rescued via the MIKE forward escape trunk. The ROMANOV information indicates both the MIKE torpedo room pressure hull and the bulkhead between the torpedo-room and second compartment survived at a depth of 5530-feet for about 10-minutes before collapsing.

It is probable the MIKE torpedo room pressure hull and bulkhead collapsed nearly simultaneously because the shock-wave from the first collapse event would have propagated through the pressure hull to the site of the second collapse at the speed of sound in titanium: 19,900 f/s (13,600 mph). Already stressed beyond design limits, the second collapse site could not have withstood the shock wave from whichever site collapsed first.

Based on an estimate that the hole in the torpedo room pressure hull was about 30-feet forward of the torpedo room bulkhead, the shock wave generated in the pressure hull by the first collapse would have reached the site of the second collapse—and triggered that collapse—in about 0.002-seconds, at least several multiples of the velocity of the water ram expanding at supersonic velocity through the torpedo compartment from the site of the first collapse.

<u>The NOVEMBER Class Soviet SSN K-8, lost on 12 April 1970</u>

As an addendum to the MIKE discussions, when the NOVEMBER Class Soviet SSN K-8 sank in the Bay of Biscay (47-25N, 19-40W) on 12 (not 11) April 1970 as the result of fires, an associated collapse event was acoustically detected by a U.S. Navy Sound Surveillance System (SOSUS) array in the western Atlantic at 04:04:44Z. (This information was derived from acoustic data that has been in the public domain for more than 40-years but is reported here for the first time.) The K-8 also sank down by the stern with 52 of the crew still onboard.

Analysis of the acoustic signal (bubble pulse frequency) indicates the collapse event occurred at a depth of 2020-feet (900-psi) with an energy release equal to the explosion of 1050-lbs of TNT at that depth. Based on the MIKE and STERLET data, that event was the collapse of the NOVEMBER torpedo room bulkhead and/or the torpedo room pressure hull. The published test-depth of the NOVEMBER Class was 985-feet.

Since it is probable all modern Russian submarines have torpedo room bulkheads with the same depth capability as their pressure hulls, and also have a reserve bouyancy greater than the volume of the torpedo room, the penetration of the torpedo room pressure hull by a weapon and the flooding of the torpedo room—even at significant depth—will neutralize the submarine weapon-firing capability but will not necessarily result in the loss of the submarine if the torpedo room was sealed prior to weapon impact.

Technical Comment

The empiric relationship that exists between the volume of a collapsing structure and the bubble pulse frequency (the compression-expansion cycle - oscillation rate - of air contained within the collapsing structure) permit determination of the depth of the event. In turn, that depth value and the bubble pulse frequency provide the size of the energy release—expressed in pounds of TNT—required to create that frequency at that depth.

Such forces are produced when potential energy in the form of sea pressure is converted almost instantaneously to kinetic energy, the motion of the water ram which enters structures that collapse at great depth at supersonic velocity. In the case of the NOVEMBER, all internal structures contiguous to yet unflooded areas were destroyed in less than 0.04-seconds as determined from the frequency of the collapse event bubble pulse.

Note: *(1) USS SCORPION (SSN 589) RESULTS OF NOL DATA ANALYSIS (U) (NOLTR ser 69-160 of 20 January 1970) states that the STERLET after escape trunk collapsed at a depth of 9100-feet. The forward escape trunk collapsed at 10,300-feet.*

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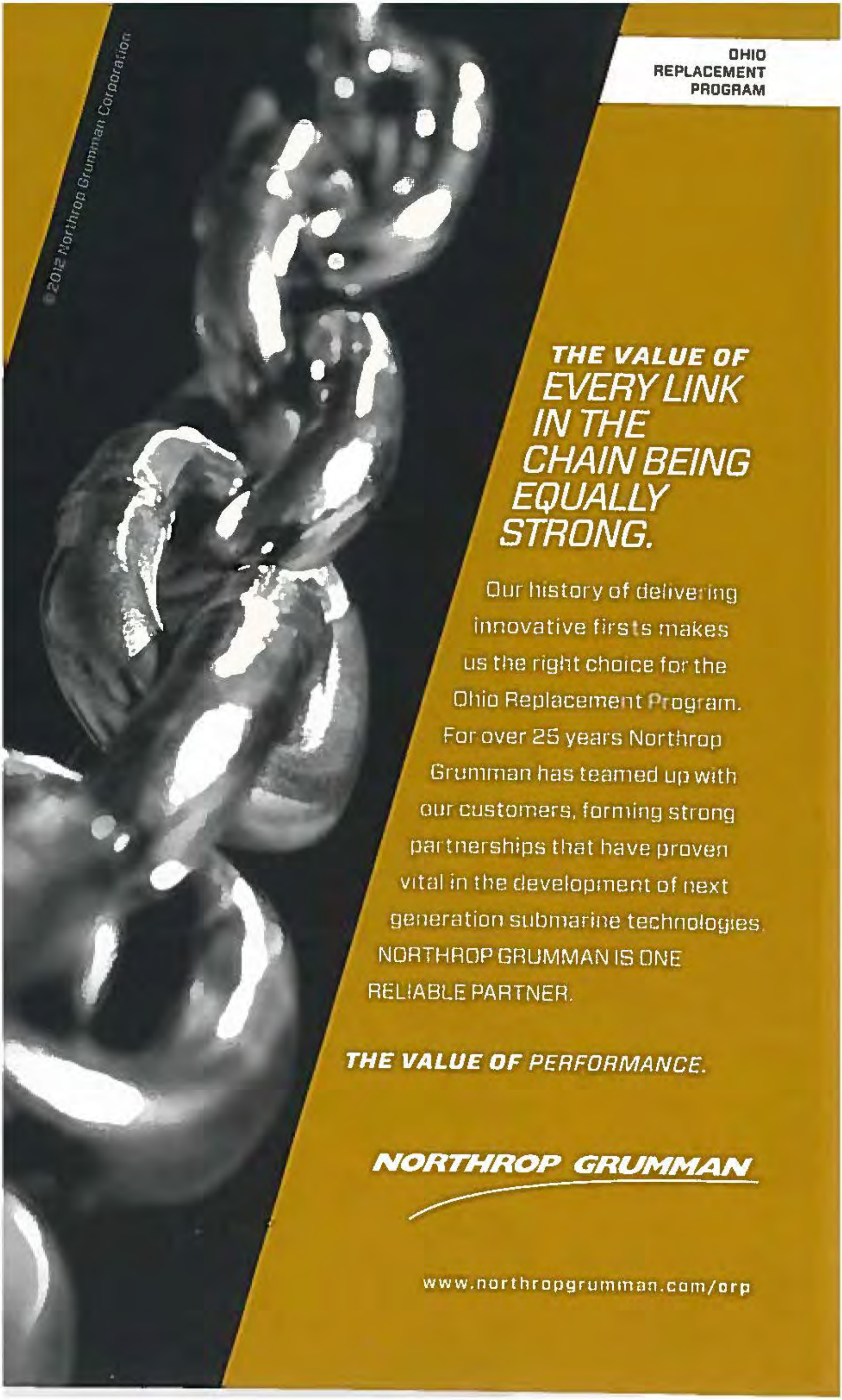
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SUBMARINE NEWS FROM AROUND THE WORLD

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From the October 2011 Issue

SOUTH KOREA—Chang Bogo Class Submarines: In late September 2011 South Korea's Defense Acquisition Program Administration (DAPA) selected Sagem to modernize the Republic of Korea Navy's (ROKN) Chang Bogo class submarines. Sagem will modernize the navigation system on the entire nine-unit class.

Each submarine will be fitted with two Sigma 40XP Intertial Navigation Systems (INS) and integrated into the existing combat system. Sigma 40XP INS combines high performance laser gyros with the advanced digital filtering techniques. The entire class will be upgraded by the end of 2012.

POLAND—Kobben (Type 207) Class Submarines: In late September 2011, AMI received information that Sunlight had been awarded a contract by the Polish Ministry of Defense (MoD) to supply batteries for the four Polish Navy Kobben class submarines. The four second hand Kobben class submarines were procured from Norway from 2002 through 2004.

The batteries were procured as part of a larger modernization effort by the Polish Navy. In 2010, the sea service announced a US$1.68B procurement and modernization effort that would run through 2018. One of the projects mentioned was a continuing modernization effort of the Kobben class. The four units will continue to receive hull, mechanical and electrical (H, M&E) upgrades as well as software upgrades to weapon and sensor systems and now the installation of the new batteries.

MALAYSIA—On 26 September 2011, the ex-French Navy Agosta class submarine, OUESSANT, was officially transferred to the Royal Malaysian Navy (RMN). The transfer occurred in Brest and the submarine will be moved to Malaysia on a cargo ship. OUESSANT will become a museum in Klebang.

OUESSANT was procured by the RMN in 2002 and was utilized to train the new crews for the induction of the Scorpene class submarines into the RMN.

From the November 2011 Issue

INDONESIA—DSME Appears to be Preferred Supplier for Submarine Program; Contract Negotiations Underway

Throughout October and November 2011, AMI sources continue to indicate that Daewoo Shipbuilding & Marine Engineering (DSME) has been selected as the preferred supplier (priority bidder) for the Indonesian submarine program. However, multiple sources have indicated that negotiations are continuing and the deal is not yet final. Various sources have stated that negotiations for a three submarine purchase should be complete by the end of 2011 under a US$1.1B deal and will be followed by a construction contract, in 2012.

The South Korean offer is for the Chang Bogo (Type 209/1300) class that was built for the Republic of Korea Navy (ROKN). The first two units will be built at DSME and the third unit in Indonesia with South Korean assistance. DSME has also been the primary maintainer of Indonesia's two Cakra (Type 209/1200) class submarines and have performed overhauls on both units in South Korea.

The other apparent finalist for the Indonesian submarine program is the joint German/Turkish team with the Type 209/1400. Reporting indicates (not confirmed) that this two-submarine deal is worth an estimated US$1B with both units being built in Turkey with German assistance. If the German/Turkish team would in fact win; the US$1B contract would probably be signed sometime in 2012.

Sources also indicate that the other entrants, the DCNS Scorpene and Russian Kilo/Amur were eliminated during the down select process. If negotiations are completed by 2011 as indicated by AMI's sources, the first unit could begin construction at DSME in 2012 followed by unit two in 2013.

Unit three could begin construction at PAL Shipbuilding by 2013. AMI believes that the willingness of South Korea to help develop Indonesia's submarine building capabilities as well as the lower price per unit (US$366M per unit for three versus US$500M per unit for two under the German/Turkish deal) puts South Korea in a very favorable position to finalize this deal.

ARCTIC REGION—Unresolved Claims Influence Future Procurements

In May 2011, the first definitive treaty regarding the Arctic region was signed by the US, Russia, Canada, Denmark, Norway, Iceland, Sweden, and Finland—All of whom have maritime claims (some of which overlap) in the region. The accord—*Aeronautical and Maritime Search and Rescue in the Arctic Region*—covers search and rescue operations. This accord helps to illustrate the growing significance of the area. AMI also believes it will help to shape the procurement of the signatories patrol forces over the next two decades.

Although the first international treaty has been signed, one can expect significantly more difficulty when it comes to any agreement dealing with international boundaries, mineral rights and the settling of international claims.

For this reason, there has been a general posturing by some of the Arctic powers over the past several years. On 06 July 2011, Russia's Defense Minister Anatoly Serdyukov announced its intention of deploying forces to protect its interests in the Arctic region. Two brigade-size formations would be created and they would be stationed at Murmansk. Over the next several years, Russia will invest RUB41B (US$1.34B) to improve infrastructure and transportation systems in and out of the region to support Arctic operations and deployment of the new regional force. Although the exact composition of the Arctic force is uncertain, it is estimated that it will combine elements of each branch of the Russian Armed Forces.

Additionally, the Federal Security Bureau through the State Border Guard Service has plans to establish a network of monitoring posts in the Arctic from Novaya Zemlya to Wrangel Island, a distance of approximately 3,218.5km (1,737.9nm). Lastly, Russia plans to build a US$33M year-round port facility on the Yamal Peninsula. The Russian Federation has staked a claim to a large part of the Arctic, which is thought to contain as much as a quarter of the world's petroleum and natural gas reserves. Prime Minister Putin has said Russia is open to dialogue, but will strongly and persistently defend its interest concerning the region.

As one of Russia's two closest regional neighbors, Canada has made protecting its sovereignty in the region a part of its national defense policy. The *National Shipbuilding Procurement Strategy (NSPS)* includes several platforms that would be used to defend its Arctic claims, most notably the Arctic Offshore Patrol Ship (AOPS) and several new icebreaking patrol platforms. Canada also has plans to establish a fulltime presence in the region of the Northwest Passage. In late 2009, AMI learned that Worley-Parson, an engineering firm based in Vancouver, British Columbia had won a C$900K (US$901K) contract; for the development of a naval base at Nunavut, near the Arctic Circle. Most recently, the call for the construction of possibly four nuclear-powered submarines at a cost of US$10B was also linked to protecting Canada's interests in the Arctic region.

Denmark's ambitions most closely overlap Russia's in the region. Already holding all of Greenland, they intend to submit a formal claim of sovereignty over the North Pole to the UN by 2014. The Royal Danish Navy (RDN) has built two Knud Rasmussen class Offshore Patrol Vessels). These are Arctic capable patrol vessels and AMI estimates that the RDN has plans for building a third hull by 2020, at an estimated cost of US$54M. Additionally, the RDN is planning a new class of OPVs that could be in service with the Danish sea service by 2022. This class of four hulls will also likely have the capability for Arctic operations.

While Iceland does not have a navy, the Icelandic Coast Guard (Landhelisæsla Ísland (LÍ)) possesses five ships capable of patrolling the Arctic region on fisheries protection, salvage, rescue and survey missions. Most recently, the ICGV THOR joined the LÍ. Additionally the sea service has plans for a class of two OPV's that AMI believes will join the Coast Guard by 2018 at a cost of US $45M each.

Norway also lays claim to nearly 235,000 square kilometers (90,734 square miles) of Arctic territory. To enforce its potential sovereignty claim it has built the Arctic-capable Barentshav class Royal Norwegian Coast Guard (RNoCG) OPV to replace the obsolete Nordkapp class vessels build in the 1980's and the Royal Norwegian Navy is constructing the seven-unit Nornen class of OPVs. Each of these classes could see extensive service in the region over the years, as the issue of claims over sovereignty continue to develop.

It seems the US has only recently awoken to the significance of the region. Despite an ongoing disagreement over the demarcation of the Northwest Passage with Canada and with significant claims in the area, the US Navy and Coast Guard are only now just beginning to define their overall Arctic policy with regard to protecting its sovereignty over disputed claims. Although the US Navy occasionally sends submarines on missions in the north polar region and the Coast Guard has a few aging icebreakers, they have no current or future plans for the development of their replacement or for the procurement of naval Arctic patrol vessels.

AMI believes that Russia and Canada have the best established plans for defending their perceived claims. The other signatories are either formulating their plans or are just beginning to establish a regional policy. As the Arctic ice pack continues to recede in what appears to be a warming cycle and surveys are conducted to determine potential resources, AMI believes that approximately US$78B in resources are at stake. The need to claim and or protect these resources, unless governed by treaty, will continue to drive naval platform procurements by the Arctic powers.

<u>From the December 2011 Issue</u>

SOUTH KOREA—KSS-500A Class Mini-Submarine: The KSS-500A mini-submarine program began in 2008 and is currently under development at South Koreas Agency for Defence

Development (ADD). The KSS-500A 37-meter (121.3ft) 510-ton submarine is the replacement for the Dolgorae class mini-submarines that are currently being phased out of ROKN service.

ADD is now selecting key systems suppliers. Construction will probably begin in 2012. At least six of the submarines will be built under this program. The KSS-500A pressure hull is divided into four compartments consisting of a combat information center (CIC); machinery room, a special operations forces area and an accommodations area.

The sail is streamlined and houses five masts including one electro-optical, one radar, one for satellite communications and the last for electronic support measures (ESM). The fifth mast will be able to handle a modular payload for the launching of small unmanned aerial vehicles (UAVs). The mini-submarine has the endurance of up to 21 days and a range of 2000 nautical miles and all electrical power is provided by two banks of lithium batteries rather than the traditional electrical generators.

It has a crew of 10 and can carry an additional 14 special opertions forces personnel. Its armaments will include two heavyweight (HWT) and four lightweight torpedoes (LWT). A payload interface module will enable the submarine to carry two box launchers for vertical launch (VL) missiles and mines.

RUSSIA-Yuri Dolgoruky (Borey Project 955) Class (SSBN) and Severodvinsk (Yasen Project 885) Class Submarine (SSN) Expansion: In early November 2011, among seven contracts signed by the Defense Ministry and United Shipbuilding Corporation (OCK) were orders for five Yasen and Borey class submarines. Although the precise amount of the contract was not released, the approximate price of the Severodvinsk class SSN's is US$1B and Borey around US$2B. Since the early 1990s both classes have suffered setbacks, including delays, controversies, questionable technologies, as well being the victims of budgets decreases. AMI believes that five-hull submarine order breaks down to two Borey SSBNs and three Yasen SSNs.

Increased Fleet Modernization: In November 2011, the VMFR completed the midlife modernization of the Antyey (Oscar II) class SSGN VORONEZH. The SSGN was modernized at Zvezdochka (two-years longer than planned) and will be followed by a modernization effort on the Orlan class heavy cruiser RFS ADMIRAL NAKHIMOV. The ADMIRAL NAKHIMOV has been laid-up since 1999 and is expected to re-enter service when complete. The modernization efforts are part of Russia's planned retooling of its defense industry, to streamline procurement processes, increase efficiency and ultimately modernize existing units for further service while beginning a new generation of combatants and submarines to meet the VMFR's 2020 goals.

DID YOU KNOW?

GERMANY: On 15 November 2011, the German Navy christened the fifth Type 212A class submarine, U35. U35 will enter service in 2013.

IRAN: On 26 November 2011, the Iranian Navy took delivery of three Ghadir class submarines.

UNITED STATES: On 03 December 2011, the United States Navy's (USN) ninth Virginia class submarine, USS MISSISSIPPI (SSN-782) was christened at General Dynamics Electric Boat Facility in Groton, Connecticut.

From the January 2012 Issue

2012 Defense Budget Approved, 2013 and Beyond Uncertain

On 31 December 2011, US President Obama signed the 2012 defense budget into law (took effect on 01 October 2011). US$533.1B was requested by the Department of Defense, which excludes funding that is directly related to overseas contingency operations (OCO). US$117.8B was to be set aside for OCO requirements (US$41.5B lower than the FY2011). The base line was slightly modified by the Congressional Budget Office (CBO) in their proposal, while OCO funding was slashed by 74-percent (due to Iraq drawdown). The overall budget signed into law by the President is approximately US$9B less than the FY2012 budget proposed by the US Congress. Although the overall defense budget is 4.2% less than the last full year budget in 2010, the base budget for 2012 is actually 3% higher than the 2010 budget.

Of this amount, approximately US$113B has been allocated for procurements (roughly 21% of the total base) with the US Navy (USN) receiving approximately 29% of which US$14.6B is for ship construction (SCN budget).

DoD Budget (in US$B)							
	FY 2010 ACTUAL	FY 2011 CR	FY 2011 REQUEST	FY 2012 REQUEST	FY 2012 CBO PROPOSAL	FY 2012 FINAL	Difference
Base	527.9	526.1	548.9	553.1	553	544.2	-8.8
OCO	163.1*	159.0	159.3	159.3	118	117.8	-.2
Total Budget	691.0	685.1	708.2	712.4	671	662	-9

**Included US$.7B in non-OCO funding for Haiti support operations.*

In regards to the USN's Future Years Defense Plan (FYDP) 2012-2016, there has been an addition of two ships in 2012 in comparison to FYDP 2011-2015. One Littoral Combat Ship (LCS) was added and one Mobile Landing Platform (MLP) slid from 2011 to 2012. In regards to the entire 2012-2016 FYDP, five ships were added since FYDP 2011. This is attributed to the addition of one Arleigh Burke Flight II destroyer in 2014, three TAO(X)s (2014-2016) and the one additional LCS in 2012. Although within the five-year FYDP, the second Ford class aircraft carrier has slid two years to 2015 and is now experiencing cost overruns estimated at US1.1B.

US Navy FYDP 2012-2016						
Ship Type	FY '12	FY '13	FY '14	FY 15	FY '16	Total
Ford (CVN) 78) Class Aircraft Carrier	-	-	-	1	-	1
Virginia (SSN 774) Class Attack Submarine	2	2	2	2	2	10
Arleigh Burke (DDG 51) Class Destroyer (Flight II)	1	2	2	2	-	7
Arleigh Burke (DDG 51) Class Destroyer (Flight III)	-	-	-	-	1	1
Littoral Combat Ship (LCS)	4	4	4	4	3	19
San Antonio (LPD 17) Class Amphibious Ship	1	-	-	-	-	1
Fleet Tug (TATF)	-	-	-	-	1	1
Mobile Landing Platform (MLP) Ship	1	1	-	-	-	2
Joint High-Speed Vessel (JHSV)	1	2	2	2	1	8
TAO(X) Oiler	-	-	1	1	1	3
TAGOS Ocean Surveillance Ship	-	1	-	-	-	1
Total	**10**	**13**	**10**	**13**	**9**	**55**

Although FYDP 2012-2016 appears to be fairly rosy at this point due to 2012 funding levels, 2013 and beyond must be considered precarious at best. FY 2013 through FY 2016 does not include any of the forced defense budget cuts (estimated at US$450B over ten years) that will take affect beginning in 2013 and last through 2022. It also does not include any implications that may stem from the new strategic defense plan (Sustaining US Global Leadership: Priorities for 21st Century Defense) just released in 05 January 2012. Admittedly, the strategic plan at the outset appears to favor the USN with a focus on its strategic ballistic missile forces, general purpose forces and the Asia-Pacific Region. Larger cuts (63%) will come from the US Army as well as additional downsizing from the Air Force and the Marine Corps.

However, when the new strategic plan is digested in combination with forced budget reductions, one can surmise that the FYDP 2013-2017 could look considerably different than today's. The first indication of the future of the USN will be with the release of the FY 2013 defense budget proposal by Congress on 06 February 2012 that will include consideration of the just released strategic defense plan. Although the USN may be an overall winner, the types and numbers of new construction units will more than likely change as a result of the new strategy; i.e., possibly more surface combatants and submarines (ballistic and general purpose) with reductions in aircraft carriers and amphibious ships.

INDONESIA

South Korean Type 209 Selected

On 23 December 2011, Daewoo Shipbuilding Marine and Engineering (DSME) won a US$1.1B contract for the construction of three Type 209 submarines for the Indonesian Navy (TNI-AL). DSME bested its French, German, Turkish and Russian competitors for the program. One of the keys to the win was the technology transfer agreements that will allow Indonesia to develop its submarine building capabilities at PAL Shipbuilding.

The first two units will be built entirely at South Korea's DSME with assistance from Indonesia's shipbuilding industry personnel. Indonesia expects to supply up to 30 personnel to DMSE for the construction of the first unit and 130 for the second unit with the intent of acquiring enough experience to build the third unit at Indonesia's PAL Surabaya with South Korean assistance only.

The first unit is scheduled to be delivered to the TNI-AL in 2015 and 2016 and the third unit (Indonesian-built) in 2017. AMI believes that the two South Korean units will probably be delivered on schedule. However, the Indonesian unit will probably face at least a two-year delay as it is the first attempt to build a submarine in country.

The construction of the third Type 209 will give Indonesia the experience to build additional units if it desires or move forward with other submarine designs. Additionally, the TNI-AL will be able to better maintain its Submarine Force in the future without outside assistance.

WORLD MISSILE DEVELOPMENTS

RUSSIA: On 23 December 2011, the Russian Navy successfully tested to Bulava (MACE) submarine-launched ballistic missiles (SLBM) from the submarine RFS YURY DOLGORUKY in the White Sea. Both missiles reportedly hit their target on the Kamchatka Peninsula.

The last two launching make a total of 18 for the Bulava, 11 of which have been successful, four in 2011 alone.

As the four new Borey class submarines enter service through 2015, the Russian Navy has confirmed that the Bulava missile will equip all units of the class (16-missile per submarine) and become the standard SLBM in Russia's inventory. Bulava, also know as the SS-NX-30/Mace weights 36.8 tons and has a range of over 8,000km (4,445nm) and can carry a mix of ten warheads and decoys.

THE SUBMARINE COMMUNITY

SHANNON D. CRAMER, JR., VADM, USN

Published in The Washington Post on March 4, 2012

Shannon D. Cramer, Jr., VADM, USN, Ret., 90, formerly of Clemson, SC, passed away at his home in Washington, DC, surrounded by family on February 15, 2012. Shannon was born on September 18, 1921 in Washington, DC to Shannon D. Cramer, Sr, and Mary Hazen Duffy Cramer. He attended Central High School in Washington, DC, where he excelled at football, was named to the National Honor Society and was the President of his graduating class of 1939. He skipped one year in high school and attended Admiral Farragut Academy in Pine Beach, New Jersey to prepare for his entrance to the United States Naval Academy. World War II accelerated the wartime classes including the Class of 1944. Shannon graduated early, after only two years and nine months, on June 9, 1943 and was commissioned an Ensign.

Admiral Cramer served aboard USS LAUB (DD613), USS FURSE (DDR882), USS COCHINO (SS345), USS HALFBEAK (SS352), USS COBBLER (SS344) and USS SIRAGO. He commanded USS SWORDFISH (SSN579), the Gold Crew of USS PATRICK HENRY (SSBN599), Submarine Division 102, Submarine Squadron 15. Admiral Cramer's other assignments included; aide to the Executive Officer of the Submarine Base, head of the Reserve Training and Ordnance Departments; submarine advisor to the Chief of Naval Reactors Office, Atomic Energy Commission; head of the Material and Submarine Propulsion Sections, Office of the Chief of Naval Operations; deputy director of Operations in the National Military Command Systems, J-3, Joint Chiefs of Staff; and military assistant to the Assistant Secretary of Defense (Public Affairs). He became commander, Submarine Flotilla 6 in May 1970, and in August 1972, he reported as deputy director (strategic) of J-5, Office of the Joint Chiefs of Staff. From August to September 1974, he was deputy director for Plans, Defense Intelligence Agency. Admiral Cramer consolidated and streamlined production elements of the Defense Mapping Agency (DMA). He directed the efficiencies to the growing demands of the services and commands for geographic information. He retired in 1977. Following retirement, he served as the Department of Defense/Joint Chief of Staff representative to the United Nations Law of the Sea Conference from 1978 to 1981. He received the DoD Outstanding Award for Public Service for this assignment. Vice Admiral Cramer was a founder and the first President of the Naval Submarine League. His tenure in that role was from 1981 to 1989. Vice Admiral Cramer was recognized for his outstanding contribution as director of DMA and was inducted into the National Imagery and Mapping Agency Hall of Fame in 2003.

Admiral Cramer's decorations and awards include the Legion of Merit with four gold stars; the American Defense Service Medal; the American Campaign Medal; the European-African-Middle Eastern Campaign Medal with two stars; the Asiatic Pacific Campaign Medal; the World War II Victory Medal; the Navy Occupation Service Medal; Europe Clasp; the National Defense Service Medal with bronze star. Admiral Cramer was a member of Eternal Shepherd Lutheran Church in Clemson, S.C.

He was preceded in death by his parents, brother Hugh, spouses Elizabeth (Betts) Stewart Cramer and Marie Ploetz Cramer and son Shannon D. Cramer III. Left to honor Shannon and remember his love are brother Calvin Cramer (Sandra) and children John Cramer (Beverly), Beth Churchya (Dave), Susan Algeo (Michael), Mary Cramer Wagner, Lawrence Ploetz (Denise), Frederick Ploetz (Sandra), Joanne Biery (Tom), Janet Davis (Don), Judi Petersen (Mark) and John Ploetz (Carol) as well as many grandchildren, great grandchildren, nieces and nephews. The family of Admiral Cramer also wants to acknowledge the tender care given to Shannon by his caregiver Rutendo Ried, the staff of Grand Oaks and Capital Care Hospice.

LETTERS TO THE EDITOR:

Re: Submarine Design

I have little confidence that my critique of current submarine design, will elicit greater response than it has during the past twenty years. During that time and often before, leaders of our submarine community have suggested required design changes. They have proposed that smaller size can reduce their cost to construct, and that insufficient compartment separations endanger their survival from flooding. It's been observed that too few harbors can accept their size, and that automation can reduce crew size to save operational costs. Others argue for increase of mission capability to lower the number of new constructions.

The standard rules of thumb for hull length to width ratios, and allowable operating depth for a platform of a certain length are no longer being observed. They also note lower safety margins, and that double hull protection is no longer afforded. Much of this results from constant construction, maintenance, and operational cost increases. The intended savings for additional operational capability is perhaps lost by that increased requirement for size and manning to operate. The current trend to replace crew by automation has significant added risk as well as its benefit. Now the threat of budget restraints could lower the number of platforms on station. Never the less, our submarines are considered the best in the world. The great concern now must be their ability to meet the next new challenges and how long it would take to adapt for it. The trend to copy the success of the previous design, to avoid risk of failure inherent with new concept, cannot continue. We must not attempt to fight the next war with the weapon platforms of past.

My experience during thirty plus years in submarine design, being the first designer assigned to the *Trident* project, and involved for its full development period, provides me considerable insight to that process. I know the things we chose not to do as well as those we did. My assignment to NAVSEA for an alternate diesel submarine proposal, provided understanding on goals and limitations. All of our current designs are cylindrical, and of single hull construction, and are most similar to that of a reinforced flexible hose. This gives limitation of their resistance to longitudnal bending, and to external pressure. That weight of required structural reinforcement gives limitation to hull plating thickness and to compartment arrangement. Hull reinforcement ring framing gives limitation from about ten percent of internal volume. Hull diameters are limited by the platforms' draft, thus size increases extend the platforms' length. The accepted ideal length to width ratio of six, has never been achieved in current submarine design. The claim, of a greater expense in double hull design, must be challenged, as it provides longitudinal stiffness, removes ring framing from within the pressure hull, and can reduce hull and shaft length by twenty percent. Testing has shown hull length extension to increase drag and therefore limits hull speeds. Submarine operation in shallow water had been limited to a depth not less than its length. When submerged a submarine becomes less longitudinally stable. This all suggests an extensive opportunity for redesign.

Respectfully,
C. Clifford Ness

Inventor of U.S. Pat. 5,477,798. and 6,371,041

BOOK REVIEWS

WHY THE USS SCORPION (SSN-589) WAS LOST: DEATH OF A SUBMARINE IN THE NORTH ATLANTIC

by Mr. Bruce Rule

Nimble Books, LLC, Ann Arbor, MI

Reviewed by CAPT Jim Patton, Jr. USN (Ret)

It was an honor to have been asked to review Mr. Rule's book for a number of reasons. Most importantly at a personal level, SCORPION was my home from October 1961 to December 1962 and three deployments when, as one of the first group of direct inputs I learned the trade from giants such as Bessac, Carr, Kaufman, Trost, Holland and Fountain. There were also several still aboard I had served with such as Mazzuchi, Huckelberry and, most notably, Wally Bishop—who had been made Chief of the Boat as a First Class Petty Officer (with full support of the Goat Locker) while I was aboard. I also remember Admiral Rickover's stern admonition about the heavy responsibility one assumes when he is so presumptuous as to advise potential readers about another person's writings.

Significantly, *Why the USS Scorpion (SSN-589) was Lost* is not a book in the traditional sense of the word. Far from being a novel or historical documentary, it is a superbly prepared technical report based on empirical evidence and written to high forensic standards by an individual who served in the acoustic intelligence field for 40 years. Mr. Bruce Rule had been the Lead Acoustic Analyst as the Office of Naval Intelligence, and quite simply, has no peer capable of having accomplished what his book does—the striping away of *almost* all of the erroneous myths and conjectures concerning the demise of SCORPION.

Since 2002 there has been a well-moderated Yahoo Group concerning SCORPION's loss on which there have been nearly

15,000 postings ranging from the ridiculous to the sublime. I *lurked* in the group and occasionally contributed, as did Mr. Rule. A major contributor was Stephen Johnson—the author of *Silent Steel*—the only other book about SCORPION that is worth the time to read, and which is the ideal companion piece to Bruce Rule's work. As tribute to the focused nature of *Why the USS Scorpion (SSN-589) was Lost*, one could read all 15,000 of those postings and not get as complete an understanding of SCORPION's loss as exists in the book's 75 or so pages.

If *Why the USS Scorpion (SSN-589) was Lost* has a flaw, it is that portions of it are very technically complex—the very same characteristic that makes it so credible. For those not feeling up to that intellectual challenge—or merely in a hurry—the 7 pages of Chapter 5 (a 6 August 2010 letter to the Director of Naval Intelligence), Chapter 6 (a 22 May 2011 letter to the Director of Naval Intelligence) and Appendix B (an article published in the Submarine Library and Museum's Electronic Newsletter the PING) nicely capture the history and forensic analysis leading to Mr. Rule's conclusions.

After being Navigator on three SSNs, it finally dawned on me that the secret is that one never really knows where they are, but it's a question of just *how badly* you don't know—navigational uncertainty. Similarly, we will never know what really happened on SCORPION on 22 May 1968, but *Why the USS Scorpion (SSN-589) was Lost*, has reduced the existential uncertainties of the root cause to nearly zero.

UNDERSEA WARRIOR: THE WORLD WAR II STORY OF "MUSH" MORTON AND THE USS WAHOO

By Mr. Don Keith,
Published by NAL Caliber, New York, 2011
Reviewed by
by Lieutenant Joel Ira Holwitt, USN

Lieutenant Holwitt is the Navigator/Operations Officer of USS New Mexico (SSN 779). A 2003 graduate of the U.S. Naval Academy, he earned a Ph.D. in naval and military history from Ohio State University in 2005. He is the author of "Execute Against Japan": The U.S. Decision to Conduct Unrestricted Submarine Warfare, published by Texas A&M University Press in 2009, and reviewed in April 2010 issue of The Submarine Review.

Having already published four submarine histories, and co-authored William Anderson's second memoir, *The Ice Diaries* (2008), Don Keith should rightly be regarded as the most prolific current historian of U.S. submarine history. His writing captures a sense of adventure during the exploits of the submariners he discusses, a reverence approaching awe when he discusses their bravery and heroism, and expresses the tragedy of their loss. All of these traits are on display in Keith's latest book, *Undersea Warrior*, the first dedicated biography of Commander Dudley W. *Mush* Morton, the famous Commanding Officer of USS WAHOO (SS 238).

There have been a spate of recent biographies of submarine aces in the last decade, including new books about Richard O'Kane, Slade Cutter, *Red* Ramage, and Eugene Fluckey. In light of these recent biographies, Mush Morton certainly merits his own biography. Dick O'Kane, the top submarine ace of the war, and Edward L. Beach, another great U.S. submariner of the war and possibly its finest chronicler, both credited Morton with single-handedly turning the Submarine Force around with his aggressive conduct and unorthodox tactics. In only five war patrols, spanning a little over nine months, Morton sank more shipping than any prevous U.S. submariner, earning four Navy Crosses and the admiration of countless submariners. Although not the only factor, Morton's training and aggressive attitude affected a number of future submarine aces, including O'Kane, George Grider, and John R. Moore.

This is not to say that Morton has not been previously written about. If anything, Morton and WAHOO may very well be the most chronicled topic in U.S. Submarine Force history, with accounts in books by Beach, Vice Admiral Charles Lockwood, Clay Blair, Edwin Hoyt, and James DeRose, as well as first-person accounts by O'Kane, Grider, and Forest Sterling. As a consequence, one wonders what Keith could possibly add to this already crowded field of literature.

The short answer is that there is not much Keith could add. Although written with an undeniable sense of excitement that swiftly carries the reader through all seven war patrols, Keith's account does not expand on the well-told narrative of WAHOO's war patrols, Morton's tactics, or the remarkable and heroic actions of her crew. Keith does his best to make an old tale new, but there are only so many ways to write about Morton's death-defying down-the-throat torpedo shot against HARUSAME in Wewak Harbor or the subsequent 14-hour convoy battle, and at this point, they've been done by the other authors listed above. Readers looking for new details or a radically different perspective on Morton at war will be disappointed.

What Keith adds is a human dimension to Mush Morton. In most previous books, including memoirs, Morton's personality comes across one-dimensionally as someone who was born to be only a submarine commander—almost recklessly brave and a natural leader of men, but with little to no details of his family life, prewar service, or even his hobbies. Using family interviews with Morton's niece-in-law and children, some of Morton's correspondence, and interviews with Morton's acquaintances and friends from before the war, Keith fills in a far more complete portrait of Morton as a man. Readers may be surprised to discover that Morton was a fine sailor, who learned a significant amount about the Chinese coast from tacking through it in his personal sailboat while stationed in the Asiatic Fleet, or that he prided himself upon being an excellent tailor, personally stitching some of WAHOO's battle pennants.

Keith's biography of Morton makes it clear that Morton's success as a submarine commander was neither preordained or even endorsed by the entire Submarine Force. Although some Submarine Force leaders provided providential support at critical junctures, such as Admiral Lockwood and then-Captain John H. *Babe* Brown, Morton frequently found himself criticized and even on the razor's edge of expulsion from the Submarine Force. He was relieved from command of DOLPHIN when his division commander lost confidence in his ability to resolve her material problems. And Morton still experienced pointed criticism after proving himself in combat and turning in the top war patrol until that point, nine ships sunk in the Yellow Sea, which ultimately ended up as the second best U.S. submarine patrol of the war.

Keith also asks the question, previously asked by Dick O'Kane, of why Morton never received the Medal of Honor. Based on his correspondence and a submitted citation, Morton was apparently considered for the award. Like James DeRose and some other authors, Keith speculates as to whether Morton's shooting of survivors from the Japanese transport BUYO MARU, which included Indian POWs, may have torpedoed postwar efforts to award Morton the medal. Although Keith does not bring this up in his book, Morton's penetration of Wewak Harbor was certainly as daring as similar incursions by Eugene Fluckey and George Street III, perhaps more so based on the quality of his chart and the enemy he faced. And Morton's tenacity and bold aggressive combat, against convoys and other merchant ships, was as dogged and courageous as that of Red Ramage and Dick O'Kane. Indeed, Keith would have done well to ask if these other Medal of Honor winners might have taken the chances they did if Mush Morton hadn't led the way.

For a historian who has become so well versed in World War II Submarine Force history, Keith makes some surprising errors. Most of these are minor in nature, such as misidentifying USS

POMPANO as a Dolphin-class submarine. Some are a little more significant, such as misidentifying a famous photograph of the sinking Japanese destroyer YAMAKAZE*Y*, torpedoed by NAUTILUS in 1942, as HARUSAME, which was sunk by WAHOO. Similarly, he attributes laudatory message traffic from COMSUBPAC to WAHOO in late January 1943 to Vice Admiral Lockwood, who did not take command of the Pacific Fleet Submarine Force until February 1943. Although these errors are minor and do not detract from Keith's narrative, they illustrate that additional research by the author may well have yielded a stronger biography. And Keith claims that Morton "show[ed] the world how to conduct submarine warfare" (p. 117), despite the fact that the Germans had arguably already done so.

Undersea Warrior is a fast-paced and well-written history. Although it brings very little that is new, it certainly is a worthy introduction to Mush Morton and his heroic crew of WAHOO. Those who desire a deeper discussion of the technology and tactics involved may do well to read O'Kane's *Wahoo!* or DeRose's *Unrestricted Victory*, but those who want to learn about the first U.S. submarine ace and WAHOO's remarkable story will enjoy *Undersea Warrior*.

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