THE SUBMARINE REVIEW

NAVAL SUBMARINE LEAGUE

APRIL 2006 **PAGE**

EDITOR'S COMMENTS

The FEATURES section of this issue is all about the state of, and the prospects for, the US Navy's Submarine Force. However, as the knowledgeable reader, and all of the League's members are very knowledgeable, is aware, there is a fundamental relationship of the Submarine Force competence in capabilities and strength in numbers to the Sea Power useable by the United States in critical world affairs. The status and prospects of the Submarine Force are, therefore, prime factors in the calculation of US Sea Power, and not just parochial concerns of a relatively small part of the US Navy. One of the hard-learned lessons of the Cold War was about that submarine aspect of Sea Power and how influential it was in effecting a checkmate of Soviet power.

Congressman Rob Simmons, a Republican from the Second Congressional District of Connecticut, spoke to the NSL's Corporate Benefactors Day observance on February first and put his emphasis on the impending loss of submarine design capability. He voiced his concern in terms of the potential for grave threat from both the emergent China and the re-emergent Russia. His proposed solution to the problem is a return to a building program of two submarines a year well in advance of rather vague plans to do so in more than a few years.

VADM Chuck Munns, in his ComNavSubFor/ComSubLant address to the same gathering, very completely covered the organization and the operations of today's Submarine Force. His emphasis on the goals of the Force demonstrate a sophisticated, above-the-usual-just-immediate-focus, political-military awareness and a recognition of the need to act accordingly every day, and not just in crises times. RADM Joe Walsh, the Director of Submarine Warfare on the CNO's staff, also gave the NSL Corporate Benefactors a great rundown of the programs being worked for the immediate future and of the problems he can foresee for the mid-term future.

The fourth part of the overall picture given here of the Submarine Force's current status and prospects for the future comes from RADM Jerry Holland, well known to readers of these pages as a respected, up to date observer of the Washington defense policy scene. He has based the *heavy weather* he forecasts on forces readily apparent to those who watch national politics. Not so obvious to the

general public are those undercurrents of inter- and intra- service affairs which do not fully subscribe to the goals, awareness and recognitions by which the Submarine Force has become known.

In addition to the weighty issues addressed by the FEATURES, a special gift is presented here for all submarine enthusiasts, whether they be historians, operators, technicians or just appreciators of great sea stories. Through the good offices of the retired submariners in Hawaii THE SUBMARINE REVIEW received a copy of Thomas O. Paine's 1984 letter to Richard Compton-Hall about his adventures with the post-surrender surviving IJN submarines, especially one of the monster aircraft-carrying I boats. His *Last Voyage* took place at the end of 1945 as the "tides of war receded" and left a fairly *forgiving environment* in which his "largest undersea inter-island trader" conducted its transit from Honshu to Hawaii. It's a great story–enjoy. Incidentally, this is the same Dr. Paine who had a distinguished scientific/governmental/industrial career during which he collected over three thousand books about submarines. That treasure is now a special collection at the Naval Academy's Nimitz Library.

Another gift for our readers is Jim Bloom's piece Nemo's NAUTILUS about the Jules Verne creation of a concept for an undersea warship of great endurance and performance. There is enough history there about Verne's association with French submarine pioneers of the period to show an advanced appreciation for the potential of submarine warfare. It can be seen also what a *futurist* can do with imaginative extrapolation of known technological potentials. With our long lead times for politics, development and construction there might be a lesson to be learned there in terms of what threat we have to design against.

There is an innovation being tried in this issue about the presentation of new submarine books. In lieu of an observation and a report by a knowledgeable reviewer, perhaps the readers would prefer a sample of the author's work, especially when it is a memoir from a profession shared by many of us. Please let us hear about any thoughts & opinions after you read the excerpt from Tom Smith's book.

Jim Hay

FROM THE PRESIDENT

The Naval Submarine League completed its fiscal year on 31 March 2006. A record attendance at the Submarine Technology Symposium coupled with continued fiscal constraint enabled the League to contribute approximately $60,000 to the fiscal health of the NSL while maintaining a robust program of educating the public in the importance of submarines as the Crown Jewel of national defense. Additionally, this year we restarted the grant program. The Board of Directors approved a budget for next fiscal year that will continue to grow the corpus to the goal of $500,000. The NSL supports a Studies and Analysis program to identify ways and means of increasing the capabilities and employment of submarines.

The Corporate Benefactors continue to be the backbone of support for the NSL. It is their support that allows the NSL to support the membership and the Force. This year Benefactor support included renovation of the NSL offices, support for many events at NSL symposia and sponsorship of events the NSL supports for the active duty Submarine Force. This year we welcomed four new Corporate Benefactors bringing the total to 73.

The 2006 Corporate Benefactor Recognition Days was a resounding success. The event, held 31 January and 1 February 2006, set an attendance record. Fifty-one of the NSL 73 benefactors were represented. The active duty submarine Flag Officers and guest speakers were the centerpiece of the event. Over 240 members of the League's submarine support community attended. The opportunity to interact with the active duty Flag Officers at a reception following Admiral Kirk Donald's remarks was one of the highlights of the event. The Chief of Naval Operations, Admiral Mike Mullen, spoke at the luncheon. CNO provided attendees a candid view on his approach to running the Navy and his views on what is necessary to improve the submarine build rate. Congressman Ron Simmons (R-CT) addressed the Benefactors at the Congressional breakfast. He gave his assessment of the need for acquisition of two submarines a year.

This edition of Review was on the way to the printer when the 2006 NSL Submarine History Seminar was held. The theme, "SP at

50!" honored a part of submarine heritage that was instrumental in winning the Cold War. The event featured individuals who played key roles in the success of SP over half a century. The event contributed chronicling the legacy of the Submarine Force. This year's event was sponsored by one of our Corporate Benefactors.

The 2006 Submarine Technology Symposium will be held at The Johns Hopkins University Applied Physics Laboratory on 16-18 May 2006. The theme this year is "*Submarine Technology in an Era of Transition*". The event features five sessions chaired by experts in their field. Keynote speakers include Admiral Kirk Donald, Vice Admiral Chuck Munns, Vice Admiral Eric Olson, Deputy Commander, U. S. Special Operations Command and Vice Admiral Paul Sullivan, Commander Naval Sea Systems Command. The full agenda is available on the registration website, http://www.jhuapl.edu/sts/. This classified event is limited to the first 500 attendees by the size of the auditorium. Please register early.

Our final event for this year will be the Annual Symposium held at the Hilton Alexandria at Mark Center in Alexandria, VA on 7-8 June. The keynote speaker on Wednesday afternoon will be Admiral Ed Giambastiani, Vice Chairman of the Joint Chiefs of Staff. Please look for the mailing to all members later this month and participate in the election of the members of your Board of Directors.

NSL members are the connection to the public. To be effective in accomplishing the goal of educating the public the NSL needs to increase membership. We are pursuing several initiatives to recruit active duty and retired service members and submarine advocates. I ask each of you to recruit a new member. To better support the membership we are reviewing the timing and structure of our major symposia. Our goal is to have every event relevant and support the submarine community. We are continuing to work to develop Chapters that will support our members in Middle America. We hope the commissioning of TEXAS in Galveston this year will be a catalyst to bring that Chapter to reality.

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

J. Guy Reynolds
President

24th Annual Symposium

7-8 June 2006

Hilton Alexandria Mark Center

5000 Seminary Road

Alexandria, VA 22311

State of the Submarine Force Report

Annual Awards Luncheon

Submarine Social

Distinguished Submariner Banquet

Corporate Exhibits and Receptions

Watch for your symposium mailing this month.

For assistance, please call the Naval Submarine League at 1-877-280-7827 or in the DC Area at 703-256-08791

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NAVAL SUBMARINE LEAGUE - Box 1446 - Annandale, VA 22003
(703) 256-0891 Fax (703) 642-5813 E-mail: subleague@cavtel.net
Web Page: www.navalsubleague.com

KEYNOTE ADDRESS
NAVAL SUBMARINE LEAGUE
CORPORATE BENEFACTORS DAY
1 FEBRUARY 2006

REMARKS BY
CONGRESSMAN ROB SIMMONS (R-2nd District, CT)

Good morning; it's great to be here with the Naval Submarine League, a great advocate of the United States submarine community. Last night I watched the President's State of the Union Address. The question is: am I disappointed? The answer is: yes, because I was waiting for him to say "two submarines per year."

I have always been proud as a Connecticut state representative, and as a Member of Congress, to represent Groton-New London, *the Submarine Capital of the World!* For us, it's more than a name; it's more than a title. It's our history and our culture. It goes back to the days of the Revolutionary War, when General Washington authorized a Connecticut resident from Old Saybrook to design and build a subsurface vessel. The world's first submarine, TURTLE, engaged in operations against enemy British forces in New York harbor by trying to affix an explosive device onto one of Admiral Howe's ships. The attack did not work perfectly—but it did encourage Howe to move his fleet away from an anchorage near Manhattan; so, in that regard, it was a success. It was also one example of the U.S. Army and the U.S. Navy working together. That's because, when TURTLE was designed and built, no self-respecting mariner would attempt to operate it, so they had to get an Army sergeant.

Today, we're in trouble. I would have said six months ago we were in trouble because Naval Submarine Base New London was on the Base Realignment and Closure list. For the life of me, I could not understand why people over on the other side of the Potomac River would place Sub Base New London on the BRAC list. It's the heart and soul of what we do in Southeastern Connecticut. It's the heart and soul of a center of excellence, which has existed in that part of the country along the Thames River for over half a century. Yet, it was on the BRAC list; and with a great deal of effort and with the

assistance of some of the people in this room we were able to take it off the list, and were able to breath a sigh of relief. We were able to sustain and maintain the synergy that exists between that base, and the design and construction force at the Electric Boat Corporation, and some of the academic excellence that we have in that area, and some of the ocean surveying excellence that we have, such as Robert Ballard, who heads the Center for Exploration in Mystic. So, that whole center seemed to be preserved and protected into the future. But as I speak here today, Electric Boat has issued layoff notices to over a hundred designers employed at Electric Boat—almost two-hundred pink slips on average. I can't tell you how much that concerns me. I know it concerns John Casey and others in this room.

This goes beyond a simple pink slip or a simple layoff notice at an industrial facility. We are laying-off the design force. We are laying-off people who are critically important to the future of our subsurface capabilities and our subsurface dominance. We are laying-off people who Admiral Rickover referred to in June 1968, when he testified before the Joint Atomic Energy Committee about a submarine program cut that would cause about 25 percent of the design force at Electric Boat to be laid-off: "As you know, there is a great scarcity of submarine design personnel in this country. The effect on our submarine design capability is obvious…Of course, we shouldn't build [submarines] just to keep people busy. However, these designers are the scarcest class of personnel in ship design in the United States. Our big problem… is that we don't have enough qualified submarine design people." That was Admiral Rickover in June, 1968.

Later in July of the same year, at a similar hearing before the Joint Atomic Energy Committee, Admiral Moorer: "In the Navy we have this problem because there is no commercial use for submarines. Consequently, unless the Navy builds submarines, those people who are capable of doing so then seek some other type of employment. If the amount of design work that was being done was significantly reduced, then these talented personnel would be dissipated throughout American industry and it would be very difficult to call them back together."

Admiral Rickover: "You talk about a faucet and, of course, you don't turn these programs on and off like faucets even though this is the theory of the cost-effectiveness people."

Surely there are no *cost effectiveness* people in here. I certainly hope there are no cost effectiveness people in this room.

The message of Admiral Rickover should resonate with us here today. What are we doing to ourselves? What are we doing to our capability to design and develop for the future? Why is it that for the first time in half a century we don't have a new design on the board or coming down the pike? Why is it that the MDA, the Marine Draftsman Association, with 1,700 people at Electric Boat, which is substantially lower than it was 15 or 30 years ago, is being laid off? Is it because there is no threat? Is it because the Chinese aren't building submarines as fast as they can—nuclear and diesel? Is it because the Russian industrial line has gone cold? It hasn't. They're designing and building right now. The Chinese are deploying right now. We've got a serious problem here. And it goes far, far beyond the parochial problem of one Congressman in one district, in one state in New England. It goes to the issue of future generations losing the subsurface dominance that we take for granted—just the way we take for granted our control of the airspace. When you lose it, you don't get it back.

Now, some say that, "well, you know, we can work on multi-mission modules, and do some unmanned undersea vehicles, and we can work on some mini-subs, and this will keep people kind of around the design table for the next couple of years until we need to turn the faucet back on." That doesn't cut it. It's not going to solve the problem. What is going to solve the problem is two submarines per year. Two per year has to be the focus. Two per year is going to allow us to sustain these critical workers. Two per year is going to allow us to sustain the total force, which Admiral Charles Munns properly testified before our subcommittee should be around 54. Two per year allows industry to reduce the prices and stabilize the prices at $2 billion a copy.

Two per year is cost effective and cost effectiveness is important—but it is not absolutely important. What is absolutely important is maintaining our capabilities. What is absolutely important is bringing on the next line, whatever it may be; the next set of

systems; the next design, whatever it may be. What is absolutely important is that the United States does not lose its subsurface dominance in a world that is becoming increasingly hostile; in a world where subsurface systems are proliferated; and in a world where China wants to regain its dominance.

How many people in the room have read *1421*? Not enough. *1421: The Year That China Discovered the World*. A lot of people say that "the Chinese don't have a maritime tradition"; "they don't have a real interest in projecting power beyond their littorals and their shoreline." Well, read *1421*; because in 1421 they built and deployed a navy that was the largest fleet in the history of the world, and that was not matched, really, until the D-Day landing. 4,000 ships it had, the largest of which could have put the Nina, the Pinta, and the Santa Maria on its deck with plenty of room to spare. China has that tradition; they have that history; it's part of their culture, and they are looking to get it back. If we are not aware of that, and if we are not listening to that, and if we are not watching that, then we are making a huge, huge mistake.

I lived in Taiwan for three years. I speak Chinese. I've studied the culture. We are going to have to deal with it. People tell me, "well, you know, our systems are much more sophisticated, much more capable; they just do a hell of a lot better." That's true one-on-one. Let me ask you this: if you've got the best heavy-weight boxer in the world, and you put him up against a middle-weight or a light-weight, he's going to win. But, what if you take the best heavy-weight boxer in the world and put him in the ring with two light-weights and a medium-weight. Then, what's going to happen? Is he going to win? I don't think so, because numbers count. Numbers are important.

If we are letting our numbers slide, and we are letting our design force go, and we are turning off the faucet to be cost effective, what are you going to tell the young man who is signing up for the Submarine Force over the next five years? What are you going to tell him? Good luck? That is not a responsible thing to do.

That is why I have joined with my colleague, Jim Langevin of Rhode Island, to form the Congressional Submarine Caucus. We decided to form it in December, after we heard about the layoff notices. By the way, those layoff notices hit us all; they hit everybody in this room. Jim and I agreed to form the caucus, and with

virtually no publicity other than word of mouth we have 15 members. It will pattern some of the activities we've done in the Shipbuilding Caucus, which we started some time ago and now have 99 Members of Congress. We will systematically identify those districts around the country that have substantial research and development or manufacturing capability that goes into our subsurface fleet, and we will recruit them into the caucus. And we are going to make a major effort to get to two per year and we are going to do it in the coming year. We want advanced procurement in this coming year. And we are going to talk about the loss of designers, the impacts on the industry, and the future of our Navy. The health of the total Submarine Force is a critical issue. It's not an issue for Republicans, for Democrats; it's not an issue for senators or representatives. It's an issue for us, as Americans. If we let the cost-effectiveness people rule the day, we may end up like the British. They lost their designers. Unlike us, they are unable to bring a new system from computer-assisted drawings to salt water tests in five years. They are unable to do it. We sent our people over there to assist them after they let that capability slide.

My final question to you all here today is: what happens when we lose that capability, and we can no longer do what we have been doing for half a century—and taking for granted for half a century? When it's gone, who do we go to for help? China? Russia? Think about it.

Thank you all very much, and God bless you.■

NAVAL SUBMARINE LEAGUE CORPORATE BENEFACTORS DAY FEBRUARY 1, 2006

VADM CHUCK MUNNS COMNAVSUBFOR

Good morning. I'm very pleased and grateful to the Naval Submarine League for hosting this event, so thanks so much. This really is a good time to get together and talk. I believe strongly in the team approach between government and industry, and those of you that know what my last job was know that I learned that the hard way—I'm not going to say any more about that except, that it was a very good experience for me.

Admiral Cassias sends his respects. We have changed the TYCOM structure into one Naval Submarine Force, both Jeff and I oversee all the Force. We each operate our respective submarine. Jeff as the operations officer worries about tactical and operational performance. I coordinate our strategic vision and direction. It's a great relationship between the two of us. We're trying to act for each other where we go, so you'll probably see less of us together at places as we're trying to spread out and cover more territory.

There's a whole bunch of stuff to cover today. The bottom line is: the Submarine Force is doing great. The foundational theme of what I want to talk about today is the day-in and day-out performance of our Submarine Force, because I think that's where our value is. While I talk about our product I want to make the point that we go where others can't go. I think that's the unique value we bring to this nation with submarines, and it's really point number one. You've already heard point number two, which is VIRGINIA production at two per year with the right capabilities. That is crucial to where we're trying to get in the near future.

VIRGINIA is a great ship and it's exactly the ship that we need for our future. VIRGINIA has already finished her first deployment. Not only was she built roughly on cost and certainly on time, but she also deployed several years earlier than any other new construction ship has to date.

What We Do

- ***Why Submarines:***
  - ***105 Years***
  - ***Measure of National Prestige/Power***
  - ***Deter Major Attack***
  - ***Win Battles / Wars***
  - ***Achieve National Interests***

COMNAVSUBFOR — Submarine Defense, Deep Discussion, Defeat — 4

Let's start with *Why Submarines*. This is the biggest part of my message. There's enough discussion around that shows most others don't understand why we have the Submarine Force. So that's an important place to start. We've been here for a hundred and five years, it's a part of our legacy that has gotten us here to where we are today. We should not forget that history. I'm not going to recite it all here because I think you all know it.

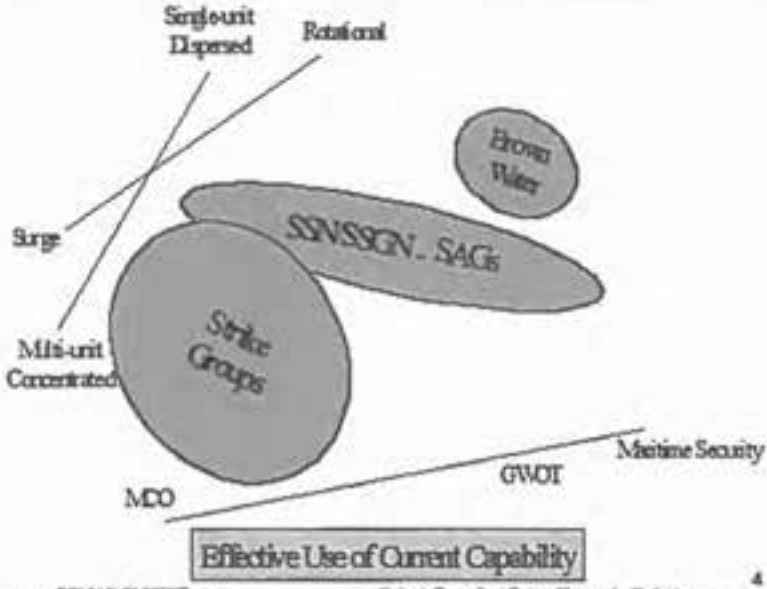
Second, I'll say a few words later about our connection to the rest of the world and their Submarine Forces. Submarine Forces are a measure of national prestige and power to other countries.

We have obviously deterred major attacks in this world. We have SSBNs out there today alert and undetected, protecting this nation. We have 10 SSNs out there today in waters along other countries' coasts. We're there to win battles and wars as they come, which we have done throughout our history.

Last and probably most important, we're a tool to achieve national interests. I'll say much more about that because that's the day in and day out product of what we do. It's more than just being ready to fight a war. It's what we do every day to forestall that war and to learn about the world in which we live.

The next three slides address how we fit into this structure and I would ask that you help us tell this story to those that have not been inside and don't understand the real value of submarines.

How Employed



COMNAVSUBFOR — Detect, Describe, Deter, Dissuade, Defeat — 4

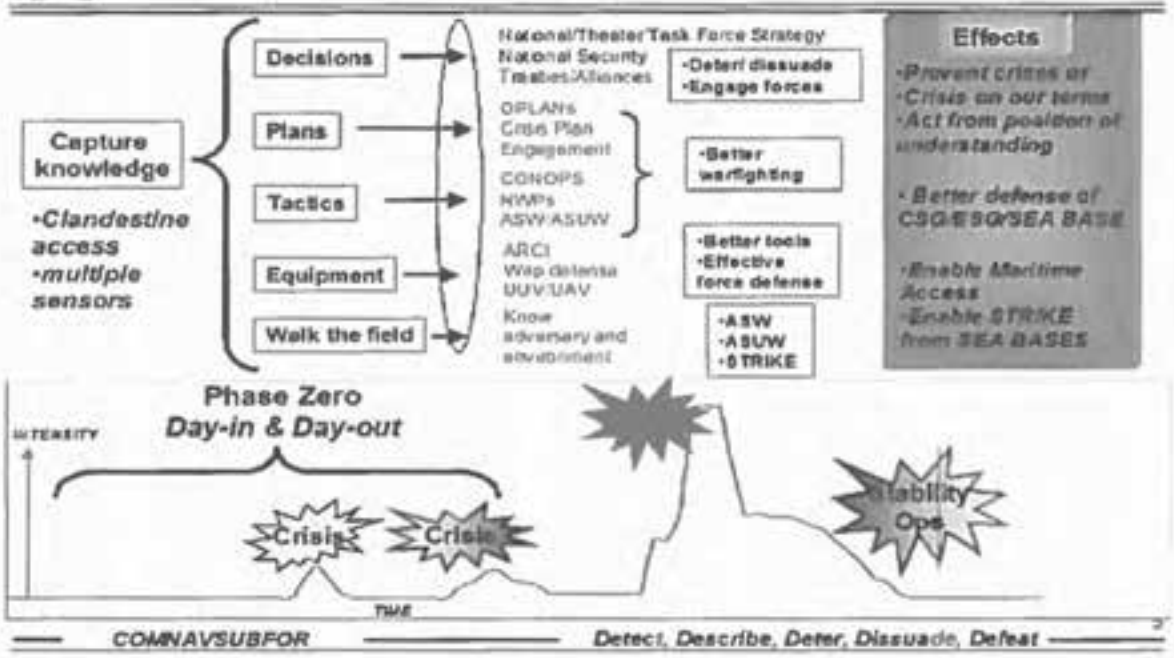
This is my rendition of the Navy presented in a somewhat unique way. What I've shown here is the Navy plotted across axes for a couple of parameters that I'd like to talk about.

Certainly the Navy is aircraft carrier strike groups (CSGs) and expeditionary Strike Groups (ESGs). We are also SSNs, SSGNs and SSBNs. You've heard the newest talk about the brown water Navy in the future. My point here in this slide is that the Navy is more diverse and more complex than we often talk about. I would argue that we often talk about the Navy as a strike group; it certainly is that, but my point here is that it is much more. Let me compare across these three parameters and draw distinctions. The first parameter is the spectrum of war, with major combat ops on the left hand side and maritime security on the right, with the global war on terror between them off center to the right. You'll notice that the Submarine Force participates along the entire aspect of that parameter. Strike Groups today also create maritime security, but that's an area where we've always had a significant strategic value.

Submarines are certainly single units and dispersed, but also connected in the network where we can act independently, which is quite different from how the Navy often talks.

And Submarines are rotational as opposed to surge platforms. You've heard the Navy talk a lot about surge over the last four or five years. We can surge. We've always been able to surge. I remember my earliest time on SEA DRAGON sitting in the officer's club in Hawaii when a phone call would come in on a Friday night. Once a month some boat would end up going out the next day, surging on a Saturday for something we had to go do in the cold war. But in the main we're rotational because we can only supply about 60% of the Combatant Commander's (COCOM) demand. We are most efficient at providing our service to the COCOMs with a rotational employment model. The bottom line here is the Navy is not just strike groups, it's the other forces that bring rich, diverse, and complimentary capabilities. SSNs are a big part of that.

Product / Effects



This next slide says a little bit of the same thing. I don't intend to elaborate on it much, but I do want to talk about our five products.

Along the bottom is a plot of time versus the intensity of conflict. Major Combat Ops (MCO) is what the military was designed for and has prepared for. This is the type of conflict with lots of intensity over a short period of time. That's kinetic strike and we can do it. We have Tomahawks, torpedoes, and ballistic missiles. We have Information Operations including Electronic Attack that can work there.

But if I had to pick just one point of value creation I'd say it's under the circumstances on the left side of the timeline.

We're out there day in and day out gathering knowledge for our nation and bringing back product which fits into the five categories shown here. We bring back product that informs national decisions. I would argue that the Cold War is the case where the product we brought back, understanding the Soviets, helped the National Security Council and the President to decide with confidence from a position of knowledge and strength in the Cold War—and we won it.

At very strategic levels of engagement we bring back information that informs Warfighting. We're certainly doing that today. The knowledge we bring back informs war plans, improves national actions and creates better operational tactics. Tactics like ballistic missile, cruise missile, or torpedo defense.

When we learn what world actors are doing and how they are doing it, our nation is able to tailor equipment to address the threat.

What may be most important is that we are just out and about, going places that others can't go, walking the field, understanding that coastline and what goes on there, so we know that place better than the adversary might know it. We can operate and, if necessary strike from there with confidence. What we are really about is being the scout for the Force, and our primary product is the day in, day out flow of information we bring back as that scout.

Free World Navy
1000 Ship – 224 Submarines

1. Exercises
   - Sorbet Royal
   - Pacific Reach
2. Operations
   - Active Endeavor
   - PRIZ Submarine Rescue
3. Initiatives
   - ISMERLO (International Sub rescue)
   - PEP Liaison Officers
   - Diesel Electric Submarine Initiative
   - Submarine Command Course

U.S., U.K., Canada, Australia, Netherlands, Norway, Turkey, France, Italy, Germany, Spain, Greece, Portugal, Poland, Japan, South Korea, Taiwan, Sweden, Colombia, Peru, Brazil, Ecuador, Singapore, Pakistan, India, Chile, Israel, and Argentina

COMNAVSUBFOR — Deters, Deterrs, Deter, Deterrals, Defeat — 6

The next slide goes back to the submarine as a measure of national prestige. You'll hear ADM Mullen talk about the 1000 ship Navy and that got us to thinking. We are part of 224 submarines in the free world.

This is a recognition that there is something special about Submarine Forces that brings us together. Countries talk to each other or don't talk to each other in certain instances, but Navies pretty much talk to each other all the time. There is an avenue there for communications because they operate in the same environment. I would argue that Submarine Forces talk to each other all the time. Even when countries aren't talking to each other, we're talking to each other at a working level. We're a fraternity that extends beyond our national boundaries, and we can take advantage of that. Those other countries look to us to be the leader of the fraternity. It's a pretty important place to be.

Let me down shift to operations a little bit. If Jeff Cassias were here, this is the part he would pick up. Let me walk around the world for him and for me, to give you a sense of where we're operating,

what we're doing, and a bit of the value we add. I'm going to focus on SSN current operations here. Recognize that in addition to this is SSBN and in the future, SSGN operations.

From a global overview, our concentration of operations has been in the Pacific. Last year, three Atlantic submarines deployed by the various paths to the Pacific and came back to their homeports in the Atlantic. We're actively looking at changing some ships' homeports to better balance the focus on the Pacific.

The predominance of the effort out there is aimed at major competitors that might exist in that region, but we are also committed to theater ASW and terrorism activity in all theaters of deployment. There were 17 deployments to the Pacific Theater last year and they addressed a wide range of activities.

In CENTCOM on any given day there are three submarines that are aimed mostly at the global war on terror. We were involved in the initial campaign for the war in Iraq, launching a lot of tomahawks in an example of a surge effort. We now return to rotational deployments. While that war goes on we're looking at fighting the rest of the global war on terror. For much of what we do, the specifics can't be discussed in an UNCLAS forum.

In the Atlantic and in EUCOM we had 11 deployments, but some of those subs were transiting through to actually operate in CENTCOM. On any given day two submarines are present in the EUCOM Area of Responsibility (AOR).

In SOUTHCOM, whether its drug or terrorism related, or focused on engagement of partners, we have one submarine there for about half the year.

I'll discuss a few more details about each of those theaters, but of course I have to start with USS VIRGINIA. I already made the point that we deployed her early. We utilized some time before her first maintenance period after construction. The ship had trained in the Command and Control System, Modular Off-hull Assembly and Test Site (COATS), the off hull facility where the attack center is put together, connected, and tested before it is installed on the ship. That process of testing allowed the crew to work with the equipment for a year while the ship wasn't even in the water. We made use of that expertise and put them on a two-month deployment after a shortened

workup. They went down to SOUTHCOM and conducted a very successful joint mission.

In SOUTHCOM we had great success in the war on drugs that we can talk about at a lower classification than the others. One of the ships that was down there last year participated in a number of events. Again, they were the sensor. They were the scout to see drug activity leave the coast, and then call in the rest of the joint team. In 2004, one submarine contributed to seizures of 40 tons of drugs in a little over two weeks, which was a significant portion of the total drugs seized that year. That's a success story of an operation using the submarine as a sensor and part of a network.

In EUCOM, we had nine missions, including a scientific one. There were several submarine nations connected here through EUCOM, including NATO nations, which make up a significant part of the submarine brotherhood I mentioned earlier. In addition to Intelligence, Surveillance and Reconnaissance (ISR), there were a number of exercises in EUCOM that I didn't mention before which focused on escape and rescue or theater/NATO engagement. One of these, Sharkhunt, was a theater ASW exercise with seven different nations participating. We wrung out our processes, plans, and procedures for ASW with our coalition forces. In this case the exercise ranged from the East coast of the United States, across the Atlantic to the North Sea, and halfway through the Mediterranean Sea. What we learn here can be taken and used to make decisions in other areas of the world as well.

An issue we are dealing with right now is the Emory S. Land, our submarine tender stationed in LaMaddalena. You may have read in the papers that the government of Italy asked us about six weeks ago to make preparations to leave LaMaddalena. They would like us not to be there any longer, so we're working through her relocation plan. We've been there over 30 years. These tenders are important to us. Right now we still have the Emory S. Land in LaMaddalena and the Frank Cable in Guam. Those two tenders conduct our forward deployed maintenance predominantly for our SSNs. They are also used for surface ship maintenance and in the future they will be used for SSGNs that will deploy there.

In CENTCOM we provided support to deployed CSGs and ESGs, and conducted some engagement exercises in addition to the twelve

national missions. This would be a good spot to make a point about the SSGN. USS OHIO has completed her conversion from an SSBN to an SSGN and was recommissioned in Bangor on 7 Feb. She is out in the water conducting sea trials right now. FLORIDA will follow in May of this year down in Kings Bay.

We will have four SSGNs eventually. They will be dual crewed. Once ready, OHIO will conduct consecutive patrols, changing out the crew for a total of about 15 months forward, then come back for maintenance and start the cycle again. While forward they'll carry a lot of tomahawk missiles and be ready for SOF operations, Information Ops, strike missions, or whatever the COCOMs want. It's an exciting and transformational platform.

PACOM has been the focus for us. We completed 17 deployments that included national missions and several exercises aimed at theater engagement. Part of the effort out there is theater security cooperation.

One of the activities that Joe Walsh will talk about later today is the rescue of the Russian Submersible, Priz. This is a great story. I know you probably saw it in the papers.

It was a Friday afternoon in Norfolk. I got a call that there was a Russian submersible in trouble with seven Russians on board. The first word was that it was trapped in a fishing net. That launched the whole world. We have in Norfolk an international cell of eight men with a web site linked to 37 submarine rescue countries of the world. All the data for rescue is there. When the call came in, all the countries came up on the web and we ran the coordination from there. Obviously, PACOM, with ADM Roughead as the commander, but we supported him. In less than 72 hours we had the Brits, the Japanese, the Russians, the Australians, us, and all the equipment flowing to the rescue site. We had the French and the Norwegians ready to send equipment and knowledge. You know the rest of the story; we got there with about 6 hours of oxygen left. We used robotics to untangle the submersible. It popped to the surface. The sailors came out. They were all very happy. Russians presented awards to the British, to us, and all who were involved.

Let me revert back away from operations for a few more slides and talk a bit about how we are operating our force and where our key focuses are. The way we do that is with these Measures of Performance (MOPs). We manage the force through these five MOPs. They are our focus points, so I'll very briefly go through them.

First is Operational Availability, which is getting Submarines forward so they can do their day in and day out mission and go where others can't go. COCOMs have asked for 18 Submarines next year. We can only supply about 10. So we're working to make our activity as efficient and effective as we can. Maintenance obviously is a key part of this. The two things that keep us from sending more forward are OPTEMPO of people and getting the ships in and out of the shipyards. A lot of effort both in and out of shipyards is being exerted to keep the submarines going.

Undersea Enterprise MOPs

- MOP 1: Operational Availability – "Around the World; Around the Clock" - Submarines and undersea surveillance assets deployed for sustained battle space preparation and deterrence
- MOP 2: Improved Commanding Officer Decision-Making – CO's making optimal decisions under the demands and complexity of the undersea environment
- MOP 3: Submarine Expertise - Experienced people integrated throughout the Joint war fighting, military technology and defense/government management communities
- MOP 4: Culture/Standards/Conduct – "Pride Runs Deep" – Assimilating new crew members into the submarine culture, while maintaining high standards and conduct
- MOP 5 Future Capabilities – Forecasting and meeting tomorrow's requirements for undersea superiority

COMNAVSUBFOR — Detect, Deter, Defeat, Dominate, Defend — 17

Second is commanding officers' decision-making. Our contention is the decision the commanding officer makes is what determines the success of that mission. It's obviously more complicated than that because there's a whole crew and lots of people need to feed into

that decision. The crew has to take action as a result of that decision, but our focus point is the decision. There is much that we have done to improve that decision including the training pipeline, some of the equipment, and changing some of our tactics, techniques, and procedures (TTP).

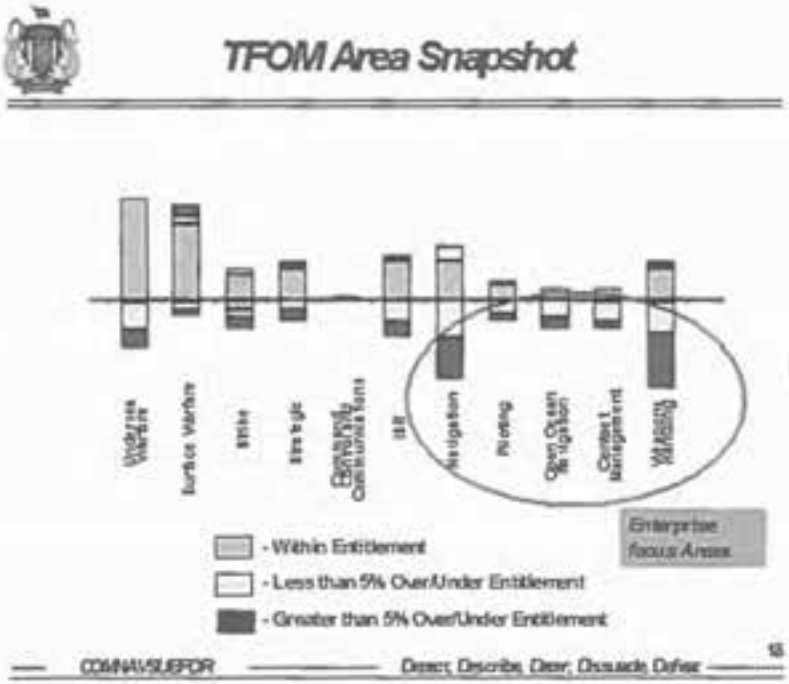
Third is the recognition that we provide submarine expertise to the Navy and across the Joint Forces. Admiral DeMar's words on *binding energy* apply here. There is an energy that keeps us knit together as a fraternity and a community. So we are now actively watching where those people go when they go outside the Force. We are mentoring that person. We are making sure that he is best educated and equipped to represent the force in that job, and feeds back to us what is going on in that job so we can best serve the COCOM needs.

Fourth is standards, culture and conduct. It's a huge area and it recognizes that we own a culture. We have been given a culture that many of you have helped to produce. We are mindful of that culture and we will keep it moving forward. The bumper sticker is that there is a science of submarining and an art of submarining and we want to hold on to both of them. The science of submarining is attributed to Admiral Rickover and all that he gave us: the checklists, procedures, verbatim compliance with procedures, feeling good about someone looking over your shoulder. That applies to Nuclear Weapons, Nuclear Propulsion, diving the submarine, etc.. The art of submarining is what we learned from World War II and other places brought to us by Mush Morton. It's being innovative and being able to out-think the other guy. The Soviets used to always call us cowboys because they couldn't figure us out. So our challenge is to merge those two quite opposite ends of the spectrum together inside the ship, to run the ship while relishing both, and to know when to use each end of the culture.

Fifth is our future capability, which is probably the one most of interest to this group and I will cover in more detail in a moment.

Those five collectively are our focus.

Coming back to the first to look at some of the metrics we use, one is a snapshot of how we use our operational inspections that show the categories and the capabilities we are looking for. These bars are made up of ships that are above or below standards, and they show us areas where me might not be doing as well as we would like. I call all of those Mariner Skills. It's Navigation, piloting, contact management, and weapons handling. That's what the data shows us we're weakest in, so we will focus on Mariner skills.



I discussed this once already and I don't want to belabor it, but it's important. This is the picture I draw to describe how SUBFOR works. If you ask me what we do to make a ship do what it does, this would be my answer. I'm going to make the point that we are

focusing on the three circled factors, but it's not just those three in yellow that make it work, it's the entire process. The submarine has to be on deployment, the CO has to make a decision, and the crew has to act on that decision. I've already mentioned we're concentrating this year on CO decision-making.

The CO's decision needs to be supported with the knowledge base, warfighting skills, mariner skills, engineering skills, and culture. The one we're working on is mariner skills. With respect to this circle on the right-represents a healthy assessment process. I think the submarine force has always had a healthy assessment process, but it may have weakened a little bit over the last few years. This is a recognition of our focus to plan, measure the outcome of the plan, ask the question of why that was the outcome of the plan that we started with, then feedback the lesson to make the plan better the next time around. That assessment needs to take place inside the ship to support CO decision-making, and it needs to take place across the force so we can make the force successful.

MOP 5 is our future capability. I'll talk about some of the specifics.

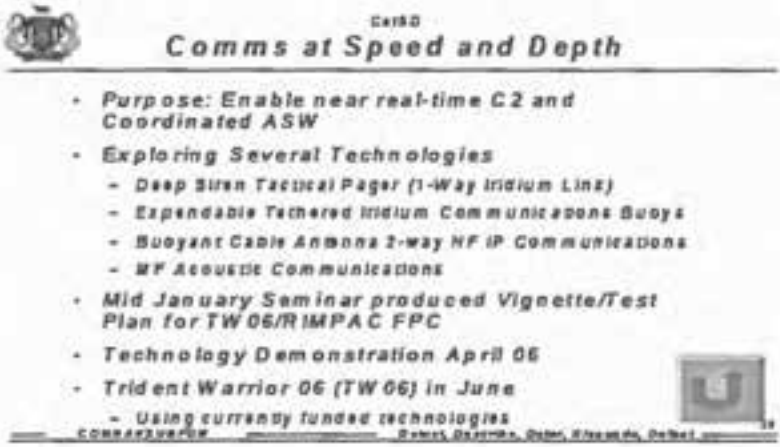
Comms at Speed and depth is our #1 focus of research and development.

Global Strike, I'll come back to talk about in a minute.

RADM Walsh is going to talk about Littoral Warfare Weapon and UUVs later today. I also show encapsulation, Virginia Advanced Sail, and SCJCC. The last future capability we track is a little different from the rest but may be the most important: VIRGINIA Cost Reduction. This is our focused effort so we can get the cost of VA to 2.0B in FY 05 dollars while building two a year. That is necessary in order to get us to two a year. We have focused activity and we are working with our partners along three different lines to get that cost down.

Lets jump into a couple things:
Comms at Speed and Depth is an effort to develop technology and equipment we can put on the ships in the near term to allow us to communicate with the submarine while it is underwater and at speed, that is, not at periscope depth. So you see some of the technologies here and some great experiments already taking place in the Pacific. We have a program now wrapped up behind this trying to bring these developments to us in the near term. And we have them integrated into the Sea Trials process and the experimentation regime.

Lets look at Global Strike. I'd like to talk about Conventional Trident Ballistic Modification, an initiative started by General Cartwright at STRATCOM, which now has SECDEF and presidential authority to plan. SSP really is technically behind it, and as an aside I'll tell you I'm very proud. When General Cartwright started asking this question and asked all the services to explain to him what we could do to put a conventional warhead on a ballistic missile and launch it within two years. Charlie Young came in from SSP with real stuff—concepts, prototyped equipment, test results and a plan. We could have a few of these conventional tipped missiles on each of our Tridents and they would be available to the President for short notice launch. It would clearly be a silver bullet designed to stop something from proceeding. These would be expensive bullets, but if you think in terms of launching a few of these and it stopping the campaign, then they are very cost effective. We are working the



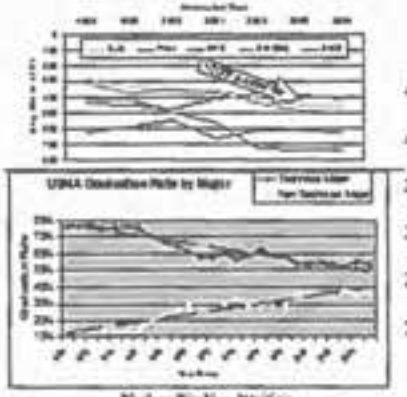
technology. We are working the TTP. The whole nation is working the CONOPS for how and when they might be used. We are clearly going forward and this is an important capability.

Lets jump to acoustics, then I'll move on. Acoustics continues to be very important to us and several initiatives are ongoing. You hear sometimes that Passive is dead. I don't believe that. I believe there is a role for active so we're pursuing that too, but clearly for us there is a role for passive, so much of what you see here is furthering the capability of passive. If you go back to the context that I laid out up front, you recognize that we are working day in and day out in parts of the world where others can't go. We do that work with passive acoustics because you can't go active in those places of the world. So if that job is important, and it's proven that it has been, then passive needs to continue to advance and we need to continue to support it.

These are capabilities we focus on; we have the entire enterprise working on these things. Admiral Walsh will talk about some of these programmatically, and I can come back and answer your questions about the rest.

Submarine Officer Accession/Retention

USNA Average OOM



Nuclear Pipeline Attrition

COMNAVSUBFOR

Dance, Describe, Dance, Choreograph, Define

21

We're going to shift gears with a few more slides then take some questions. I will talk about education and I will talk about accession and retention. I believe we are in great shape in both accession and retention. This is the retention chart showing years against percentage retention. You can see we're now up in the 40% range, above where we've been in more than several decades. I don't know fully the cause of that. I wish I did. I'm worried about what might be out in the future. We ought to all worry about that. But right now we're in a great place. We're in a place where we've had to cut back on our accessions because we have too many Junior Officers. Some of our submarines have thirteen or fourteen Junior Officers on board today. It's a nice problem to have, but we're dealing with that. We're in a

very good place. But let me talk about the other side, and that's education. On this chart you see the percentage of technical and non-technical majors from 1980 through today. ROTC is not too much different. You can see what's happened. It's something we need to all be worried about as a nation and something about which we're concerned within the Submarine Force. We operate very complex equipment and we have some very talented sailors and officers who just have to have the technical competence to do this business, so it's of concern.

This is still fun. There is no other place I would rather be than where I currently am, overseeing and leading forward the great sailors that we have. They need to be enjoying what they are doing in this business. CHARLOTTE was at the North Pole after surfacing through five feet of ice. Santa Claus was up there while they had a ball game. ALABAMA did some work with Special Ops people, so even our SSBN sailors get out and get to see some of the fun. USS MIAMI was at Port Everglades with a cruise ship. So we're trying to get quality liberty ports wherever we can. USS SAN JUAN was in Souda Bay, Crete with a visiting SSK. There have been a number of SSKs we work with from South American countries on both the east and west coasts. They provide services to our Carrier Strike Groups. A Colombian SSK spent three months with us, and came to Mayport. Peruvians were also up, Chileans were up, and of course those from NATO and our friends from Europe come over.

Finally, let me pause and describe the Undersea Enterprise. I'm doing this because you will hear the Navy talk about these enterprises. I want you all to know that we have an enterprise, and I will argue that we have had one for a long time. The enterprise is more than SUBLANT or SUBPAC or a combination of the two. The Undersea Enterprise is all of the activities working on submarines. The core of the enterprise is as it always was. It's the operators, SUBPAC and SUBLANT. It's the banker, N77 now, I think Joe Walsh will tell you it's actually been changed this week to name it N87 and used to be OP 02. It's Naval Reactors and it's Pers-42. We've had that as the cell of our enterprise for decades, others have not. What we are now doing is taking that cell and expanding it to make it more inclusive and get more out of it. VADM Paul Sullivan, NAVSEA, will be sitting with me on the Board of Directors

watching over maintenance activity. We're working with ONR, who is a member on paper and when we get into research and development he will actually sit in his chair. It's a good activity for us going forward.

In summary, it has been a great year. We produce a real product every day while our submarines are out there on mission. Our product is of value to the combatant commanders. We're in demand, they asked for 18 submarines every day and as I said we can only supply 10. We're of value to the national agencies.

We need to get two per year VIRGINIAs. VIRGINIA is the ship for our future. It's a great ship and has great capability well beyond 688, and we just need to build more of them. The key is getting to two per year in this budget cycle.

Comms at Speed and depth is our major focus for R&D and future capability.

Other focus points I am working on at SUBFOR are Cost of Maintenance, CO decision-making, and mariner skills.

On behalf of the Submarine Force, all 25,000 of us, thanks for the opportunity to talk to you all. Thanks to the Submarine League for putting this activity together today, and for the Corporate Benefactors. We truly are one team and we've got a great cause.■

NAVAL SUBMARINE LEAGUE CORPORATE BENEFACTORS' DAY 1 FEBRUARY 2006

REMARKS BY RADM JOE WALSH DIRECTOR, SUBMARINE WARFARE DIVISION

Thank you Admiral Reynolds for that kind introduction. Today I would like to provide you with an update on Submarine Force programs and issues that are important to both the Navy and our industry partners.

Let me start with Submarine Force structure. Currently we have 53 SSNs in the fleet, comprised of 49 LOS ANGELES Class (688), 3 SEAWOLF Class, and 1 VIRGINIA Class. USS SAN FRANCISCO (SSN-711) is included in this total. Last fall, the CNO approved the repair of SAN FRANCISCO after its tragic undersea collision with a seamount in the Pacific. I will discuss the plan to repair her later in the brief. We also have four SSGNs and 14 SSBNs and these numbers will remain steady pending any changes to the Nuclear Posture Review. Currently, three SSGNs are undergoing conversion, and USS OHIO (SSGN-726), completed her conversion and was delivered back to the fleet in December 2005. She will IOC in 2007.

Focusing on the period encompassed by the President's Budget for Fiscal Year 06 (PB 06) Future Year Defense Plan (FY 06 through FY 11), SSN force structure will remain above 53. However, this is not the period that concerns me. The period that concerns me is in the out-years when SSN force structure begins to dramatically drop off. Looking out to 2011, four out of five submarines in the Submarine Force will be 688 Class submarines. 688s will continue to be the workhorse of our fleet in the foreseeable future, and this illustrates the importance of maintaining a robust modernization program. Today, USS LOS ANGELES' combat system is as modern as USS CHEYENNE's, our newest 688 Class submarine. We have done a great job modernizing our submarines, and modernization will remain a budgeting priority for me. However, around 2018, we will start decommissioning 688 Class submarines at a rate faster than we

are building VIRGINIA Class submarines. Remember, in the late 1980s and 1990s we were building three and four 688s per year, and they will begin to reach their hull end-of-life starting around 2018. Under the program of record of building two VIRGINIA Class per year starting in FY 12, SSN force structure will drop to 40 in 2028. If we were to only build one VIRGINIA Class per year, force structure will drop to 28 in 2029. In any case, to maintain a force of about 48 SSNs, we would have to build more than two VIRGINIA Class submarines per year, and that is just not possible considering the CNO's current SCN budget and cost.

Let me take a few moments to discuss SSN force posture. Earlier I mentioned the CNO approved the repair of SAN FRANCISCO. SAN FRANCISCO will undergo repairs at the Puget Sound Naval Shipyard in Bremerton, WA, and then return to service in either San Diego or Pearl Harbor. To restore the Pacific AOR SSN operational availability, USS BUFFALO will transfer from Pearl Harbor to Guam to replace SAN FRANCISCO, and USS HAMPTON will transfer from Norfolk to San Diego. Additionally, over the past two years, three Atlantic based SSNs have deployed to the Pacific Area of Responsibility (AOR) in support of Combatant Commander operational requirements.

Let me give you a quick update on the VIRGINIA Class program. VIRGINIA has more than exceeded all expectations since her commissioning just over a year ago. Due to fleet operational commitments, the Type Commander chose VIRGINIA to fill an emergent need for an *early* deployment. In support of this deployment, VIRGINIA completed the first ever COMOPTEVFOR Quick Reaction Assessment for an entire platform, allowing VIRGINIA to deploy prior to completing her Post Shakedown Availability, Developmental and Operational Testing, and four years ahead of her projected first deployment date.

VIRGINIA proved to be fully ready for her historic deployment, providing critical mission deliverables to her operational commander, employing front line and ship unique combat systems, ship control systems, propulsion systems, and communication systems with resounding success. The crew clearly demonstrated the flexibility of the newest class of submarine to deploy independently, and sustain operations for extensive periods of time.

VIRGINIA's performance working up to and executing this deployment was nothing short of remarkable. Advanced design and modular construction techniques, effective crew training, and successful sea trials were key enablers for this early and successful deployment. VIRGINIA is currently undergoing an 11-month Post Shakedown Availability (PSA) at General Dynamics Electric Boat, currently scheduled for completion in December 2006.

There has been much discussion about the cost of the VIRGINIA Class. Even with its advanced design, modular construction and advanced upgrade flexibility, the ships are considered to be *too costly* in today's fiscally constrained environment. Therefore, in cooperation with its industry partners, the Navy is taking action to drive down the cost of VIRGINIA, with a goal to reach an average per-hull cost of $2 billion (FY05$).

There are several cost savings initiatives that will result in achieving the $2 billion (FY05$) per hull goal. These initiatives include enhancing construction efficiency, increasing the production rate to two hulls/year, taking advantage of Economic Order of Quantity cost savings through multi-year procurement contracts, and designing reduced cost into VIRGINIA.

One example of enhancing construction efficiency is through the Capital Expenditure (CAPEX) program. The CAPEX program is designed to help the shipyard make capital improvements to their infrastructure that will ultimately result in VIRGINIA Class cost savings. The shipyard presents a business case to the government for the proposed CAPEX, and if the business case meets all of the requirements, the government pays one half of the investment up front for the capital improvement. When the improvement delivers the projected cost savings, the government then pays the other half. If the CAPEX does not deliver the expected savings, the shipyard must return the money.

The Transportation Upgrade CAPEX, for example, will allow VIRGINIA to be built with four *Super-Modules* at the facilities of the former Quonset Point Naval Air Station. This results in reduced construction time through improved modular assembly (CAPEX-enabled) in the Steel Processing Facility, and the Sheet Metal Fabrication Facility. Additionally, benefits include improvements in final assembly and testing.

Another CAPEX example is the Coatings CAPEX. The Navy and its Industry Partners are now using a new SHT mold-in-place Coatings Facility to reduce SHT cost, and shorten PSAs by five months. This initiative delivers the ship sooner and more economically.

Let me shift gears and talk about Tango Bravo. As you remember, Tango Bravo is an initiative to develop emerging technologies that allow us to overcome Technology Barriers (TB) that may ultimately result in the reduction of the cost and displacement of our submarines. To date, five contracts have been awarded that cover three of the five key Technology Barriers, to include Shaftless Propulsion, External Weapons Stowage and Launch, and Reduced Hull Mechanical and Electrical infrastructure. Contracts were not awarded in two of the Technology Barrier areas: Hull Adaptable Sonar Arrays and Reduced Crew/Automated Attack Center. It should also be noted this program is divided into three separate phases to ensure progress is made in each phase before the additional funding is awarded.

Tango Bravo Phase 1 efforts are well underway. Shaftless propulsion contracts complete Phase 1 in late May 06. External weapons and infrastructure reduction (X-Planes) contracts complete Phase 1 in Nov 06. Work is progressing on schedule and there are no *show stoppers* to prevent achieving technical objectives. Funding for Phase 2 contracts will be awarded depending upon a thorough technical evaluation of Phase 1 efforts. Information will be made available to the design community in FY 08 with final results in FY 09.

Looking towards how we might utilize the results of Tango Bravo, we need to consider when the next VIRGINIA block buy will occur. Tango Bravo demonstration information should be available by the end of FY08, with fully evaluated results in FY 09. However, the technology probably will not be mature enough to incorporate directly into the VIRGINIA design. The next block buy in 2014 may be the first opportunity to use the technology developed through Tango Bravo.

Another area that is extremely important to all of us is the preservation of the Design Industrial Base. The advanced submarine Design Industrial Base is comprised of 19 critical engineering skills

and 5 designer skill areas. Under the current plan of record it is estimated that critical engineering and designer skill areas will begin to atrophy in the near-term (2006). By 2009, most skill areas (16 of 21) will be at or below the critical minimum level.

Mitigation efforts to help sustain these critical skills through 2012 are underway. The VIRGINIA Program Office is funding the RAND Corporation to conduct an independent study to investigate the minimum core requirements and inform Navy on costs, benefits and risks of different options for sustaining the submarine design capabilities. Results of this study will be available in the late summer/early fall of 2006. Additionally, VIRGINIA cost reduction initiatives are a possible near-term solution for partial sustainment of critical submarine design resources. This solution uses portions of the Design Industrial Base from FY06 through FY13 to develop recurring, long-term SCN cost reductions in support of attaining the $2 billion/hull (FY05$) goal. These two initiatives will ensure portions of submarine design industrial base are maintained until approximately 2012, but with skill area shortages in 5 of the 24 skill areas. However, this will not exercise the large-scale integration skills necessary for cost effective whole ship design programs.

Other solutions being considered include new follow-on design work that may include VIRGINIA technology insertion to achieve reduced cost using Tango Bravo initiatives. Another possible option under study is to begin design work on the next generation undersea strategic deterrent concept around FY12 to support authorization in FY20 for the lead ship (this supports Initial Operating Capability in FY28). However, large-scale integration and other specific skill areas necessary for a high quality, cost-effective design could be degraded or lost if initial concept design does not begin earlier than FY12.

I would now like to shift topics and discuss the SSGN conversion program. Currently, three ships are undergoing refueling and conversion. The fourth ship, USS OHIO, completed her conversion in November 2005 and was delivered to the Navy in December 2005. She is currently undergoing extensive post delivery testing. Her return to service/rededication ceremony was held on 7 February 2006.

OHIO's conversion is truly remarkable considering the program did not receive its first SCN funding until January 2002, with an Initial Operational Capability (IOC) of 2007. To meet the desired IOC date, the design, manufacturing, and conversion were conducted concurrently using many of the same design tools and processes pioneered by the VIRGINIA Class program. OHIO will be homeported in Bangor, WA. FLORIDA will be homeported in Kings Bay, GA. The other two SSGN homeports are yet to be determined.

The SSGN is an outstanding example of the Navy's commitment to getting everything possible out of the existing submarines in the force. In addition to carrying as many as 154 TOMAHAWK land attack cruise missiles in its Multiple All-Up-Round Canisters (MACs), it can carry two Advanced SEAL Delivery Systems (ASDS), each a 60-ton ship, or two Dry Dock Shelters (DDSs) (or a combination of one each), plus up to 102 Special Operations Force personnel, including all of their ordnance.

Let me give you an idea of just how much SOF equipment an SSGN can carry in addition to the two SOF delivery vehicles. An SSGN can carry 26 combat raiding craft, 150 6-gallon fuel bladders, 39 outboard motors, small arms weapons and over 8,700 pounds of high explosives. Carrying up to 8 SOF Stowage Canisters and dual Lockout Chambers for SOF egress and ingress further enhances the SSGN's warfighting capabilities. With this kind of manning, equipment, firepower, and payload an SSGN can support a SOF campaign, with multiple, simultaneous operations taking place. This represents a significant improvement in SOF capability over that of a 688 Class submarine.

Speaking of payload, we are committed to improving the submarine's warfighting capability through the integration of a wider range of payloads. One payload we are developing is the Mission Reconfigurable Unmanned Underwater Vehicle (MRUUV), which is launched from a 21-inch Torpedo Tube, and designed to operate independently of the submarine to conduct Mine Warfare and ISR missions. In October 2005, we conducted at sea testing onboard USS OKLAHOMA CITY (SSN 723). This testing demonstrated end-to-end pier side functionality of the UUV, its recovery system, UUV impulse launch capability, and UUV post-launch operations. Unfortunately, during this test we were not able to demonstrate UUV

homing, docking, and retrieval due to a failure of the recovery Arm Acoustic Array. Following repairs to the recovery arm, additional MRUUV launch and recovery testing was conducted onboard USS SCRANTON in late January where UUV #1 successfully homed and docked in the recovery arm on SCRANTON (SSN 756). Considering the complexity of this system, this is a real success story, but we have more work to do in order to deliver this capability to the fleet. In closing you can see the Submarine Force has made good progress over the past year. VIRGINIA completed her first deployment, OHIO has been delivered, and we have conducted successful testing of weapons encapsulation technology and the Mission Reconfigurable UUV. We continue to focus on VIRGINIA Class cost reduction initiatives, and the right focus is being applied to the full spectrum of Undersea Warfare in a fiscally austere environment. We will continue to push the technical envelope to maintain our asymmetric advantage and our total dominance of the undersea battlespace. Thank You.■

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HEAVY WEATHER AHEAD

by Rear Admiral W. J. Holland, Jr. USN(Ret)

Jerry Holland writes on maritime subjects and has been a frequent contributor to the Submarine Review. He is Vice President of the Naval Historical Foundation and the Editor in Chief of their book, The Navy.

The direction in the 2006 Quadrennial Defense Review (QDR) to increase the submarine building rate to two a year by 2012 is heartening to all interested in maritime supremacy and knowledgeable of the submarine's role in achieving and maintaining it. After years of being cast by analysts and editorial writers as a Cold War weapon without an enemy, the importance of the submarines' role in maritime dominance in East Asia is now evident. Endorsements come from such diverse authorities as Richard Armitage, "Thank God we did not cancel submarine construction as proposed in the nineties",[1] and Andrew Krepinevich of the Center for Strategic and Budget Assessments, long an exponent of canceling submarines entirely. Krepinevich is most explicit in his analysis of the positive in the QDR where he says:

> "Increasing our submarine production to send a clear signal to China, and our allies, that Beijing cannot expect to threaten U.S. freedom of action in an area of vital interest or coerce friends and allies in East Asia." [2]

As encouraging these signals are however, other matters presage coming difficulties as surely as the falling glass heralds a coming hurricane. And while submarines can dodge the storm at sea by going deep, realities that cannot be dodged promise to plague future planning.

- The Navy in general and submarines in particular do not have much of a role in the anti-terror wars in Middle East. As the insurgency drags on and leadership concentrates on withdrawal from Iraq and homeland security, the Navy will have even less

relevance in the minds of many responsible for the country's defense.

- The costs of Middle East Wars, particularly infrastructure repair in Afghanistan and Iraq, will demand large amounts of the Federal Government's discretionary income—shifting them out of Defense and foreign aid.
- The need to repair and replace Army and Marine equipment worn out in the Middle East and to fund the already approved increase in the Army's end strength will have priority in the Defense budget for the foreseeable future. These considerations will shift money in the Defense budget away from the Navy and Air Force.
- The large and growing Federal deficit eventually will limit government's borrowing and spending power and eventually cap the monies available to the government. The federal budget deficit has already begun to limit funding for existing programs in the civil sector and when the demands of Iraq ease will almost certainly crimp the defense budget.
- The cost of the all-volunteer force will continue to rise as demands for technically skilled people increase and disincentives to join or remain have to be balanced by additional financial rewards.
- Controlling the costs of doing business, i.e. infrastructure maintenance and repair, personnel, and other semi-discretionary funding, will not be adequate to compensate for the scope of the reductions resulting from these influences.

Faced with these economic and political pressures, the Navy will find it difficult to maintain a strategic vision in which control of the seas remains paramount. But such a vision is crucial to make clear, first to the Navy itself, and then to policy makers and public sponsors a consistency of purpose and dedication to maritime dominance.

Building such a long-range focus is possible because while the Army and Marines are engaged in an intense conflict requiring all their resources, the Navy is being allowed a high but relatively peaceful tempo of operations. This relative leisure permits formulating a coherent strategy recognizing that the most important improvements and innovations take twenty years to bring to fruition.

Avoiding infatuation with the short-term focus on the FYDP and the political objectives of any particular administration will be necessary to avoid sharp swings of the rudder that waste resources on fads.[16]

During this phase, submarine supporters must resist the demands of those shouting for lower expenditures or economic analysis that rationalizes all things to a bottom line can never be meet. This will not be easy: "keeping faith with ideas rather than things is difficult when institutions and resources are focused on things".[17]

Outside the service few recognize that the most important parts of a Navy, the ships and the sailors who man them, cannot be generated quickly. Warships are long-lead time items and cannot be mass-produced even in a full wartime production. On the other hand, today's ships and aircraft are long-lived assets not throwaway toys. The Navy's first submarines were built in twenty months and had a service life of less than eight years. Today's submarines require four or more years to build but last forty. Such long-lived assets deserve as much intellectual effort as monetary capital investment. To use these resources efficiently requires steering a straight course.

Naval forces face significant changes in the environment in which they will have to operate in the years ahead. The nature of potential enemies has changed, the technologies related to detection and computation of target location as well as those related to command and control continue to improve exponentially, and military forces will be employed in endeavors which both transcend the capabilities of single services or organizations and are of increasingly broad nature. This triad of change, political, technological and military, changing at different rates and in different ways, complicates the omens on which prognosticators rely when moving from the realm of educated guess toward flights of fancy. But it is possible that, unlike oracles of old who read tea leaves or entrails of animals, *seers* today can provide a glimpse into the distant future - and if it can be done, does it make a difference?

Four facets of the long-range vision can be easily identified. These basic factors underline comprehension of the possibilities in the future. They are propositions that Admiral Art Cebrowski taught when he said, "We know a great deal more about the future than we think we do".

- Geographic realities will not change. Three-quarters of the earth's surface will continue to be covered with navigable waters.
- Technology will continue to define what is possible. Development of truly unique technical changes takes time. Careful examination of present research and development trends permits more than simple extrapolation of what may be likely to be possible in twenty years. Reasonable expectations for improvements that technology will bring can generally be forecast with some degree of reliability as long as the predictors recognize that there are Laws of Physics.
- Technical advances will drive the operational arts. Careful attention to technological opportunities, in-depth experimentation and realistic exercises will be necessary to be able to keep pace with the technical changes taking place. The Development Squadrons are now more important than they have been any time since the early 1950's even though the employment of the submarine in future roles is much less clear now than then.
- Political considerations will lay the background on what military forces will be used, how and where. These are the most difficult eventualities to predict and least likely to be accurate.

In spite of the hazards in predicting the future, the value of attempting predictions cannot be gainsaid. Analysis of computer software development demonstrates that careful planning and design yields great dividends; the cost to make changes in the design phase are twenty times less than the cost of making those changes after the program is coded. The same sort of benefit obtains if one carefully examines the expected environment. A proven corollary is that the longer the look ahead the greater the potential return.

During this century, technology will continue to offer many more opportunities than can be turned into capabilities quickly. But investments in such opportunities must address the questions "What for?" "Why submarines?" "How much?" In this environment, the Navy as a whole must be careful to pay attention to its historic tasks because few others will. Jointness is a wonderful concept but does not apply here; *no other service or entity cares except NOAA.* Addressing these historic tasks becomes a Mahanian quiz for which answers are not always understood much less appreciated:

- What is the requirement for Naval presence?
- How do we bring useful forces to bear in a timely manner?
- How does naval power influence actions ashore?
- Where do submarines fit in these questions?

These questions do not address a specific scenario or enemy. Specific scenario planning has a weak track record. As future threats become less well defined, the potential utility of forces, units and systems designed for specialized or unique purposes will become less and less. Since the future is dimly perceived, in meeting the CNO's announced aim of flexible, persistent and decisive forces, those forces and equipments with wide ranges of utility will be most valuable.[8]

While theorists can fairly agree on these points, translation of these into a consistent long term policy is necessary so that someone may *bend metal* to achieve their ends. Such a policy needs concrete pillars to serve as guides and support that transcend individuals' tenures and buttress organizational consistency when assaulted by political forces that have other goals and mores. History again offers guidance:

- Build warships to win wars: on the sea first and only then to influence actions ashore.
- Build no second rate ships.
- Resist the calls for limited mission or special purpose hulls. There won't be enough ships to spread around to all the potential trouble spots all the time so the ones there are must be able to go where needed quickly (fast) and stay for a long time (endurance).

This means

> "... platforms and their weapons systems must be multi-purpose. Equipment cannot be optimized for service in the Norwegian Sea ...if it means their performance would be marginal in tropical waters...and we cannot afford to buy and maintain more than one set of forces."[9]

- Continue to insist that those parts of the ship that will have long life (hull and propulsion plant) must be first class. Electronics

and weapons will change two to five times in the ship's life, the hull and propulsion never.

- Build ships that have enough weapons to make a difference, enough people to fight the ship, enough room to allow new weapons systems to be added, and can sustain battle damage.

Expectations that technology will reduce crew size should be treated with great skepticism. The current concern with personnel costs is driving surface ship designs to limit crews to handfuls of people with little regard to historical experience. The Navy's track record here is abysmal: and the Submarine Force's probably the worst. Submariners invented *hot bunking*, a custom that does not add glory to our reputation. Every class since 1908 has needed more people to operate and maintain the ship than the design predicted. Manning a ship in peace is easy but prolonged operations wear people out. The US Navy is not a Baltic flotilla that goes into port each night and on the weekends. Every proposed Watch Quarter and Station Bill must provide for General Quarters for days and Condition Two watches for weeks.

- Building ships that can fight hurt requires enough people to find, fight and repair the damage. The Soviet's experience demonstrating the limitations of unmanned fire suppression and automatic isolation systems should reinforce conservative design in damage control.
- Push the technical envelopes. Small numbers (one?) in a ship class are best in times of peace even though the budget process shouts for production runs to spread the initial development costs over a number of platforms, and logistic and maintenance organizations loath one-of-a-kind units that complicate support. In the coming years, large numbers of ships will not be authorized or funded in any case. Current plans for the Virginia class, where each ship differs from the last in significant features, allows incorporating technology changes in an orderly fashion and helps keep competent design organization alive.

Trial and experimentation must follow construction because some designs will fail, e.g. GLENARD P. LIPSCOMB and TULLIBEE.

When that happens, the ship can be retired in order not to perpetuate error by throwing good OM&N money after poorly spent SCN funds in spite of the heat that will be generated by accountants and media critics.

- Finally in planning modernization, new designs must be vigorously defended. Expenditure for better ships is hard to justify when present construction is turning out ships better than any others in the world. But to have *good enough* in the future, one must commit to excellence in the present.[vii] Twenty years between major designs is too long to keep a design base healthy. Building more complex ships has the advantage of challenging the constructors and enervating their work forces. Keeping that industrial base alive in order to support the inevitable expansion is important and not well understood outside the Navy and the representatives of those states and districts hosting such facilities.[viii]

Development of the expertise of the people who will use the new equipment will be as important as construction of the best possible ships and the development of technology. However advanced future technologies may become, their military application has to be developed and their implications understood by those adopting them to doctrinal and organizational structures. Technology requires appreciation of the physical limits plus an understanding of the battlefield environment on which it will be applied in order to maximize its potential. For the Navy in general and for submarines in particular, this is NOT a joint warfare task. The joint field has places where technologies overlap – stealth aircraft, communications and information systems (in part – a chart looks different than a map), propellants and explosives – but most of the technologies crucial to maritime dominance do not overlap other services, most especially where submarines are concerned. Dedication of resources to these service unique functions will always be under fiscal fire from those who do not see an enemy at sea or understand the nature of modern maritime warfare.

Long term strategic planning today requires a vision of the future that is not necessarily constrained by an identified enemy. In the

post-Soviet world, this sort of planning requires more than a simple definition of who and what the enemy might be and creation of scenarios related to a *best guess* technique.

In fact, the enemy of sound long term defense planning is the scenario based approach in which well meaning officials respond to the pressures of short termism by trying to predict the way in which forces may have to be used. This method has a historical record of being almost 100% wrong; based as it is on a combination of wish fulfillment and the assumption that even well armed regimes are amenable to arguments of reasonable men."[8]

The intellectual capital that must be invested in planning for this future is immense. Reaching consensus will be daunting. Issues will be dynamic and the institutional memory short. Programmatic difficulties will grow as resources dwindle. Nevertheless, long range planning must be a priority to inform, educate and facilitate decisions on the allocation of resources. Not everything planned will come to fruition, but the act of planning will identify opportunities as well as uncertainties.

The output or conclusions of long term strategic planning will be formulative rather than definitive. Its aims should be:

- To provide comprehensive long term view of the elements and needs of American maritime power as guideposts for those at lower echelons on what elements have the most enduring worth.
- To aid the Navy's leadership in real time budget decisions particularly when those decisions must be made under economic and/or political stress.
- To buffer the effects of volatile political change in regimes: administrations that last four years cannot adequately plan or promote ships that take ten years to design, build and test.

"The swift changes in regimes in France, some of whom were mere 'placemen', ...had ...[the] consequence that... although large sums of money were spent on the French navy, the money was not well spent: the building programs reflected frequent changes from one administration's preference... to another's...{leaving} the navy itself with a heterogeneous

collection of ships that were no match for those of the British or later the Germans."[vi]

- To guide the Navy train back onto the tracks after political decisions have switched the train onto a siding. Guideposts to consistency and utility are particularly valuable when mistakes have led to error in design, resources or decisions.
- To publicize an appreciation of the present and future needs and to elicit comment and to elicit reaction from those inside and outside the service on the planning aims and goals. While partly propaganda, the products of such planning serve to build understanding and consensus among the officers of the submarine force and the Navy, its constituency in the political arena and in the general public. This last is particularly helpful in preparing for the storms of lowered resources and increased expectations.

As the Chief of Naval Operations, Admiral Mike Mullen, has observed, the defense budget is at a high point in its cycle. The QDR's prescription for more submarines is only of moral value: its actual decision point to increase production is pushed into the next national administration's budget. Policy statements made public in the recent past have been long on rhetoric and short on substance. Thinking longer is important. With the storm approaching, it's time to rig for heavy weather.■

ENDNOTE

i. Richard Armitage, Remarks to the Washington Chapter of the U.S. Naval Academy Alumni Association, Arlington, Va., Feb 25, 2006.

ii. Andrew F. Krepinevich, "Old Remedies for New Evils" Wall Street Journal, February 14, 2006, page 22.

iii. Rosen, Peter Stephen, "Winning the Next War," Ithaca and London, Cornell University Press, 1991, page 259.

iv. Builder, Carl H. And Dewar, James A. "A Time for Planning? If Not Now, When?" Parameters, US Army War College Quarterly, Summer 1994, page 9.

v. Admiral Vern Clark USN Chief of Naval Operations and General James L. Jones, Commandant of the Marine Corps, "Naval Operating Concept," November 30, 2002.

vi. Captain James H. Patton, USN (Ret), "U.S. Navy Technology in the 90's", A&DS, Spring 1991, page 58.

vii. Captain Dick White, SC, USNR, *Proceedings*, February 2006, page 6.

viii. For more discussion of these points see "Norman Friedman, James S. O'Brasky and Sam J. Tangredi, "Globalization and Surface Warfare" in Sam J. Tangredi, Ed., Globalization and Maritime Power", Washington, D.C., National Defense University, 2002, pages 373-385.
ix. Captain Richard Sharpe, RN, Forward, *Jane's Fighting Ships 1991-92*, reprinted in SEAPOWER, July 1991, page 20.
x. Paul Kennedy, *The Rite and Fall of the Great Powers*, New York, Random House, 1987, page 220.

ARTICLES

THE LAST VOYAGE OF A SUBMARINE AIRCRAFT CARRIER

by Dr. Thomas O. Paine

Editor's Note: The following is a letter written in 1984 by Dr. Paine to CDR Compton-Hall of the British Submarine Museum. Both were experienced World War II submariners and both men were well known to the submarine community during the Cold War. While still on active duty in the Royal Navy, Richard Compton-Hall served in New London with the Development Group. In retirement he wrote a number of submarine-related books, contributed frequently to these pages, and spoke to the League's Annual Symposium.

Dr. Paine also kept up his interest in submarine matters through a distinguished technical career during which he directed a major laboratory, headed NASA, and served as President of Northrop. Part of his continuing interest involved collecting books about submarining and after his death in the 1990s his library of over three thousand volumes was given to the Naval Academy's Nimitz Library as one of its special collections. In addition, he put together a Submarine Registry which listed every submarine built anywhere up to 1992, and included an annotated bibliography of about eight thousand books and articles about submarines.

A note from RADM Joe Vasey, USN(Ret) about Tom Paine and how his letter to Richard Compton-Hall came to be in the Submarine Archives:

I am the one who gave a copy of Tom Paine's letter with material on the I-400 to the Bowfin museum in the mid-1980s. We were good friends with a mutual interest in submarines and both WW2 SubVets.

Tom Paine served as Board Chairman of Pacific Forum 83-87, a non-profit foreign policy institute I founded in the 70's to focus on US-Asian relations. All the while, he was President of Northrop Aircraft Corporation.

On a couple of my visits to his Northrop office on Wilshire Blvd. He showed me his Submarine Warfare Library maintained in a large adjacent room as a separate entity and not involved with Northrop. There he pursued his fascinating hobby during rest periods and at the end of the day. He was proud of his invaluable collection and with good reason. It contained a wealth of material on submarining and submarines worldwide. The I-400 project is typical. I don't think there is anything comparable anywhere else.

At that time I don't believe the collection was nearly as large as the final one, but obviously growing.

In 1984 he sent me a copy of his illuminating letter to Compton-Hall and later I gave it to the Bowfin Submarine Museum requesting it be maintained as a WW2 historical item.

Commander Richard Compton-Hall MBE, RN, (Ret)
Director - the Submarine Museum
HMS Dolphin
Gosport, Hampshire, U.K.

Dear Commander Compton-Hall:

Here is the material I've been able to assemble for you on Japan's secret SENSUIKAN TOKU (*Special Submarine*) aircraft carriers. I'm delighted that you're writing about these undersea giants, and only wish I had more to send you.

In many ways HIJMS I-400 was decades ahead of her time, with a range of 37,500 miles at 14 knots, snorkel, radar detectors, and a 115 foot long, 12 foot diameter hangar opening onto an 85 foot long catapult. Like Germany's Type XXI U-boat she was too late to influence World War II, but the advent of the atomic bomb and guided missile transformed her overnight from an ineffective curiosity to a major strategic threat. A 400 foot long, 3530 ton monster of a boat, the I-400 could have stowed several of your X-Craft below as cargo, but as Executive Officer of her U.S. Navy prize crew I grew fond of her ponderous ways.

Not knowing what material you already have or exactly what kind of book you're writing, I'm not sure what information would be most useful to you. The U.S. Navy was still under security wraps in 1945, and the Japanese deep sixed their papers before surrendering, so I don't have any unpublished photos, diagrams or technical manuals from my own records to send you. At the risk of telling you more than you want to know, and duplicating information you already have, I'll try to give you a feeling for these remarkable submarines, an account of how I became a Japanese submarine officer, and a narrative of the I-400's transpacific voyage from Sasebo to Pearl Harbor. I'll throw in extra material because I've always wanted to write a journal recording my experiences in the Occupation of Japan; anything you don't need can be filed in your museum archives for future researchers.

LIBRARY REFERENCES AND COMMENTARY

There was a unique asymmetrical cross section of the I-400 class, with the bridge and conning tower offset seven feet to port of the centerline and the hangar offset two feet to starboard. A Japanese quartermaster told me that because of this he had to use a seven degree starboard helm to steer a straight course at periscope depth, resulting in a larger submerged turning circle to starboard than to port. A flooded conning tower would have posed an interesting stability problem, requiring quick lateral compensation by blowing a port tank.

The long vertical trunk outside the hangar from the conning tower down to the control room is another noteworthy design feature. With a diving time of 56 seconds, spectacular action followed "Clear the Bridge!" as the lookouts dropped into the conning tower and then hurtled 25 feet down this tube to man their diving stations in the control room below. To cushion the landing impact a three foot thick canvas hassock was positioned at the foot of the ladder. This was so filthy that we finally heaved it overboard. Afterwards an unfortunate Japanese sailor who hadn't got the word dropped down from the conning tower and struck the steel deck with a mighty crash. Although he must have been in great distress, he staggered off without a sign...no weakness would be shown in front of the Americans!

The I-400's four 1900 horsepower diesels drove two propellor shafts through Vulcan hydraulic couplings, with a 1200 horsepower electric motor on each shaft. These gave her a top speed of 18.7/6.5 knots. Her athwartships twin pressure hulls did not extend the entire length of the boat. The crew compartment aft reverted to conventional single pressure hull/double hull design, while forward the twin torpedo rooms were stacked vertically, with four 21" tubes and ten torpedoes in each. This arrangement permitted a reasonably fair external hull shape with good stability on the surface and a reasonable draft of 23 feet. The test depth of the pressure hull was 328 feet (80% of her 400 foot length).

Below the hangar in the starboard hull was a special compartment well equipped for aircraft engine overhaul and test, and a magazine to stow four aircraft torpedoes and fifteen bombs to arm her three M6A1 Seiran (*Mountain Haze*) twin float planes. These planes were 35 feet long with a wingspread of 40 feet and could be flown without floats on missions where they were to be expended. Manufactured by Aichi Kokuki K. K., they were stowed aboard with floats detached and wings and tail folded. A SEIRAN could be rigged for flight by a trained team of skilled technicians in as short a time as seven minutes. The magazine also stored ammunition for the 5.5" 50 Caliber deck gun, the bridge 25mm A/A gun and the three triple 25mm Antiaircraft mounts atop the hangar, which also had ready use ammunition lockers on deck.

The I-400's round-the-world cruising range made possible air raids with three bombers against targets as distant as San Francisco, Panama, Washington or New York, and all of these missions were considered. Accommodations for a crew of 145 were designed into the big hulls, but her wartime complement was nearly 200, and a Japanese officer told me that they'd actually carried as many as 220 men to facilitate rapid submarine and aviation operations at sea. This made it possible to unstow, assemble, arm and catapult all three aircraft within 45 minutes after surfacing. Meals for this big crew were prepared in a galley in the starboard hull where great steam kettles turned out huge quantities of rice. A four month supply of food was stowed in every cranny (as in all submarines), including a layer of crates laid out on the decks which the crew walked on until they'd eaten their way through. Supernumeraries slept on the decks

(as you and I have done); they were accustomed to a deck and tatami mat. The oriental style heads were just holes in the decks above sanitary tanks...one did not linger there.

You would have recognized most of the fittings and general layouts of the torpedo rooms, engine rooms, motor rooms, auxiliary machinery compartments, control room, battery compartments, conning tower, and bridge. These and the tankage, piping and electrical systems followed fairly standard submarine practice, so it didn't take us long to master the boat despite the lack of plans and manuals. With much gesticulating, sketching and exchanges of broken Japanese and English we and the Japanese petty officers traced every system and operated all of the gear, tying descriptive tags on critical valves and switches until we got to know them. For a while the interior looked like an inside-out Christmas Tree festooned with dangling paper ornaments. I still remember some of the Japanese submarine terminology: Barasuto Tanku = Ballast Tank, Gyorai = Torpedo, Hatsudenki To = Electric Light, Benjo = Head, Sembokyo (*underwater looking mirror*) = Periscope.

Actually the feature that I found hardest to adjust to was the very existence of the two *Siamese-Twin* pressure hulls and giant hangar compartment. When you walked aft through the port hull your experience told you that you were inspecting an entire submarine—you passed through a torpedo room with four tubes, chiefs' quarters, radio shack, capacious wardroom (beautifully fitted with fine wooden cabinet work, a shrine and comfortable staterooms), large control room with conning tower trunk in the overhead, engine room with two 1900 HP diesel engines, motor room with a 1200 HP electric motor, and crew compartment with raised wooden decks varnished like a dance floor (you removed your shoes before walking there). You had to remind yourself that welded to the large submarine you'd just inspected were two other big hulls. You'd only checked a third of your boat—and had better keep going because every compartment in all three hulls required manning, rigging for sea, maintenance, etc. I kept a particularly wary eye on the enormous hydraulic door opening into the hangar; you can imagine the devastating effect of a loss of buoyancy and a 115 foot long free water surface so high above her metacenter (shades of HMS M-2).

Abaft the periscope shears is the rather crude snorkel fitted as an afterthought with its exhaust piping branching over the hangar to reach the starboard hull engine room. The horn-shaped surface search radar is forward of this. The very large pressure proof binoculars in massive mounts port and starboard at the forward end of the bridge reflected the inadequate performance of Japanese radar.

The submarine had a hydraulic deck valve that opened and shut our big hangar door. We enjoyed majestically swinging open this rumbling portal to expose our cavernous hangar to astonished visitors, or raising, operating and lowering our massive seaplane crane (to impress VIPs we fired our pneumatic catapult).

HISTORY OF I-400 CLASS OPERATIONS

Commander Mochitsura Hashimoto, IJN (I-58), and Captain Zenji Orita, IJN (I-47), have written valuable commentaries on the development, training and operation of the I-400 class boats from the perspective of contemporary Japanese submarine commanders. An interesting recent reference is Richard O'Neill's *Suicide Squads: W. W. II*, 299 p., illust., St. Martin's Press, New York 1981. These references describe the organization of the giant boats into SubRon 1, a special ten-aircraft strike force:

Submarine Squadron One - Captain Tatsunoke Ariizumi, IJN
* HIJMS I-13 (2 Bombers) - Commander Ohashi, IJN
* HIJMS I-14 (2 Bombers) - Commander Shimizu, IJN
* HIJMS I-400 (3 Bombers) - Commander Utsunosuke Kusaka, IJN
* HIJMS I-401 (3 Bombers) - Commander Shinsei Nambu, IJN

SubRon 1 commenced training in early 1945 for a bomb and torpedo strike against the Panama Canal's vital Gatun Locks. Each of the I-400 class submarines required 1600 tons of fuel for the 17,000 mile round trip to Panama, which was more than the total then available at Kure. The I-401 was therefore dispatched to Dairen, Manchuria, in mid May to bring back the needed oil, but she was damaged by a mine and forced to return. The I-400 made the trip instead, after which all four boats, newly equipped with snorkels and false funnels for disguise, moved north through the Sea of Japan to the Ominato Naval Base at the northern tip of Honshu. There they

were still hampered by B-29 laid mines, U.S. submarines penetrating their training areas, and shortages of fuel, material and aircraft, but they nevertheless managed to launch their bombers for simulated attacks on a full scale model of the Gatun Locks erected at Toyama Bay.

While SubRon 1 was training at Ominato the position of the Japanese Navy was steadily deteriorating. By June, 1945, there were more than 3000 American warships and transports already in the Pacific preparing to invade Japan, so the distant raid on Panama began to appear a questionable diversion. Despite Captain Ariizumi's violent disagreement he was ordered to abandon his carefully rehearsed attack on Panama and strike instead the American task forces at Ulithi Atoll. Captain Orita relates how Sixth Fleet staff in Tokyo told the protesting ComSubRon 1 "A man does not worry about a fire he sees on the horizon when other flames are licking at his kimono sleeve!" Sixth Fleet staff planned to coordinate the air strike with a suicide torpedo attack by Kaiten carrying submarines.

The I-13 departed Ominato on 5 July and sortied through Tsugaru Strait into the Pacific. I-14 left next, followed on the 15th by the I-400 and the I-401 sailing on separate tracks far to the east for a rendezvous at sea southeast of Ulithi. The I-14 docked at Truk on 4 August to unload two long range Ayagumo scout aircraft for a reconnaissance flight over Ulithi in preparation for the air strike by the I-400 and I-401 planned for 17-25 August.

Bypassed Truk had become a practice bombing range for new USAAF B-29 crews flying from Guam, and as a result no long range reconnaissance aircraft were still intact there, although a few other planes were operational. (I speak from personal experience, having been Officer of the Deck of USS POMPON (SS267) on lifeguard station off Truk on 5 July when a circling plane we thought friendly suddenly dove at us; the orange *meat balls* on her wings convinced us we'd better eat our breakfast down at 150 feet).

Commander Hashimoto reports that Captain Ariizumi still hoped to strike the Panama Canal if he could recover his planes after a dawn raid on Ulithi, but other sources say a Kamikaze strike was intended. Suddenly on August 6th the Atomic Bomb devastated Hiroshima, followed on the 15th by the Emperior's dramatic radio

address accepting defeat. With the combat careers of his giant submarines over before they'd begun, ComSubRon 1 reluctantly carried out his new orders to cease hostilities, hoist the black flag and return on the surface to his home port in northern Honshu.

Admiral Lockwood recounts the interception and surrender of the giant boats east of Honshu on 28 August, and the American Navy's astonishment at their size. His statement accurately reflects our feelings at the time, including elation that the war had finally been won and rage and disgust over the enemy's ill treatment of the pitifully few survivors from our lost submarines. I was one of the officers at Guam detailed by Admiral Lockwood to meet and interrogate released submarine P.O.W.s as they were flown down from Japan. We needed to prepare quickly a complete muster list of the known survivors from all of our lost submarines to ensure that we recovered every prisoner still alive. We also wanted to establish how each boat had been sunk - many were simply "Long Overdue and Presumed Lost."

It was a sobering experience. Many of my friends and former shipmates were missing in action, and I was grieved to find none among the human wreckage we recovered. We directed the Japanese Naval Staff to prepare a list specifying the time, place and circumstances of every U.S. submarine sunk by Japanese ASW forces during the war, but the hand written document proved of little use since it described some 500 confirmed sinking's against our loss of 52 boats. (I did note with satisfaction my *certain destruction* on at least three occasions following some rude act by USS POMPON.)

After the I-400 struck her colors to Commander Hiram Cassedy, USN he became her first Prize Crew Captain. I'd known Hi as skipper of the old SEARAVEN (SS-196), and considered him quite a character. Although never fortunate in tonnage sunk, he'd rescued 31 RAAF personnel from Timor in a bold two-night operation in 1942, and picked up a record 31 U.S. airmen from the sea off Honshu in 1945 in the new Tigrone (SS-419). He didn't last long as the I-400's skipper, running afoul of Admiral Halsey for disregarding orders about taking swords as souvenirs. Hi thus became the first U.S. naval officer to be relieved of command of a Japanese submarine. I remember him for another first though: when he died his ashes were placed in a canvas covered metal box which was fired from a

forward torpedo tube of USS BARRACUDA (SSK 1) in deep water off Key West...a unique submarine Viking funeral.

Admiral Lockwood recounts the saga of the recalcitrant Japanese Squadron Commander who shot himself rather than surrender; this was the above mentioned ComSubRon 1, Captain Tatsunoke Ariizumi. Neither Admiral Lockwood nor the Japanese authors mention that as Commander of the I-8 operating out of Panang in the Indian Ocean on 26 March, 1944, Captain Ariizumi had methodically collected from the water and then massacred 98 unarmed survivors of the big Dutch merchantman TJISALAK he'd sunk south of Colombo. He was repeating this brutal performance with 96 bound prisoners from the American JEAN NICOLET in the Maldives on 2 July when he was forced to dive, leaving 35 survivors on deck, 23 of whom managed to untie themselves and swim until rescued next day. These atrocities may have contributed to Captain Ariizumi's decision to commit suicide as his squadron was being escorted by U.S. Naval vessels to Yokosuka.

HOW I BECAME A JAPANESE SUBMARINE OFFICER

I'd joined the Naval Reserve with a brand new engineering degree in 1942 and after *90 Day Wonder* midshipman training at Annapolis had been commissioned Ensign. I volunteered for *The Silent Service* because I'd always been fascinated by submarines. My father, the late Commodore George T. Paine OBE, USN, was an M.I.T. naval architect who specialized in the design and construction of submarines and destroyers. Boyhood memories of being allowed to peer through the periscopes of S-Boats and V-Boats sold me on subs—that's what the big guys did. My father had begun his naval career doing the deep submergence testing of the World War One R-Boats built in San Francisco, so it seemed appropriate that my first submarine was the USS R-14 (SS 91). (Appropriate to me, not to him - he thought it foolhardy to dive those old rust buckets!)

The R-14 was then performing *Clockwork Mouse* duties for the Fleet ASW School at Key West, Florida. As you know, diving and surfacing all day long to give sonar operators experience in submarine detection provides ideal training for *Makee Learn* submarine officers. When we weren't operating rusty kingston valves or starting balky air injection diesels we were putting the low pressure

pump on the main drain and practicing surfaced and submerged ship handling. We learned the boat by tracing and drawing all of the piping and electrical lines, hull openings, duct keel and other mysteries of R boat design. In early 1943 this was repeated at the Submarine School at New London, and repeated again after graduation when I was ordered to the fleet submarine USS POMPON as Radar and Assistant Engineering Officer. I reported aboard her at the principal U.S. Submarine Base in the Southwest Pacific, which consisted of the submarine tender PELIAS (AS 17), a converted merchantman moored to North Wharf in Fremantle, Western Australia. Quickly learning our way around the Japanese submarines we took over in 1945 was thus standard operating procedure.

As the war drew to a close in July, 1945, I was Engineering and Diving Officer of the POMPON refitting at Guam after my seventh war patrol. We didn't realize that the war was almost over; our hopeful slogan was *The Golden Gate in '48*. I did note, though, that Japanese shipping had been almost completely driven from the seas, and the B-29 raids had become such *milk runs* that ComSubPac had to issue a stern letter forbidding submariners from hitching sightseeing rides on the night raiders. I was impressed every evening when our Marianas Armed Forces Radio Station switched from English to Japanese for fifteen minutes to broadcast a warning to Japanese civilians to flee the next cities marked for destruction by fire bombs. While a voice of doom slowly read the list of specific cities targeted for tonight I could hear outside the roar of B-29 engines as the long stream of heavily laden bombers rose into the night. This broadcast was not an act of humanity—there is no humanity in setting cities aflame—but a contemptuous display of America's overwhelming air/sea power. As powerful propaganda it surely beat *Tokyo Rose*.

Suddenly within an eventful eight days, dread mushroom clouds rose over Hiroshima and Nagasaki, Russia declared war on Japan, and the Emperor's own voice told his stunned subjects that Japan was defeated and hostilities must cease. When the shouting died away I was transferred to the submarine tender USS EURYALE (AS 22) for intensive training in the Japanese language as the U.S. Navy prepared to demilitarize the Japanese Submarine Force.

I had a large lump in my throat when I waved goodbye to the homeward bound POMPON as she backed out from the nest of boats alongside the tender, sounding a prolonged blast on her whistle and streaming a long commissioning pennant held aloft by balloons. I wasn't sure she could dive safely without me, but I wasn't ready to head back to the states yet because I was determined to marry and carry home with me the smashing WAAAF I'd fallen for in Perth. I wanted to head south, not east, and north at least kept me on the right longitude. On 16 September EURYALE set sail for Kyushu via Okinawa. On arrival we took care to enter Sasebo Harbor with all watertight doors dogged shut steaming in the wake of our escorting minesweeper right down the middle of the swept channel. The burnt out city and oily harbor littered with wrecked naval vessels was an unforgettable sight, underscoring the tragedy of World War II for Japan.

I landed at the naval base in the first boat with orders to seize samples of every model of Japanese torpedo, complete with chests of spare parts and special tools for each. We had learned to respect Japanese torpedoes, which substantially outperformed our own. Of course our first hours in Japan were very tense—no one really knew what to expect, and we were fully prepared to deal with kamikaze resistance from diehard fanatics. One patrol boat crew threatened trouble, but this was decisively handled by the Japanese, and everyone on both sides was relieved when an orderly local surrender took place. I soon found myself with a Japanese officer's sword and a detail of Japanese naval personnel to help me assemble my collection of torpedoes and ordnance equipment.

Since your interest is in their submarines, I'll just say that after many days sloshing through the mud in dark, dripping caves piled high with rusting gear I did find all of the requested ordnance specimens for shipment back to the states. Do you remember the large Japanese torpedoes on display at the Submarine School when you were in New London? They were part of my collection. A point that may interest you is the procedure the Japanese torpedo officer used to bleed the pure oxygen charge from an oil-coated midsection of a *Long Lance* torpedo. I didn't see how this could be done safely in view of the obvious fire and explosion hazard of oil and oxygen, but it proved to be simple. The torpedo was carted to the middle of

an open field where a junior rating was handed a spanner with instructions to open the oxygen valve after the rest of us had retreated to a safe distance. In response to a shouted order he spun open the valve and darted to safety as high pressure oxygen whistled out around the greasy torpedo—no explosion—no casualties—that time. Of course it was far safer to go into combat armed with the mighty Japanese oxygen torpedo than with our Bureau of Ordnance's poorly designed, inadequately tested Mark 14 (which sank at least two of our own submarines).

My torpedo collecting was just a sideline to our primary mission, which was to locate and disarm the Japanese submarine fleet, interrogate the crews, study the material and, when ordered, scuttle the boats. The duty of Boarding Officer was rotated, and I happened to be on watch when the giant I-402 appeared off Sasebo from Kure requesting clearance to enter harbor in accordance with U.S. Navy orders. She was told to heave to, and a group of us shoved off to board her in a whaleboat. Our armed detail included an interpreter, Chief Torpedoman, Gunners Mate, Signalman, and Radioman. This was my first experience aboard an I-400 class submarine, and I recall my mixed emotions as we pulled alongside her towering hull and clambered up her superstructure over the degaussing gear and onto her foredeck. I was excited to be carrying out a *Boarders Away!* operation, wary of the impassive Japanese who stiffly greeted us, curious about the unfamiliar aircraft handling equipment all around us, delighted to be directly involved in this historic finale of the undersea war, and concerned about both the technical and human problems involved in carrying out our orders to disable her torpedo, ordnance and radio gear before bringing her in.

That's a lot of excitement for a notoriously phlegmatic submariner, but you must bear in mind that I was only 23 years old. Joseph Conrad's Youth captures my emotions perfectly:

> *"And then I saw the men of the east - they were looking at me.... I have known its fascination since; I have seen the mysterious shores, the still water, the lands of brown nations, where a stealthy nemesis lies in wait, pursues, overtakes so many of the conquering race, who are proud of their wisdom, of their knowledge, of their strength. But for me all the East*

is contained in that vision of my youth. It is all in that moment when I opened my young eyes on it. I came upon it from a tussle with the sea - and I was young - and I saw it looking at me.... Ah! The good ole time - the good old time. Youth and the sea. Glamour and the sea!"

A stiffly formal Japanese officer conducted us aft alongside the catapult, up the port ladder to the top of the hangar, aft and up onto the bridge, whose bizarre offset position distracted me. I exchanged proper salutes and introductions with the Captain, stating slowly in what I hoped was impeccable Japanese: "Watakushi wa Beikoku no Kaigun no Sensuikan shoko, Painu Tai, des!" He looked blank and unhappy, and mumbled something in reply which neither I nor our interpreter caught. Eventually we made ourselves understood, though, and arranged for his petty officers to conduct our specialists to the designated compartments, with our interpreter to facilitate communications and report back. This left me surrounded by the non-English speaking officers and bridge watch, who clearly didn't realize that I was speaking Japanese. This was somewhat disheartening after all those studious hours aboard EURYALE, but I just raised my voice and plunged on.

The I-402's navigator kept insistently repeating something like *Hobby Sea Toy*, which I struggled to link to some English or Japanese nautical phrase. Then it came to me: "Haben Sie deutsch?" –he must have made one of those Penang to Germany I-boat voyages. "Ja, Ja, Herr Leutnant, aber mein deutsch ist nicht sehr gut! Konne Sie mein Nihon verstehen, bitte? Anata wa Watakushi no Nihon wakarimaska?" I asked hopefully. "Ah, so! Sehr gut, sehr gut!", he replied with a bow, telling me nothing, but conveying to everyone else on the bridge the impression that two great linguists had established communication.

Fortunately word was soon passed up that all was secure below, and we managed to muster enough fractured Japanese/English/German among us to bring her safely in to her moorings. Later, when I'd gotten to know the Japanese officers better, I learned that part of our problem was that our interpreter instructors had been taught by elderly Japanese-American ladies who spoke only old fashioned, very honorific Japanese. Thus, instead of

barking out orders in proper quarterdeck style I'd been most respectfully and politely requesting. The puzzled Japanese must have thought that we were a boarding party from HMS PINAFORE under instructions from Sir Joseph Porter, KCB:

"For I hold that on the seas,
The expression 'If you please',
A particularly gentlemanly tone implants,
And so do his sisters and his cousins and his aunts..."

Although Sasebo was our home port, the EURYALE (fondly known as *Urinal Maru* to her crew) also sailed around Kyushu and up through the Inland Sea to Kure to pick up a number of surviving boats there. All of the mines in the harbor had not yet been swept, but Hiro Wan was clear so we anchored well out from the burned out Navy Yard and put our ship's boats in the water to ferry our boarding parties to the Japanese submarines moored around the harbor. I remember that first boat trip on a sunny autumn afternoon past picturesque pine clad islands right out of a Hiroshige print - except for the blackened hulks of burned out warships canted at rakish angles littering the oily shores. Rounding the awash deck of the wrecked battleship HARUN we drew alongside the anchored HIJMS I-58, a large Kaiten carrier with six suicide torpedo launching racks visible on her decks.

The deck watch announced our approach and tended our lines as a group of officers clambered out of her hatches and lined up on deck to meet us. Because our scarce interpreters were assigned elsewhere, I climbed aboard the I-58 with only a non-Japanese speaking fellow submariner and a naval intelligence officer, hoping we'd find someone aboard who spoke better English than my halting Japanese. We were in luck as the Commanding Officer introduced himself in highly accented but understandable English as Commander Mochitsura Hashimoto, IJN. He invited us to accompany him below to conduct our business, and led us down the forward torpedo room hatch and aft through a bulkhead into the wardroom. There we sat down across the wardroom table from Commander Hashimoto and several of his officers; on the table lay his sword.

That dramatic scene in the I-58 wardroom from 39 years ago is very clear in my mind's eye today. Since I don't want to spin this yarn out beyond your interest, or stray too far from your topic of giant submarines, I'll just recount the high spots of this first U.S. Navy contact with the I-58. After I refused to accept his proffered sword, explaining that I had come aboard specifically to issue disarmament instructions and to learn about the I-58's operational career, he said proudly that of course he'd been expecting us since "This is the submarine that sank the U.S. navy warship that carried the atomic bomb."

We were thunderstruck at this statement, and exchanged looks of consternation—what ship was he talking about? Atomic weapon information was Ultra Secret - we had never been told which ship had transported atomic bombs. As we fired questions at him he drew out a chart for us and described precisely how he'd recently sighted, approached, attacked and sunk USS INDIANAPOLIS. He told us that he'd manned his Kaiten human torpedoes, but with a clear moonlit night, a calm sea, a target proceeding at moderate speed without zigzagging, an advantageous position forward of her beam, and no sonar transmissions or escorts detected, he'd decided that conventional torpedoes were adequate for this elementary attack.

We knew of the sinking of INDIANAPOLIS, and the tragic loss of life that ensued when a bungling staff failed to note her absence while her survivors battled exposure and sharks for days. We had no idea that INDIANAPOLIS had carried the components for the first atomic bomb to Tinian, though. How did commander Hashimoto know this? Did a P.O.W. from one of the final B-29 raids reveal it? Was there a news release we'd missed? Or could the I-58 have picked up and interrogated an unknown survivor from INDIANOPOLIS? This still remains a mystery to me.

While we were at Kure I went over the hill to see Hiroshima. Both cities were utterly devastated, with rubble and ashes stretching as far as you could see. Once it was decided to destroy the cities I couldn't see that it made much difference how the flames had been lit. The destruction and casualties were the same; the difference was only the number of aircraft employed—and the frightening implications for the future.

By the end of October we'd gathered together in Sasebo enough operational Japanese submarines to require some administration, so on 2 November I received Memorandum No. 4-45 from ComSubDiv 131 organizing the boats for which we were responsible into four divisions:

Japanese Submarine Division 1 - LCDR F. B. Tucker, USN
* HIJMS I-158
* HIJMS I-162
* HIJMS I-201
* HIJMS I-202
* HIJMS I-203

I-158 (8 Torpedo Tubes) and I-162 (6 Tubes) were older 1640 ton, 20 knot Kaigun Dai (*Large Fleet*) Submarines with 4.7 inch deck guns and test depth of 200 feet. Launched in 1927/30 as I-58 and I-62, they were renumbered and retired to training duty in 1942, then refitted in 1945 to launch five Kaiten torpedoes against the expected U.S. invasion fleet. The I-201 to 203 Sensuikan Taka (*Fast Submarines*) were modern 1070 tonners designed for mass production with four torpedo tubes and 360 foot test depth. Like the German Type XXI they were true submarines with streamlined hulls, great battery capacity and 5000 HP motors that have them a top submerged speed at the one hour rate of 19 knots, enough to show a clean pair of heels to many escorts. I wanted to try one out in underwater exercises with a U.S. ASW team, and grumbled when our high command rejected this as too risky - it was hard for me to readjust to such a sensible peacetime decision.

Japanese Submarine Division 2 - Comdr. J. P. Currie, USN
* HIJMS Ha-103 Lt. Y. Murayama, IJN
* HIJMS Ha-105 Lt. T. Kiuchi, IJN
* HIJMS Ha-106 Lt. T. Tatiyama, IJN
* HIJMS Ha-107 Lt. S. Takezaki, IJN
* HIJMS Ha-108 Lt. O. Oshiro, IJN
* HIJMS Ha-109 Lt. Kunihiro, IJN (Senior Captain)
* HIJMS Ha-111 Lt. Ono, IJN

The Ha-101 Class Sensuikan Yu Sho (*Small Supply Submarines*) were simple 370 ton boats without torpedo tubes designed to transport aviation gasoline from Singapore to Japan or to carry 60 tons or 103 cubic meters of cargo to bypassed garrisons within a radius of 3000 miles. The Ha-100 class was equipped with snorkel and radar. Their top speed from a single 400 HP diesel was 10 knots, submerged endurance at 2.3 knots 20 hours, test depth 300 feet, armament one 25mm gun, and complement 21 officers and men. Later, when I got to know these officers better, they confided that their initial reaction to news of Japan's defeat had been to sail at once on a mass suicide mission. Fortunately they'd soon simmered down and turned back.

Japanese Submarine Division 3 - Lt. Comdr. P. R. Schratz, USN
* HIJMS Ha-201
* HIJMS Ha-202
* HIJMS Ha-203
* HIJMS Ha-205
* HIJMS Ha-210

The Ha-201 Class Sensuikan Taka Sho (*Small Fast Submarine*) was a new 320 ton coastal defense boat with a test depth of 350 feet. Designed for mass production, they were armed with two torpedo tubes and had a snorkel range above 5000 miles. Their streamlined hull and 1250 HP motor gave them an underwater speed above 13 knots and great maneuverability. In skilled and determined hands they might have given our ASW force a hard time. The Sasebo Navy Yard was full of additional Ha-201 Class hull sections in various stages of completion. I wondered how I could sail one home—the ideal yacht for a retired submariner.

Japanese Submarine Division 4 - Lt. Comdr. J.D. Mason, USN
* HIJMS Ro-50
* HIJMS I-156
* HIJMS I-157
* HIJMS I-159
* HIJMS I-366

Ro-50 was a Kaigun Chu (*Medium Navy*) 960 ton, 19.7 knot submarine of 1944 vintage with an 11,000 mile radius of action, four torpedo tubes and a three inch deck gun. The I-156, 157 and 159 were sister ships of the I-158, but with slightly different bow shapes.

I-366 was a 1440 ton, 13 knot Type D.1 Cargo Submarine built in 1944 to transport 82 tons of cargo 7500 miles. She had a 5.5 inch gun and no torpedo tubes, but with the invasion looming she was refitted in 1945 to launch five Kaiten torpedoes. We lost one of her sister ships, I-363, to a mine while enroute to Sasebo on 29 October off my old patrol area in the Bungo Suido. With the war ended this struck me as a particularly tragic loss, yet a few weeks before I'd have worked desperately to sink her. Sanity was returning.

I list the names of the Ha-100 boat skippers in Japanese SubDiv 2 because I later became acting Division Commander—the peak of my naval career! A short boat ride each morning brought me to my nest of seven submarines, where I was greeted formally by the Commanding Officers. Since Lieutenants Murayama and Takezaki spoke some English, and my Japanese was improving with practice, our daily joint inspection proceeded smoothly. After each boat had been methodically checked the seven skippers and I sat around the wardroom table of one of the boats to resolve any problems that had arisen (an ill quartermaster, next weeks rations, a hot engine bearing, detachment orders, etc.). When business was over a warm bottle of sickly sweet orange beverage was produced (U.S. Navy regulations against alcohol were strictly enforced—for obvious reason) and informal conversation followed. Topics discussed ranged from professional naval subjects to the complexities of the game of *Go*.

Our extreme curiosity about each other's submarine combat experiences quickly broke through our initial reserve, and I learned a lot about the war patrols of the boats in the harbor, emotions on launching Kaiten torpedoes, midget submarine effectiveness, hazards of supply runs (they never suspected that we were decoding their rendezvous messages), their respect for American radar and contempt for our torpedoes, etc. These discussions were essentially verbal patrol reports in Homeric style.

Even the decrepit old I-158 had a story to tell. While patrolling 300 miles north of Singapore on 10 January, 1942, she'd sighted and fired at HMS Prince of Wales and Repulse. The torpedoes missed,

but her contact report brought in the 22nd Naval Air Flotilla, which sank the two capital ships before dark, dooming Malaya. Ha-106 had supported a desperate long range air strike from Kanoya, at the southern tip of Kyushu, against Ulithi Atoll. Lacking sufficient range for the round trip, the bombers had ditched on the way home off Minami Daito Shima, 200 miles east of Okinawa, where Ha-106 waited to pick up the aircrews. A number of the Ha-100 boats had patrolled the Bungo Suido and served as submarine tenders for hundreds of Kairyu (*SEA DRAGON*) two-man midget submarines being prepared to repulse the U.S. invasion fleet. Ro-50 had had several brushes with U.S. carrier task forces, and was credited with sinking a carrier and destroyer 150 miles northeast of Lamon Bay in the Philippines on 25 November, 1944 - but the U.S. Navy recorded no such attack. She was more successful 300 miles southeast of Surigao Strait on 10 February, 1945, when she torpedoed and sank USS LST-577.

The venerable I-157's saga included running hard aground at 14 knots on Little Sitkin Island in the fogbound Aleutians, from which she escaped only by throwing overboard everything movable, firing all torpedoes, pumping all tanks, and breaking up and jettisoning over one hundred battery cells. I-366 had released three Kaiten torpedoes against an American convoy 500 miles north of Palau on the evening of 11 August, 1945, and was credited with three sinking's, but the three explosions she'd heard had only marked the ends of the torpedo runs—and of three brave young pilots. Within a few days I was startled to note that when the Japanese officers and I discussed submarine attacks and ASW counter-measures we used the terms *us* and *them* to refer to *Submarines* and *Surface Ships*, not to Americans and Japanese. I was surprised how quickly bonds of mutual interest developed based on our shared experience in a hazardous, demanding, professional enterprise.

By mid November most of the operational Japanese submarines slated for scuttling off Goto Shima were moored in Sasebo harbor awaiting orders. It was decided that the unusual design features of the giant boats and their implications for the atomic age merited more detailed study in the United States. U.S. Navy Prize Crews were therefore ordered to prepare the I-14, I-400 and I-401 for a transpacific voyage to the Submarine Base, Pearl Harbor. Thus, I

received orders to leave my roomy stateroom aboard EURYALE and report to Commander J. M. McDowell USN, the Officer-in-Charge of the Prize Crew of ex-HIJMS I-400, for duty as Executive Officer and Navigator of that vessel.

TRANSPACIFIC VOYAGE OF THE I-400

After the I-400 was taken over from the Japanese on her way home from patrol you can imagine that she required a massive clean-up from stem to stern. The field day started one night with all hands moving aboard the tender, after which cylinders of fumigating gas were opened in every compartment and the boat sealed. Next morning bushel after bushel of dead rats and cockroaches were swept up. I'd noted with some disgust on our Japanese boats the occasional rat leaping through a hatch from compartment to compartment, and hordes of scurrying roaches when a light was switched on. I had no idea that so many verminous shipmates went on patrol in these boats, though. If the I-400 had been rigged for dive when the rats and roaches were thrown overboard the Diving Officer would have had to order *Flood two hundred pounds to Auxiliary Tank from sea.*

Sailing across the Pacific to Pearl Harbor (or through space to the moon) requires a sound plan for fitting out, manning and supplying your ship. The I-400 had no blueprints or *Machinery History* describing her equipment, no crew's *Watch, Quarter & Station Bill*, and no *Standard Allowance Lists* of tools, spares and supplies. It was clear that we'd have to improvise, so we were given wide latitude by the powers that be in readying and supplying our unusual boat for her transpacific voyage. EURYALE's workshops and stores were put at our disposal, and we were authorized to salvage any Japanese spare parts and supplies we wanted from the warehouses and caves I'd explored around the Sasebo Navy Yard.

An experienced submariner like you can imagine the results of opening a trove of untended Japanese stores to the crew of a homeward bound submarine equipped with a cavernous hangar and a 12 ton crane. Yes, the I-400 quickly became history's first Undersea Interisland Trader. Overnight our hangar became an armory suitable for a major gun running operation, with stacks of rifles and bayonets from a relatively dry cave I'd spotted. From

Japanese uniform buttons and rating badges to rubber stamps and a sampan, down our capacious hatches they went to stock our Submarine War Surplus Store.

The prize crew which had brought the I-400 from Yokosuka had maintained her well, and it didn't take us long to put her in shipshape seagoing condition, with vital machinery inspected, overhauled and tested by a responsible crew member. Since we had no plans to dive the boat before a complete overhaul at Pearl Harbor we didn't worry about an inoperative snorkel, stiff diving gear or minor defects like leaky hatch gaskets. By the end of November we were able to report the I-400 *in all respects ready for sea*.

Our squadron of giant I-Boats got under way for Pearl Harbor via Guam on 11 December, shepherded by the submarine rescue vessel USS GREENLET (ASR 22). She had escorted them from Sagami Wan a month before and was well equipped to support us, including deep sea towing gear—just in case. The minesweeper that escorted us to the end of the channel blinked *Bon Voyage!* Instead of *Good Hunting!*; the Pacific was again pacific.

Falling in astern of the I-14 we made turns for an easy 12 knots on a southerly course clear of the unswept minefields west of Kyushu. We kept a sharp lookout for floating mines, but the Officer of the Deck's main concern became precise station keeping. It seemed unnatural not to be constantly alert, meticulously sweeping the horizon for enemy mastheads or smoke, the sky for ASW aircraft, and the sea for periscopes. When I climbed up to the bridge at twilight to get my evening star sights I felt a strong urge to douse the running lights. My unease soon passed, however as the pleasures of peacetime submarine cruising began to sink in. It was perfectly safe to be running so casually here on the surface - we owned it!

The shallow East China Sea grew choppy, and we found that the I-400's high freeboard, broad beam, deep draft and ample bow buoyancy tank gave her a dry bridge and an easy roll and pitch. She was a comfortable boat in a seaway. Her 130 foot long gun platform atop the hangar gave us a promenade deck worthy of the Queen Mary, while our small prize crew spread out luxuriously in the spacious compartments below. For peacetime surface cruising she couldn't be beat. As the I-13 demonstrated, however, in combat submerged, such a huge, low speed target with a shallow test depth

would not last long against a modern ASW team. Her best strategy would probably be a bold offensive against ASW vessels, taking her chances with aircraft while staying at periscope depth and rapidly firing and reloading her eight torpedo tubes. *Down the throat* shots are sporty, though, and you can understand why the Japanese turned next to small, fast, handy deep diving submarines.

We passed uneventfully through the Tokara Gunto, and I enjoyed the contrast with my last wartime passage against vigilant ASW patrol craft and planes equipped with radar and magnetic airborne detectors. Now the I-400's 1700 horsepower diesels pounded steadily on, driving us southeast on the 1200 mile leg of our voyage across the Philippine Sea. Soon we were sailing through tropic seas, where we discovered a culinary failing of the I-400: fewer fresh flying fish on deck each morning for breakfast than we'd have collected on a lower freeboard fleet submarine. Overall, though, I can report to you that our giant submarine liner proved to be a fine sea boat throughout our transpacific voyage.

The I-400's 23 foot draft was not so handy, though, as we led the division up the harbor toward the Submarine Base at Guam. In submarine fashion we'd taken no pilot, and I was surprised when we suddenly came upon a new pipeline from a SeaBee dredge crossing the shallow channel under our route. It was unmarked on our charts, and I grew increasingly nervous about our clearance. It was too late to take the way off our ponderous bulk, though, so we ploughed on and slipped across. I assured my skeptical skipper that I knew every inch of the muddy bottom of that harbor, having strolled around with lead shoes, canvas suit and brass helmet getting my deep sea diver's rating there. He hissed that I'd damn well better be right, gripping the bridge coaming with white knuckles until the division commander made it also in our wake.

Our trials were quickly forgotten as we threw our heaving lines across to the tender at the Submarine Base. We were met with a tumultuous welcome—whistles blowing, bands playing and VIPs lining up to board our esoteric squadron. In the six months since the end of the war Guam had become a dull backwater as *Operation Magic Carpet* ferried its once great Navy and Air Force population back to the states. For the rear echelon personnel still there the arrival of our giant I-Boats flying the stars and stripes over the rising

sun provided a stimulating release from their boredom and *Island Fever*. Visitors of all ranks swarmed aboard.

In the corner of your Submarine Museum is a busy souvenir stand offering everything from ash trays and emblazoned mugs to tea towels and tee shirts. In every corner of the I-400 were Japanese artifacts liberated by our crew from the deteriorating caves of Sasebo. You trade souvenirs for money; being outside the cash economy we bartered for goods. The receding tides of war had left Guam's quonset huts as crammed with unneeded supplies as Sasebo's caves, and our crew quickly opened our floating flea market for informal trading. I can't give you the texts verbatim, but all over the Naval Operating Base Guam you might have heard:

> "Could you use a couple of these rifles, Chief? I need two 16mm projectors and some good movies - *good* movies."
> "This bayonet used to belong to Tojo, Swabbie, but we'd swap it for a new automatic Silex Coffee Maker - OK?"
> "My guys won't eat no more lousy Spam, Cookie. Now I figure your wife and kids would like to flash this genuine Japanese stuff around back home to show how you won the war; we need some canned hams and prime steaks - is it a deal?"

The transformation of the I-400 had begun.

These yarns may be historically significant when future underwater archeologists diving on the I-400 where she lies in deep water off Hawaii wonder why every scuttlebutt was equipped with a General Electric refrigerated fountain. What was the reason for installing in her galley all of that gourmet cooking equipment (including an ice cream machine)? Why deluxe porcelain plumbing fixtures in all of the heads? Who decided to mount such crude electronic gear topside and then wire every bunk below for music from a juke box with flashing colored rights? You have the explanation.

Of course all of this *cumshaw* dealing was bound to lead to trouble, and it came in the form of an irate marine officer storming on board demanding that the I-400 return his motor scooter. Discreet inquiry pointed to the culprit being a swindling motor pool sergeant,

but our Chief of the Boat reassured me "Don't worry, Mr. Paine, we'll take care of that gryrene, and they won't find any motor scooter in this boat." That was not quite the same as saying that the motor scooter was not aboard our labyrinthine craft, but I believed him: it would never be discovered. Clearly it was time to crack down on our I-Boat bazaar, so we lowered the boom on our pirates while, in the fine tradition of your Queen Elizabeth I, enjoying the fruits of their buccaneering.

I'd hoped that the submarine command at Guam might be able to help me get back to Perth to settle my personal affairs, but with all U.S. Navy operations in Australia being terminated there wasn't a chance. Barbara would have to come to America, and I'd better get back stateside. I was happy therefore when our now lavishly equipped and well stocked I-400 set sail from Guam with her squadron for the 1000 mile trip to Eniwetok Atoll in the Marshall Islands. Running east by south we had fine tropical weather with occasional drenching rain squalls. We took advantage of these in submarine style with a bar of soap and towel sent up to the bridge, even though the I-400's fresh water capacity was ample to provide showers for our small crew.

Christmas Eve found us cruising through tropic seas approaching Eniwetok, relying on the GREENLET's radar to pick up low lying atolls. Despite our superstructure's rubberized anti-radar coating Santa Claus had no trouble detecting our little squadron, and small presents were distributed to all. The greatest gift, of course, was the one our surroundings reminded us of: a world at peace. Christmas dinner was a magnificent feast, testifying to both the culinary and bartering skills of our submarines cooks. That's what the old hands called *Shipping Over Chow*, asking "Where would you get a meal like that on the beach?" When I run into an old I-400 shipmate now we say of her fondly: "She weren't no looker, but she were a feeder!"

Our stop in Eniwetok was short, paralleling our experience at Guam. This time, however, it was the mysterious disappearance of the Island Commander's jeep on the eve of our departure which brought wrath down upon all hands. Our buccaneers were all innocence, and a thorough search of all three submarines and the GREENLET failed to turn up a clue. We were granted reluctant

permission to sail—and told not to come back or they'd open fire on us. I still don't know what happened to that jeep, except that the I-401 crew did acquire a newly-painted one in Pearl Harbor, said to have been purchased by their welfare fund.

New Year's Eve found us steaming eastward across the International Date Line for Pearl Harbor on a course laid out to take us close to Johnson Island in case one of our boats needed repairs. Submarine tradition requires that the deck log entry for the last watch of the year be written in rhyme—is this also an RN custom? I liked Stringfellow's deathless poetry so well that not only did I keep a copy, but I set the calendar back a day, so after entering 1946 we went back into 1945 and at midnight he had to consult his muse again.

Ploughing along on the last leg of our voyage to Pearl Harbor we began to prepare a list of the work that should be done when we arrived at the Submarine Base to put the I-400 in good condition for diving. I went over this in detail with each department to make sure we included everything essential for reasonably safe submerged operations, but nothing extra that might make it too costly to refit her. After a thorough personal inspection of the boat with our petty officers I boiled the list down to three pages containing thirty nine items.

On 6 January, 1946, our unique squadron sailed triumphantly into Pearl Harbor, dipping our American and Japanese ensigns in salute as we slowly glided by the gutted hulk of USS ARIZONA on our way up the loch to moor at the Submarine Base. We were again given a lively reception by the Submarine Force, with many senior submariners showing great interest in our unconventional boats. One division commander expressed particular interest in our Japanese navigation gear, which I proudly demonstrated for him. Then, when my back was turned, the son of a bitch walked across the gangplank carrying my beautiful sextant. I knew all submariners were pirates at heart—I paid the price for failure to stay alert.

To anyone who would listen I argued the case for refitting the I-400 for submerged operation and evaluation. I was convinced that we should find out how such a huge submarine handled submerged, how her automatic trim system worked, what lessons her Japanese naval constructors had incorporated into her design from their long

experience with large submarines, and all of the other things she could teach us. Decisions had slowed to a peace time tempo, though; we were to stand by for further orders.

The time had come for me to think seriously about my own future, and it was clear that I'd already had the peak experiences of life in submarines. I'd liked to have been skipper of my own boat, but peacetime training operations would be an inevitable letdown (I didn't foresee the nuclear submarine). I decided that the next phase of my life should be in the exciting new science and technology developments that had emerged from the war. I'm sure it was the right decision, but I made it reluctantly, and I'll never forget my fascinating youthful experiences in the submarine navy. We were indeed the last of the corsairs.

I caught a homeward bound fleet submarine back to San Diego, enrolled for a doctoral degree at Stanford, and married my lovely WAAAF cutting our wedding cake with my Japanese sword. The giant I-400 was taken out to sea off Hawaii and torpedoed—well, at least the damn things worked for once.

With very best wishes for your book,
Thomas O. Paine
Lieutenant, USNR (Ret)
Ex-Executive Officer - Ex-HIJMS I-400 Prize Crew

NEMO'S NAUTILUS
19th CENTURY CONCEPT, 21st CENTURY ACTUALITY

by Mr. Jim Bloom

Mr. Bloom is retired from tax law consulting, but has written extensively on military and naval historical topics over a 40 year period, with some 60 articles in military and naval journals and several encyclopedias. His book on the Roman-Jewish war was published in 2002. He lives in Silver Spring, MD with his wife.

Jules Verne's Captain Nemo, in the science fiction classic *Twenty Thousand Leagues Under the Sea* (*20 TL*), commands a submarine vessel that is quite extraordinary. Not only is NAUTILUS a 21st Century paradigm conceived 130 years before its time. Verne wasn't merely indulging in creative, unexpectedly accurate speculation. He was quite well versed in the experiments in undersea navigation conducted during the fifty years before the novel's creation in the late 1860s. More importantly, it has recently been noted that he collaborated with his friend, the French marine engineer and sub pioneer Gustave Zede, to build an actual model of NAUTILUS. This model was discovered in a private collection in Rumania in 1993 and sold at auction in the United States. It was widely held that Verne had modeled his NAUTILUS on an 1860s sub, LE PLONGEUR .

In 1863, a French team of Charles Brun and Simon Bourgeois launched LE PLONGEUR (The Diver) – 146 feet long, 20 feet wide, displacing 400 tons. It was powered by engines run by 180 psi compressed air stored in tanks throughout the boat. Its method of operation was to fill ballast tanks just enough to achieve neutral buoyancy, and then make adjustments with cylinders that could be run in and out of the hull to vary the volume. This is exactly the visionary mathematician William Bourne's concept dating from 1578! Nevertheless, the boat was too unstable; the movement of a crew member could send her into radical gyrations. The ballast system consisted of parallel longitudinal tubes which were filled with or emptied of water as necessitated by the desired situation,

whether dive, surface or trim while underway. The problem is that the system was very unwieldy and PLUNGER lived up to her name, more often than not plunging towards the seabed notwithstanding the intentions of the OD.

However, the discovery of the 1868 model in which the author apparently collaborated, shows some of Gustav Zédé's preliminary thinking on submarine design, which was not to bear fruit until his GYMNOTE two decades later. According to Jerry Pavano, writing in the Sub Committee Report for December 2000, Zédé constructed this interesting little 6-inch model *in collaboration with Jules Verne* in 1868. If the date, a year before Verne wrote *20TL*, is accurate, this model is doubtlessly the prototype for NAUTILUS and there is a direct link to Zede's GYMNOTE of 1888. Although the actual boat being modelled would be considerably smaller than NAUTILUS—about 120 feet versus the book's 230 judging from the model's scale—it has the slender spindle tapered cigar shape, the central diving planes, longboat, wheelhouse, lantern, and deck platform of NAUTILUS. The boat is at the aft end of the platform and the lantern is located on a tower just behind the wheelhouse, a layout that is almost identical to that described in *20TL*. The model also has two metal rings on the deck, apparently on the hatch. Aronnax and his companion castaways clung to just such a ring when NAUTILUS' deck, was awash as it got underway early in the novel. There are no side windows on the pilot house, as per the Rioux illustration in the novel, nor is there a ram and the keel is very large relative to the hull.

In 1888, some 20 years afterwards, Zédé built GYMNOTE for the French Navy—65-foot, battery-powered boat capable of 8 knots on the surface but of very restricted range due to the lack of any method for recharging the batteries while at sea. Her naval service was largely limited to experimentation. However, this would appear to be the fruition of the NAUTILUS concept as worked out with the author in 1868. GYMNOTE bears a striking resemblance to the Rioux drawings (in the Paris 1870 edition) and the narrative concept of NAUTILUS as does LE PLONGEUR, which Verne observed at the Paris Exhibition of 1867 and about which had penned some commentary, as well as the scale model.

It seems likely that NAUTILUS had been under design and construction for some time prior to the arrival of the three hapless prisoners, Professor Arronax, his servant Conseil, and the Canadian master harpoonist, Ned Land, in 1867. Although Nemo later turns out to be an Indian prince whose vendetta stems from British slaughter of his family in the Indian Mutiny of 1859, NAUTILUS was completed too late to serve in the Mutiny. If this is true, NAUTILUS was designed to challenge the premier naval power of the world, a *wunderwaffen* which missed the war for which she was built. It's important to bear in mind that, while Nemo used NAUTILUS primarily as his permanent home and a deepwater research platform, he was also eager to attack British warships wherever encountered and assist those groups revolting against tyrannical foreign oppressors, mainly British. We can imagine the frustrating delays he encountered during his shakedown cruise, delays that any high technology engineer goes through during sea trials.

It has been claimed that modern nuclear submarines can outperform Verne's fictional creation. This is a debatable point. Certainly Verne's NAUTILUS is marginally faster than, and can dive a good deal deeper than SEAWOLF/VIRGINIA class attack submarines, if one trusts published statistics. Of course, modern subs are built for stealth first with speed and depth coming in second. Silence was not a major concern for Nemo, working in an era without hydrophones, sonar, or antisubmarine warfare.

NAUTILUS was cigar shaped, 232 feet long with a maximum width of 26 feet (70.7 and 7.9m, respectively). She has a surface area of 6032 square feet, and submerged displaces 1500 tons. She is of an unusual double hull construction: instead of a lightly constructed outer hull for streamlining and a rigid internal pressure bearing hull, her outer hull is pressure bearing. Arronax did not make a mistake here, because he described NAUTILUS bouncing a nine pound cannonball. She probably has no more than one and a half decks. The double hull had tapered ends, as Nemo says to Aronnax, "like your cigar". Nemo mentions the shape had already been adopted in London. This was the time of the Ross Winan *cigar ships*—experimental surface steamers which the Baltimore industrialist tried to sell to the US, British and Russian Navies—and, further, there were already some submarines built to this shape, notably LE

PLONGEUR and Gustave Zédé's model (built with Verne) of a NAUTILUS prototype, GYMNOTE, discussed above.

As Captain Nemo describes it to his tentative passenger, the French naturalist Professor Pierre Arronax, NAUTILUS has two hulls, one interior, one exterior, and they are joined by iron T-bars, which gives the boat a terrific rigidity. Because of this cellular arrangement, it is claimed to have the resistance of a solid block. The plating can't yield; it's self-adhering and not dependent on rivets, though these are used; and the homogeneity of its construction, due to the perfect union of the materials involved, permits it to defy the most violent of seas. Nemo is a bit inconsistent in his description of the hull fabrication: at one point he states it was comprised of flush, *hermetically sealed* steel plates resembling a machine rather than a marine animal, whereas elsewhere he mentions that the plates overlapped, which, along with their protruding rivet heads, gave the appearance of the hide of a large reptile.

In terms of length, NAUTILUS most closely approaches the WWII German Type IX ocean-going U-boats and the modern diesel-electric Kilo Class boats, though the Kilos are quite a bit beamier (by about 6 feet) and more voluminous (double the submerged displacement), a feature of the teardrop shape versus NAUTILUS' spindly cigar configuration.

Verne provides precise data about the forward half of the interior... There was a 7.5-meter (24.75 foot) air reservoir at the very bow. Moving aft, we find Aronnax's cabin (2.5 meters/8.25 feet long), Nemo's cabin (five meters/16.5 feet long). Next was the drawing room/salon/museum, ten meters/33 feet long, six (19.8 feet) wide, and five (16.5 feet) high. This extraordinary room contained an organ, an art collection of great value and very large number of marine specimens. There was also a fountain made from a shell about two meters across. Finally, the salon had two large oval windows protected by sliding panels, shown in the Goff/Disney version as a spirally closing helical shutter. Moving aft, the next room was the library (five meters/16.5 feet long) with 12,000 volumes, followed by the captain's dining room (also five meters/16.5 feet). Both of these rooms were exquisitely furnished. There were watertight bulkheads between the dining room and the library and salon and the captain's cabin.

Near the middle of the boat the description becomes vaguer. Apparently there was a centrally located staircase giving access to the deck platform and to the upper passage to the wheelhouse. There was also a ladder to the longboat, and near this was the divers' airlock used for adaptation and egress. The central section had at least one and possibly two watertight bulkheads. The size of this central section is not given. Moving aft there was a small cabin which Ned Land and Conseil will share (two meters/6.6 feet long), and the galley (three meters/10 feet) located between storerooms. Nearby was a bathroom with hot and cold taps. Next was the crew's berth room (five meters/16.5 feet). There was one more watertight bulkhead and then the engine room, described as at least 20 meters/66 feet long. It had a front part devoted to generating electricity and a rear part with machinery to turn the propeller.

Adding all the figures given accounts for 65 meters/214.5 feet of the boat's total 70-meter/232 foot length perhaps allowing five meters/16.5 feet for the central section enclosing the stairway to the deck.

She has a cruising speed of 30 knots and flank speed of around 45 knots (56 and 83 kph). She refuels once during the book, so her cruising range is probably in excess of 60,000 miles. By way of comparison, the VII C U-boat of World War II had a cruising range of 9000 miles and the SURCOUF submarine cruiser of 1935 could go 10,000 miles between refuelings. Of course the modern SSNs have an unlimited cruising radius, the only constraints being the need to replenish food, water and ammunition not to mention the morale of the crew. Typical patrols run to 90 days.

In the course of the book, NAUTILUS dives to an implausible five miles, although Nemo admits this is an extreme strain he does not care to subject her to for very long. This is about twenty times deeper than modern military subs are designed to reach. Most of the ocean floor is between one and two and a half miles deep; the Mariana Trench is between six and seven miles. Modern deep submersible vessels (DSVs) can reach a depth of over 16,500 feet but these are specially constructed contrivances holding only 3-4 crew members, can stay submerged for only 5-7 hours and need to travel only as far as the nearby mother ship.

NAUTILUS uses ballast tanks. These tanks are emptied by pumps: not pressurized air or the constant volume pumps used by modern subs, but extremely powerful brute strength pressure pumps which would do credit to a fire department. These pumps can be used as water cannon and in fact were the weapon of choice in disabling the pursuing American frigate ABRAHAM LINCOLN.

Let's take a closer look at the techniques for submerging and surfacing. Similar to the approach adopted by subsequent submarine pioneers Simon Lake and Thorsten Nordenfeldt, the basic technique described for submerging NAUTILUS and maintaining a desired operating depth is to flood ballast tanks to establish net neutral buoyancy at the corresponding water density. The main ballast tanks are sized to bring the boat just under the surface when completely filled. For deeper submergence, additional water is introduced into supplementary tanks, which can increase the weight of the submarine by as much as 100 metric tons to match the increasing weight of its displacement with depth. As John Holland later established in his first successful submarine designs, a much more efficient depth-control technique is to establish slightly positive buoyancy and maintain depth using the dynamic forces generated by the boat's forward speed. In fact, *with a view to saving [his] engines,* Captain Nemo also exploits dynamic forces, but only when he wants to take NAUTILUS below 2,000 meters. At that depth, two horizontal hydroplanes mounted at the center of flotation (that is, amidships) are used to angle the boat downward in response to the thrust of the propeller. Within a few decades of the appearance of *20TL*, it had also been realized that stern planes are much more efficient for controlling depth dynamically, but NAUTILUS has no stern planes. In any event, Verne claims extreme depth capabilities for NAUTILUS—Aronnax reports reaching a depth of 16,000 meters (52,500 feet) in the South Atlantic—reflecting a time when it was not yet known that the world ocean reaches a maximum depth of nearly 36,000 feet in the Challenger Deep.

To regain the surface, the ballast tanks are emptied—not by compressed air, but rather by using powerful electric pumps, supposedly capable of working against even the highest back-pressure at the prodigious depths envisioned by Verne. . .

Aronnax even describes what we would call today an *emergency surface blow*:

> *NAUTILUS rose with terrific speed, like a balloon shooting into the sky. Vibrating sonorously, it knifed up through those waters. We could see nothing at all. In four minutes we traveled those four leagues between the bottom and the surface. After emerging into the air like a flying fish, NAUTILUS falls back into the water, making it leap like a fountain to a prodigious height.*

The projected speed of this emergency ascent is an incredible 120 miles per hour.... Quite impossible even today.

She can remain submerged for 24 hours comfortably, and can extend this by 48 hours with reserve tanks. Electrolysis of oxygen from sea water is mentioned, but is not used because NAUTILUS does not have scrubbers to remove carbon dioxide from the air.

NAUTILUS ' crew wear heavy sweaters and sealskin caps: it's probably cold aboard, and her heaters don't do a very good job at keeping out the chill of the depths. Arronax doesn't mention feeling unusually cold, nor does he describe condensation on the metal walls. Warmth is all relative in the epoch before forced air home furnaces and it is likely that the boat was no chillier than a comfortable Victorian manor house. It goes without saying that there was no air-conditioning, but presumably there was adequate ventilation to keep the air circulating in the crew and passenger spaces.

Arronax doesn't mention sonar or periscopes. Instead, NAUTILUS has a dorsal mounted searchlight and pilot box, which are retracted into the hull when she is planning to attack. At battle stations, NAUTILUS is blind. She must have utilized some primitive form of directional hydrophones so a target ship can be rammed, though Verne is vague here. .

Arronax specifies her diving planes are amidships, where we would now consider the worst possible place. Clearly, NAUTILUS was intended to maintain a constant trim even while diving or surfacing. This position for the diving planes has long been believed to be contrary to the proper placement of these planes, in accordance with the modern science of fluid dynamics as applied to submarine design. However, note that modern attack subs have reverted to

placing the diving planes near the longitudinal center line, either on the conning tower/sail, or the hull.

The clutter described in her 12,000 volume library wouldn't survive many extreme attitude changes, or a ram. The library must be kept in bookcases or shelves with bars to lock the volumes in place. His art must be securely fastened to the walls. Loose books or maps would become projectiles in bad weather. The lavish Victorian furnishings must be fastened down to prevent careening across the decks.

NAUTILUS as described would have a tendency to pitch while submerged and roll while surfaced. Sharklike, she would have to maintain a fairly high speed to keep any control at all. She probably has trim cells in the extreme bow and stern. Of course, she was a high technology prototype and major design flaws are credible.

On the surface NAUTILUS remained 90% underwater so that its platform was 0.8 meter, or roughly 2 feet, 8 inches, above the water. The platform had a structure of *medium height* with inclined sides, at each end.

NAUTILUS carries a pinnace, a large sailboat encased in a depression in the hull, with a telegraph wire connecting her to NAUTILUS. This wire would break if stretched too far. Its length is not mentioned, but it is likely ½ to 1 mile—more would be cumbersome and that length would suffice for shore excursions or investigations of phenomena on the high seas. When Nemo is out on the pinnace and wishes to board NAUTILUS, he signals the sub to come to him. The pinnace is entered from below by means of an airlock; thus it can be utilized while NAUTILUS is submerged as it is a little submarine in its own right. The narrative indicates that it is solely oar-powered.

Despite some fanciful modern explanations of her power plant, Verne's NAUTILUS was not nuclear; this was not on the horizon as a possibility in the 1860s. When Nemo was asked about her engines, he replied they were electric: this is obvious obscuration on his part. Electricity is a means by which energy can be transmitted, not generated.

Nemo never did describe NAUTILUS 's engines in detail, but he may have let the secret slip accidentally. At one point during M. Arronax's stay, NAUTILUS refuels with sodium. If sodium mixes

with water, it generates heat, and then decomposes the water into oxygen and hydrogen, which recombine violently. The reaction does not require atmospheric oxygen, and could theoretically be used to power a submarine.

> *"You see," said the Captain, "I use Bunsen's contrivances, not Ruhmkorff's. Those would not have been powerful enough. Bunsen's are fewer in number, but strong and large, which experience proves to be the best. The electricity produced passes forward, where it works, by electro-magnets of great size, on a system of levers and cog-wheels that transmit the movement to the axle of the screw. This one, the diameter of which is nineteen feet, and the thread twenty-three feet, performs about 120 revolutions in a second." And what do you get then? "A speed of fifty miles an hour."*

What did these contrivances consist of? Oddly enough, Verne eschewed the rotary electric devices of his time. Already, in 1825, English scientist Michael Faraday had established the principle of the rotating motor, and an American blacksmith, Thomas Davenport, had patented a direct-current (DC) motor with all its essentials—rotating coils, a commutator, and brushes—in 1837. Yet, despite the fact that several motor-driven electric vehicles had been demonstrated in both Europe and America by the 1850s, Verne's theoretical pattern for the prime mover on NAUTILUS turns out to be the electrical analog of a reciprocating steam engine, *where large electromagnets actuate a system of levers and gears that transmit the power to the propeller shaft*. So, in spite of the fact that only a rotating motor could transmit the projected high torque required to twirl the massive propeller at a sufficient speed to shoot the boat along at 45 knots, the main engine seems to be mechanically equivalent to a steam engine with *large electromagnets* replacing conventional pistons. This is an option that seems peculiarly conservative in light of Verne's technological erudition.

In contrast, the *breakthrough* that enables Nemo to generate virtually unlimited electrical power extrapolates electrical science so far into the future that only the willing suspension of disbelief keeps technically-astute readers onboard. Thus, although, as noted above,

some impulsive commentators have mistakenly represented NAUTILUS as *nuclear-powered*, the actual source of her vast reserves of electricity is described as a hugely scaled-up amplification of a well-known 19th-century primary battery, the Bunsen cell. Invented in 1841 by German physicist Robert Bunsen—better known for devising the Bunsen burner—the Bunsen cell uses a carbon cathode in nitric acid and a zinc anode in dilute sulfuric acid, with a porous separator between the liquids. The device generates a potential of 1.89 volts, and later versions added potassium dichromate as a deplarizer. Here is Captain Nemo describing his fundamental modification:

> *Mixed with mercury, sodium forms an amalgam that takes the place of zinc in Bunsen batteries. The mercury is never consumed, only the sodium is used up, and the sea resupplies me with that. Moreover, I can tell you, sodium batteries are more powerful. Their electric motive [sic] force is twice that of zinc batteries.*

Had this actually been tried, the reaction of metallic sodium with sulfuric acid would have been terrifying to behold.

Despite some ambiguity in Verne's description, it also appears that the relatively low voltage of the Bunsen cells is augmented to a more useful intensity using a double-wound variant of the induction (i.e., spark) coil invented in Paris by another German, Heinrich Ruhmkorff around 1850. This same combination of a sodium-based Bunsen cell, probably some kind of periodic interrupter, and a Ruhmkorff coil is described later in the novel as a high-voltage power source for portable undersea lights. Ultimately, Nemo replenishes his sodium supply by distilling seawater and separating out its mineral components at a secret operating base located inside the crater of a volcanic island near the Canary Islands. The energy for this process is derived by burning sea coal, which he and his men mine from the ocean bottom.

A French Verne enthusiast, Jean-Pierre Bouvet, has some very intriguing and convincing descriptions of the likely propulsion machinery employed by NAUTILUS. He has kindly allowed me to

make use of his explanations and his diagrams of the engine room from his web site as reproduced by Michael Crisafulli's excellent web pages detailing all aspects of likely and conjectural NAUTILUS renderings.

Jene-Pierre depicted two different stylizations of the Nautilus engine.

The first one is *crab-like* and was inspired by a little electric engine Jean-Pierre saw in the *Arts et Mètiers* museum in the 1980's. He fashioned a little *cartoon* of its principle of operation. The animation demonstrates only about one quarter of the whole engine described by Verne. As the artist/creator describes it:

> *On the main axis there is a second three armed wheel in phase opposition to the first. Each wheel is moved by a pair of crab hooks, each pair moved by two pairs of electromagnets, switched by an electric inverter inspired by the tiroir of steam engines.*

The second version appears more like the steam engines of the period, and is easier to grasp. Again, here is M. Bouvet:

> *The upper part is inspired by the "électromoteur à coin à aimants fixes de Dumoulin-Froment" [Square electric motor with corners having fixed Dumoulin-Froment magnets, circa 1847]. The lower part, my own, uses clockwork cog-wheels just as in the Rioux engraving. Each tooth of the wheels, slightly advanced, matches the maximum power of attraction of each pair of electromagnets. The lateral flywheels smooth the motion through the un-powered part of the stroke.*

At 1500 tons, NAUTILUS was a large and comfortable vessel; she probably had a crew of about twenty—the maximum number observed by Arronax at any one time. Twenty seems adequate to the task of running the sub, being as there are no sophisticated armaments requiring anyone dedicated to that assignment and the engine room and navigational tasks could easily be handled by a score of men, working in three eight-hour watches. The allotted crew space,

which presumably includes a mess, as there is no mention of crew sharing Nemo's sumptuous dining room, would be quite cramped if the crew were much above 20. Jean-Pierre Bouvet has sketched a convincing plan view of the likely crew quarters…the four-stack-rack arrangement, similar to LOS ANGELES and SEA WOLF SSNs, eliminates the need for hot-bunking and also permits a mess table in the center of the compartment,

How does NAUTILUS function as a warship? After all, Nemo is intent upon attacking the warships of the *civilized world* especially those of his *bete noir*, Great Britain.

In its role as a combatant, NAUTILUS functions primarily as a high-speed ram, (contemporary practice revived this relic of the Greco-Roman trireme) and for this purpose, its bow narrows finely to a reinforced steel point, triangular in cross section. In one harrowing chapter, near the end of the adventure, Professor Aronnax describes its effectiveness in destroying a warship—presumably British. Verne traces the action from initial detection and sparring for position, through *clearing for action* by retracting the pilothouse and searchlight to produce a smooth, projectile-like shape, diving the boat, running up to speed on a broadside collision course; and passing right through the victim *like a sailmaker's needle through canvas!* None of the ill fated British crew survive the attack.

There is some inconsistency in describing the method of attack for in some instances, reported at the beginning of the novel, notably the attack on SCOTIA, it appears that merely the steel spar at the bow was used to puncture the ship, (rather than the entire vessel) the submarine withdrawing to extract this large harpoon, leaving a triangular puncture about two meters wide. Some have proposed a spar that retracts within the hull to avoid the need to reverse engines, but this would take up valuable space inside the sub.

From its encounter with USS ABRAHAM LINCOLN, we can also infer that the submarine's powerful ballast pumps can also be used as water cannon when *non-lethal force* is called for, but except for a substantial arsenal of unique small arms, NAUTILUS carries no other weapons. Nemo and his crew use highly advanced air rifles for hunting and self-defense both on land and underwater. These versatile guns are charged from portable compressed air tanks but instead of shooting conventional solid bullets, they launch small

glass capsules, which are sheathed in steel and weighted with lead. They are veritable little Leyden jars charged with high-voltage electricity. At the slightest impact they discharge, and the animal, no matter how large or strong, falls dead.

Unfortunately, this novel technique of shooting what amounts to charged capacitors as bullets falls short in NAUTILUS's celebrated encounter with a school of giant squid, because the projectiles pass right through the animals' soft bodies without activating. Thus, Nemo's crew and their *passengers* are reduced to hand-to-hand combat with the monsters, but that only makes for a more exciting story in which Ned Land can exhibit his prowess with the harpoon. In order to repel boarders, in the form of some inquisitive, and apparently hostile, natives of a South Seas island, Nemo resorts to sending a strong, but non-lethal electric charge through the hull plating.

The pilot-house is said to retract, and this is presumably for the purpose of streamlining while the sub is punching its way through the hull of its surface victims. Verne may have been aware of some experimental periscopes of his day, but none of these were adapted to maritime ventures and it apparently did not occur to him to use this device in lieu of the raised wheel-house prism-like viewports. Oddly, this method would have made no sense while operating submerged as there was really little Nemo needed to *see* under the waves that might collide with NAUTILUS or at least cause it any harm. Only a sense of direction, speed and angle of inclination would be required to navigate underwater and the instruments available in 1870 would be sufficient for this purpose.

NAUTILUS was so far ahead of its time, that even the World War II heyday of the U-boat and the US fleet subs of the GATO class were far inferior....they were really simply *diving boats* being compelled to spend most of their time on the surface, and limited to submerged operations only during the attack phase—towards the end with some snorkelling capability. We have to await the onset of SSN NAUTILUS in 1955 to arrive at the true submarine boat capable of sustained undersea long-range cruising, the duration only being limited by the need to replenish food and water supplies.... not to mention to avoid crew mutiny. But the nuke subs weren't to approach Nemo's NAUTILUS in performance until the advent of the

SSN SEAWOLF/VIRGINIA class attack subs from the end of the 20th and beginning of the 21st century. These boats, in contrast to NAUTILUS slender tapered cigar, have a blunter, more tear-drop shape, adopted to maximize stability and smooth passage at depth.

SEAWOLF's submerged flank speed of 35+ knots matches that of NAUTILUS as does her surface speed of 25 knots. Note that unlike NAUTILUS, which did not have to contend with underwater detection devices or other submarines, SEAWOLF/VIRGINIA class must be stealthy—that is silent—which tends to reduce maximum *tactical* speed.

Of course the modern US subs are quite a bit larger, at 350 x 40 feet and 7,500 tons submerged displacement, than the 230 x 26 foot, 1500 ton NAUTILUS, but the length/beam ratios at roughly 8.8 are almost identical. However the bulkier silhouette of SEAWOLFs allow for a greater interior volume, which is quite necessary given the large weapons array and navigational equipment, something that NAUTILUS didn't have to worry about, even allowing for her elaborately plush Victorian furnishings and sumptuous accommodations. SEAWOLF's 133 officers and men were allotted roughly the same space as NAUTILUS crew had. However, SEAWOLF's officers' quarters and wardroom, while roomier than the four-stack berths in three man bays of the crew, fall far short of NAUTILUS salon, library, dining room as well as her captain's and guest cabins.

The maximum depth allotted to NAUTILUS, at an impossible 56,000 feet, was rarely and perilously achieved in the novel. It seems the actual maximum operational depth was more like 6000 feet. Given the steel shipbuilding capabilities of Verne's period, and the proven record of nearly contemporary subs, 200 feet would be more likely. Nonetheless, the 6,000 feet has only been exceeded today by *deep submergence vessels*, such as US ALVIN, the French NAUTILE, the Russian MIR and the Japanese SHINKAI 6500. These vessels are not built to journey underwater, only to dive, operating from a mother ship and limited to about three or four navigators/researchers for periods of three to six hours.

SEAWOLF/VIRGINIA can be operated at depths very much like NAUTILUS nominal maximum depth, allowing Verne some slack. While the steelmaking and structural capabilities of his day were not up to the task, Verne's description of the hull plate arrangement

indicates that some analogue to the modern flexible high tensile steel shell is possible.

In 1898, upon learning of the unprecedented open ocean voyage of some 500 miles (Norfolk, VA to Sandy Hook, NJ) of Simon Lake's ARGONAUT II, Verne cabled his congratulations. His cablegram portended a prophecy fulfilled for the commanders of the new SEAWOLF and VIRGINIA subs a century later,

> *"While my book, Twenty Thousand Leagues Under the Sea is entirely a work of imagination, my conviction is that all I said in it will come to pass. A thousand miles (Verne exaggerated the distance by 100%) in the Baltimore submarine boat is evidence of this. This conspicuous success of submarine navigation in the United States will push on underwater navigation all over the world. If such a successful test had come a few months earlier, it might have played a great part in the war just closed (The Spanish-American War). The next Great War may largely be a contest between submarine boats. I think that electricity rather than compressed air will be the motive power in such vessels for the sea is full of this element. It is waiting to be harnessed, as steam has been. It will then not be necessary to go to the land for fuel any more than for provisions. The sea will supply food for man and power without limit. Submarine navigation is now ahead of aerial navigation and will advance much faster from now on. Before the United States gains her full development she is likely to have mighty navies not only on the bosom of the Atlantic and Pacific, but in the upper air and beneath the water's surface."*

In June, 1904, less than a year prior to Verne's death, there appeared in Popular Mechanics an article signed by Verne, which was at first attributed to his son, but more recent scholarship believes that the senior Verne wrote it himself. In the article Verne predicted how the submarine would be used in the future. By that time Verne was known and loved worldwide as the author of futuristic adventure stories filled with technical details that made them seem possible.

His *20TL* inspired a number of submarine pioneers, notably Simon Lake and John Holland.

In Verne's imagination, the submarine served as a comfortable home, a research lab and a deadly war machine all in one. And since many of his books had accurately foreshadowed later technical developments, it's no wonder PM turned to Verne to write *Future of the Submarine*.

Undersea vessels were a topic of great interest at the dawn of the 20th century. Though more frail than today's vessels, a torpedo-equipped submarine was a real threat to surface ships by the late 1890s. By 1900, the Navies of several nations had ordered them.

By the time Verne's article appeared in PM, submarines were seeing combat duty in the Russo-Japanese war. And the British had developed some cumbersome but occasionally effective counter-measures—basically just weighted nets, hung from booms around a ship—that could intercept the relatively feeble torpedoes.

Verne noted the submarine's capabilities to cripple and sink surface vessels revealed in the British and French fleet maneuvers of 1902 and 1903.

In his article, Verne predicted the submarine would be used purely as an instrument of war. *The future of the submarine, as I regard it ... is to be wholly a war future*, he wrote. *I do not believe that under-sea ships will be built in future years to carry traffic across the ocean's bed to America and to Australia.*

He dismissed the possibility of an underwater ocean liner for several reasons. Among them were the problems of carrying enough air for a large number of passengers, the generation of sufficient electricity, and the difficulty of constructing a vessel that could withstand pressure at a significant depth.

Despite his prediction that it would be used wholly for war, Verne hoped the submarine would eventually lead to the end of war. *Fleets will become useless, and as other war material continues to improve, war will become impossible*, he wrote.

While Verne's predictions in PM may have seemed possible at the time, it is easy today to see where he was on, and slightly off, target.

In the future they will be smaller than they are today, and manned by one or two men only," Verne wrote. He surmised

that submarines "will be able with scientific accuracy to place torpedoes underneath the greatest vessels, and to blow those vessels up.

One has only to take a look at the secretive development and recent energetic marketing of mini-subs to Middle Eastern and Asian countries. Germany and Russia lead the field in developing the minis, the Russian PIRANHA most notable among them.

What about future submarine countermeasures? Here, even Verne's great imagination floundered. *The sea is hard to pierce, and I can think of nothing ... which will enable men on board the supermare vessels to trace the tracks of their deadly little foes beneath the waves.*

Like most of his contemporaries, he didn't foresee the rise of radar and other means of detection. Nor could he anticipate the eventual use of nuclear power, which gave submarines much greater range and capability—although, as discussed above, Verne did hint at a new kind of power. As Capt. Nemo said, "My electricity isn't like everyone else's." And neither was the electricity generated by America's first nuclear submarine, USS NAUTILUS of 1955, specifically named after Verne's prophetic original.■

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CROATIA: A SOURCE OF SUBMARINES FOR TAIWAN

by Dr. Lajos F. Szászdi

Lajos F. Szászdi last year obtained his Ph.D. in World Politics at the Catholic University of America. His father is of Hungarian descent and his mother from Ecuador, both of whom are historians. Born in Puerto Rico, Dr. Szászdi is a student of sea power and naval history, and of submarines in particular. He has been attending the League's annual symposiums since 1995.

This study will consider the potential of the Republic of Croatia as a builder of modern diesel-electric submarines, and thus as a possible source of conventional submarines for Taiwan. As a background to the case, on April 24, 2001, President George W. Bush pledged U.S. assistance to Taiwan in the acquisition of eight new diesel-electric submarines (SSK).[1] However, due largely to the threat of commercial reprisals by China, the main Western builders of conventional submarines in the international arms market; that is, Germany, France and Spain, Sweden, and the Netherlands have all refused to make SSKs for the Taiwanese.[2] Presumably, Italy would have adopted the same policy posture. Another major builder of conventional submarines, Russia, would not sell its underwater warships to the island-state because of its strategic partnership with China, and since Moscow is an important supplier of submarines and submarine technology to the Chinese People's Liberation Army/Navy (PLAN).

The building of conventional submarines in the U.S. for Taiwan is riddled with difficulties. According to Wendell Minnick of *Jane's Defence Weekly*, writing in the summer of 2005: "US defence officials told *JDW* that the DoD is increasingly reluctant to provide SSKs due to opposition within the US Navy and the simple fact that the US no longer builds that type of submarine. 'The costs of such a project would be staggering,' said one US defence official."[3] More recently, Taiwan's accusations that the U.S. Navy's opposition to domestic construction in the U.S. of conventional submarines is preventing the program from materializing have again resurfaced. This claim was confirmed by an informed U.S. source that told *JDW*:

> Bottom line is that the initiation of the Taiwan submarine programme has tremendous implications for the US Navy: once it gets going, they will not be able to resist the already-existing pressure to integrate diesels with AIP (air independent propulsion) into the navy inventory for littoral warfare. So they have been artful in making it seem like they have supported the President's policy, yet purposely making it such a bitter pill to shallow (sic) – what I call "death by bureaucracy."[4]

The estimated cost of the program to construct the 8 submarines in the U.S. is indeed staggering. According to the U.S. Navy's Independent Cost Estimate (ICE), it would be between $9.4 billion and $11.7 billion, of which $5.3 billion would be the cost to build the vessels. Reasons claimed by members of the Taiwanese legislature for its repeated rejection of the Special Budget proposed to acquire the SSKs are the huge expenses of the project and the idea of funding submarines whose design has not been chosen yet.[5]

It has been suggested also that the U.S. could build conventional submarines based on its last diesel-electric design of the Barbel class, developed in the mid 1950s.[6] U.S.-made conventional submarines possibly would have been built at Ingalls Shipbuilding in Pascagoula, Mississippi, as this shipyard was chosen to build for Egypt at least 2 submarines of the Dutch Moray 1400 class.[7] However, the construction of the Egyptian submarines did not materialize after apparently being made contingent on the building of the 8 SSKs for Taiwan.[8] The building of diesel-electric submarines for Egypt and Taiwan at Ingalls Shipbuilding would have made this shipyard a serious competitor to the last two remaining yards building nuclear-powered submarines in the United States: Electric Boat in Groton, Connecticut, and Newport News in Virginia. The production of conventional submarines for export could open the door for future orders of this type of vessel for the U.S. Navy, under the claim that since SSKs are less expensive to build and operate than nuclear-powered attack submarines (SSN), more conventional submarines can be acquired for the price of a nuclear-powered vessel, thus threatening the number of future SSNs that could be procured and produced at Groton and Newport News. Such a

scenario could lead to the loss of the underwater naval supremacy currently enjoyed by the U.S. Navy thanks to its all nuclear-powered submarine fleet. It could also lead to the loss of jobs in Newport News and in Groton, if projected numbers of SSNs that could have been built at these two yards are cut back in favor of production elsewhere in the U.S. of conventional submarines for the Navy.

With regard to the option of building diesel-electric submarines in Taiwan, Commodore Saunders of the Royal Navy wrote that "this would present a considerable industrial challenge and almost certainly involve some form of technology transfer."[9] Indeed, the design and construction costs of SSKs in Formosa would be immense.

Thus, the main builders of diesel-electric submarines in the world are unwilling to construct such type of combat vessels for Taiwan. In addition, it would be very costly to resurrect in the U.S. its erstwhile expertise and capability to build conventional submarines, as it would be for Taiwan to create from scratch this genre of shipbuilding industry. Moreover, there is strong opposition inside the Navy, and probably in Congress also, for the idea of constructing diesel-electric submarines in the U.S. One consideration that remains unchanged, however, is the fact that Taiwan needs at least the proposed 8 SSKs to be able to confront with some degree of success, in case of conflict with its western neighbor, the current numerical superiority in submarines and surface combatants of China, and the challenges that in the future will be posed by a more capable and modern PLAN submarine fleet. Moreover, a larger Taiwanese Submarine Force of 8 new submarines plus the two it already has could bear some of the brunt of the fighting in the shallower waters of the Taiwan Straits, thus perhaps reducing the number of U.S. Navy units (and consequently freeing them for other missions) that would otherwise be required to defend the island-state. Croatia is thus proposed as an alternative source of conventional submarines for Taiwan, provided, of course, that the Croatian government would be willing to participate in such a plan.

Croatia has a long tradition in naval shipbuilding firmly established during the times of Austria-Hungary, constructing then in addition to surface combatants, submarines for the Austro-Hungarian Navy at the shipyards of Pola (Pula) and Fiume (Rijeka).[10] After the

Second World War, design and construction of diesel-electric submarines for the Yugoslav Navy resumed in Croatia first at Pula, and then at Split (Spalato) for the last twenty-five years or so of Yugoslavia.

Brodarski Institute

The Brodarski Institute of Zagreb is Croatia's foremost *research and development organization*, which, according to *Naval Forces*, "remains holder of technical developments of naval vessels and submarines."[11] According to the institute's website:

> Our teams design vessels with a high standard of interior design, develop maneuvering systems and test them in in-house hydrodynamic laboratories or in full scale: . . . special purpose vessels (patrol craft, naval vessels and submarines).
>
> Our specialists have long-standing experience in development, design and manufacture of underwater technology systems and equipment (underwater vehicles, integrated underwater sensors, control and guiding systems).[12]

Brodarski Institute designed the submarines of the Heroj and Sava classes and the midget submarines (SSM) of the Una and Modified Una classes.[13]

Brodosplit Shipyard

The Brodosplit Naval & Special Vessel Shipyard or Brodosplit-BSO is located at the Adriatic port of Split on the coast of Dalmatia, and it is a subsidiary of Brodosplit Shipyard, which belongs to the Croatian Shipbuilding Corporation. The Croatian state in turn controls a majority stake in the Croatian Shipbuilding Corporation.[14] According to the web page of Brodosplit-BSO:

> Over three decades of tradition in building sophisticated warships, submarines and special naval vessels gave to the Shipyard an outstanding position among the Croatian shipyards and among very few of such specialized shipyards at the international level.

The great advantage of Shipyard is shipway hall for constructing ships up to 60 m length.

BRODOSPLIT-BSO, d.o.o. is comprehensively equipped to design, construct, equip and test large scale of vessels and constructions represented by the following programs:

Naval program: conventional submarines, midget submarines, frigates, patrol boats, logistic support vessels...

Having experience with various Navies, specially with Croatian Navy expert teams of Shipyard are ready to give full after delivery support for maintenance, over-haul, training, marine support equipment, logistics. . . .

High strength steel construction program: off-shore structures, tanks for LPG [Liquified Petroleum Gas, Pressurized Gas], pipelines...

New projects: being experts in submarine technology. . . .[15]

It would appear from this description of capabilities that, since the collapse of Yugoslavia, Brodosplit-BSO has retained the know-how and maintained the infrastructure to design and build diesel-electric submarines. Tellingly, its advertising of the ability to construct with high strength steel would suggest that this shipyard can build pressure hulls for submarines, as when Brodosplit built conventional submarines for the Yugoslav Navy.

The last two diesel-electric submarines built for Yugoslavia, of the Sava class, were constructed in Brodosplit, with the SAVA entering service in 1978 and the DRAVA in 1982.[16] The pressure hull of the Sava class was reportedly made of steel with a strength of 56 kg/cm^2 that enabled the submarines to reach a diving depth limit of 300 meters. It was also reported that the outer hull of SAVA and DRAVA was made of glass-reinforced plastic.[17] With a crew of between 27 and 35, the SAVA class was said to enjoy a "high degree of automation."[18] It had a displacement of 770 tons surfaced and of 964 tons submerged, an underwater speed of 16 kts, a length of 55.8 meters and a beam of 7.2 meters, and was armed with six 21 inch (533 mm) torpedo tubes (TT) in the bow. The Sava class submarines each carried 10 torpedoes, including Swedish Tp 61 wire-guided torpedoes, or up to 20 sea mines.[19]

Sava's had a length-to-beam ratio of 7.75, which compares favorably to the length/beam ratio of 10 of the Chinese Ming class of diesel-electric submarines, of 8.9 of the Song class or of 9.7 of the future Chinese Project 093 nuclear-powered attack submarine class.[20] A submarine with a shorter length/beam ratio might be more maneuverable than another with a greater ratio, particularly in the shallower depths of littoral waters.

The Sava class was preceded by the 3 diesel-electric submarines of the Heroj class, of which the second, named Junak, was constructed in Brodosplit, entering service in 1969. The Heroj class submarines had a displacement of 1,068 tons standard, 1,170 tons surfaced and 1,350 tons submerged, a length of 64.0 meters and a width of 7.2 meters.[21] Based on these data, it can be inferred that the shipbuilding hall of Brodosplit-BSO can build a ship 64 meters long, slightly more than the reported limit of 60 meters in length for vessels constructed there as advertised for this shipyard in the Croatian Shipbuilding Corporation's website.

Before the collapse of Yugoslavia in 1991, an improved version of the Sava class was reportedly under construction, allegedly since 1986 until the cancellation of the program. Identified as the Lora class, the new SSK would have possessed a displacement of 900 tons and would have had the capability of deploying to the Mediterranean Sea.[22]

The SS 580 Barbel's Design

As suggested above, the proposed 8 SSKs for Taiwan can be based on the design of the last class of diesel-electric submarines built for the U.S. Navy, the Barbel class, and these could be built in Brodosplit-SBO. The hull of the BARBEL was built following the innovative teardrop design of the experimental submarine ALBACORE. Commissioned in 1959, it could reach an underwater speed of 25 kts, in great measure thanks to the streamlined design of its teardrop hull.[23] BARBEL had a standard displacement of 1,740 tons, 2,146 tons surfaced and 2,640 tons submerged. It had a length of 66.75 meters, a beam of 8.84 meters, and was armed with six 21in TT.[24] The submarine's successful design was adopted by the Netherlands and Japan,[25] with the Dutch Zwaardvis class of SSKs having been inspired by it,[26] and according to naval analyst Norman

Friedman, "modern Japanese submarines . . . are essentially *Barbels*."[27] So are also the two Dutch-built SSKs of Taiwan of the Sea Dragon or Hai Lung class; according to Combat Fleets of the World, these submarines' "design . . . is based closely on that of the Dutch Zwaardvis class."[28] There is also a close resemblance in terms of tonnage, with HAI LUNG's maximum submerged displacement being 2,657 tons compared to the 2,640 tons of BARBEL's submerged displacement. Moreover, HAI LUNG has a length of 66.92 meters and a beam of 8.40 meters compared to the length of 66.75 meters and beam of 8.84 meters of BARBEL.[29] Thus, the length-to-beam ratio of HAI LUNG is 7.96, compared to that of 7.55 of BARBEL. As a matter for comparison, SAVA submarines had a length/beam ratio of 7.75, while the length/beam ratio of the proposed Dutch design for the Moray 1400 type of diesel-electric submarines would be 8.95 in its basic version. The dimensions of the basic Moray 1400 are 57.3 meters in length and 6.4 meters of beam, with a displacement of 1,430 tons surfaced and 1,595 tons submerged.[30]

Proposals

Diesel-electric submarines built in Croatia, funded by Foreign Military Sales (FMS), can be fitted with U.S. made equipment such as sensors, weapons, the combat management system, and propulsion plant. The venture with the Croatian shipyard would have a U.S. defense corporation as major systems integrator for the submarines, having the potential to become as successful as the partnership between Lockheed-Martin and the Spanish shipyard Izar (now Navantia) for the building of AEGIS-type frigates and corvettes. This partnership has enabled Lockheed Martin to enter successfully into the very competitive European market for guided-missile frigates. Likewise, a partnership with the Croatian shipbuilder could allow a U.S. defense corporation selected to be the submarines' main systems integrator entry into the exclusive international market of conventional submarines, dominated now by Germany, France-Spain, Russia, and Sweden (Swedish submarine builder Kockums is owned by Howaldtswerke Deutsche Werft of the new group ThyssenKrupp Marine Systems[31]).

For example, the submarines for Taiwan can be equipped with the SUBICS 900 fully integrated sensor, command and weapons control system produced by Lockheed Martin. The SUBICS 900 was also chosen for the diesel-electric submarines that were to have been built by Ingalls Shipbuilding for Egypt. Lockheed Martin Naval Electronics and Surveillance Systems would have been the main systems integrator for the U.S. built Egyptian submarines.[32] The submarines for Taiwan can be armed with the Mk 48 Mod 6 ADCAP torpedo by Raytheon, and can carry the Improved Submarine-Launched Mobile Mine (ISLMM), also produced by Raytheon, and which were to be one of the weapon systems carried by Collins class of Australian submarines.[33] Production of conventional submarines in Croatia, with a U.S. contractor as main systems integrator, could lead after a successful Taiwanese order to further orders from friends and allies of the U.S., with Egypt being one potential customer.

Midget Submarines

RH-ALAN-Brodosplit in Split, Croatia, built the Una class of midget submarines for the Yugoslav Navy, having developed an improved version for the Croatian Navy, the VELEBIT of the Modified Una class (M-100D class). With 88 tons surfaced and 99 tons submerged, VELEBIT has a length of 20.92 meters and a beam of 2.70 meters, with a length-to-beam ratio of 7.74. It has an endurance of 7 days, and a range of 500 nautical miles at 8 kts with snorkel and of 135 nm at 3 kts submerged (Brodarski Institute gives the vessel a range and autonomy of 250 nm at 4 kts). It can operate normally at a depth of 105 meters, with a *test depth* of 120 meters, and an approximate crush depth of 182 meters. VELEBIT can technically remain submerged for up to 96 hours, and it has an X-plane control surface at the stern that enables the midget submarine to remain at the bottom in a more stable fashion. It has a lock in/lock out chamber and can carry 6 swimmers in addition to the crew of 4-6. The vessel can be armed with 2 torpedoes or carry 4 heavy seabed mines or 6 500 kg seabed mines. The SSM can also take externally 4 Swimmer Delivery Vehicles (SDV) with limpet mines.[34] In addition, Croatia is planning a bigger design of midget submarines, with 120 tons displacement, and which will be armed with four 21 in TT and could carry 4 SDVs.[35]

In addition to the 8 diesel-electric submarines, it is proposed that Taiwan could acquire midget submarines for the defense of the coastal waters of Formosa and of its various insular territories. The range of the Croatian SSMs, for instance, could enable such boats to reach on their own the islands of Quemoy and Matsu. Midget submarines could be ideal weapons against amphibious warfare ships participating in an invasion of Taiwan's island dependencies. It must also be mentioned that overall, the shallow waters of the Taiwan Straits are more suitable for not-too-large submarines to operate, with depths ranging from 13 to 37 meters in waters close to Formosa's western coastline, from 11 to 38 meters in the area of the Taiwan Banks, from 129 to 172 meters in the Strait of Pescadores separating Pescadores Islands from Formosa, and from 21 to 96 meters in the Taiwan Straits proper. South of Formosa, the seabed plunges to deeper waters as on the eastern side of the island-state.[36]

Incentives

Some incentives for the Croatian government to participate in the building program of 8 submarines for Taiwan could be:

1. Croatia could acquire (if interested) 2 or 3 diesel-electric submarines of the same type as the ones sold to Taiwan, paid by FMS.
2. Participation in the project will create jobs in Croatia.
3. It would restart Croatia's conventional submarine industry, and in cooperation with a U.S. defense corporation could become a major competitor in the international diesel-electric submarines market by building submarines for U.S. allies worldwide.
4. The United States could back Croatia's early entry into NATO and give diplomatic support in other spheres sensitive to Croatia.

ENDNOTES

1. A.D. Baker III, comp., *The Naval Institute Guide to Combat Fleets of the World 2002-2003. Their Ships, Aircraft, and Systems* (Annapolis, Md.: Naval Institute Press, 2002), 785.
2. Ibid.
3. Wendell Minnick, "Taipei embroiled in defence budget row," *Jane's Defence Weekly* 42, no. 22(1 June 2005): 17.

4. Wendell Minnick, "Taiwan claims US Navy is sabotaging SSK plans," *Jane's Defence Weekly* 43, no. 7 (15 February 2006): 5.
5. Ibid.
6. Stephen Saunders, *Fighting Ships Executive Summary 2004-2005*, 7, supplement of *Jane's Navy International*; Norman Friedman, *U.S. Submarines Since 1945: An Illustrated Design History*, with illustrations by James L. Christley (Annapolis, Md.: Naval Institute Press, 1994), 33-34.
7. Baker, 169.
8. "Egypt - German Type 206 Submarines for the Egyptian Navy," *AMI International*, December 2004 [information site on-line]; available from http://www.amiinter.com/wapr/egypt/index.html; Internet; in "Submarine News from Around the Word," *The Submarine Review* (April 2005): 102.
9. Saunders, 7.
10. See Lawrence Sondhaus, *The Naval Policy of Austria-Hungary, 1867-1918: Navalism, Industrial Development, and the Politics of Dualism* (West Lafayette, Ind.: Purdue University Press, 1994), 287-88; *Jane's Fighting Ships of World War I*, with a foreword by John Moore (Jane's Publishing Company, 1919; New York: Military Press, 1990), 228.
11. About Us: Mission and Vision," *Brodarski Institut d.o.o.* [information site on-line]; available from http://www.hrbi.hr/index.php?page=about&id=4; Internet; accessed 28 February 2006; Hartmut Manseck, "The Navies of Bulgaria, Croatia and Romania," *Naval Forces* 25, no. 3 (May-June 2004): 114. Since Croatia's independence, Brodarski Institute has published papers and internal reports dealing with unmanned underwater vehicles (UUV) and submarines. See "Publishing: Papers: Complete texts of papers 2002.-2003.," *Brodarski Institute d.o.o.* [information site on-line; available from http://www.hrbi.hr/index.php?page=publish&id=2&sub_id=11#; Internet; accessed 28 February 2006; "Publishing: Papers: Abstracts of papers 200.-2001.," *Brodarski Institute d.o.o.* [information site on-line]; available from http://www.hrbi.hr/index.php?page=publish&id=2&sub_id=10; Internet; accessed 28 February 2006; "Publishing: Papers: Abstracts of papers 1998.-1999.," *Brodarski Institut d.o.o.* [information site on-line]; available from http://www.hrbi.hr.index.php?page=publish&id==2&sub_id=9; Internet; accessed 28 February 2006; "Publishing: Papers: Abstracts of papers 1996.-1997.," *Brodarski Institut d.o.o.* [information site on-line]; available from http://www.hrbi.hr/index.php?page=publish&id=2&sub_id=8; Internet; accessed 28 February 2006; "Publishing: Papers: Abstracts of papers 1994.," *Brodarski Institut d.o.o.* [information site on-line]; available from http://www.hrbi.hr/index.php?page=publish&id=2&sub_id=6; Internet; accessed 28 February 2006; "Publishing: Papers: Abstracts of papers 1993.," *Brodarski Institut d.o.o.* [information site on-line] available from http://www.hrbi.hr/index.php?page=publish&id=2&sub_id=2; Internet; accessed 28 February 2006.
12. Shipbuilding and Offshore Technologies," *Brodarski Institut d.o.o.*[information site on-line]; available from

http://www.hrbi.hr/index.php?page=banners&bg_id=3; Internet; accessed 28 February 2006.
13. "Vessel Design and Development: References," *Brodarski Institut d.o.o.*[information site on-line]; available from http://www.hrbi.hr/index.php?page=reference2&id=155&sub_id=3&kat_id=2; Internet; accessed 28 February 2006; Manseck, 114.
14. "Brodosplit Naval & Special Vessel Shipyard," Croatian Shipbuilding Corporation [information site on-line]; available from http://www.hb.hr/shipyard_brodosplit_naval.htm; Internet; accessed 13 June 2005; "Introduction," *Croatian Shipbuilding Corporation* [Information site on-line]; available from http://www.hb.hr/introduction.htm; Internet; accessed 13 June 2005.
15. "Brodosplit Naval & Special Vessel Shipyard."
16. Bernard Prézelin, ed., *The Naval Institute Guide to Combat Fleets of the World 1993. Their Ships, Aircraft, and Armament*, ed. English language edition A.D. Baker III (Annapolis, Md.: Naval Institute Press, 1993). 961.
17. Baker, 1098; Conway's All the World's Fighting Ships 1947-1995 (London: Conway Maritime Press, 1995; Annapolis, Md.: Naval Institute Press, 1995), 645; Richard Sharpe, ed., *Jane's Fighting Ships 1990-91*, 93rd ed. (Coulsdon, Surrey: Jane's Information Group, 1990), 822.
18. Conway's All the World's Fighting Ships, 645; Baker, 1098; Sharpe, 822.
19. Baker, 1098.
20. The measurements of the Chinese *Ming, Song*, and Project 093 submarine classes used for the length/diameter calculations are taken from Baker, 110, 108.
21 Prézelin, 961.
22. *Conway's All the World's Fighting Ships*, 5645; Sharpe, 822.
23. *Conway's All the World's Fighting Ships*, 605; Jean Labayle Couhat, ed., *Combat Fleets of the World 1986/87. Their Ships, Aircraft, and Armament*, ed. English language edition A. D. Baker III (London: Arms and Armour Press, 1986), 622).
24. Ibid.
25. Friedman, 33.
26. Labayle Couhat, 622, 344.
27. Friedman, 33.
28. Baker, 786.
29. Ibid., 786; Labayle Couhat, 622.
30. Anthony J. Watts, ed., *Jane's Underwater Warfare Systems 2002-2003*, 14th ed. (Coulsdon, Surrey: Jane's Information Group, 2002), 39.
31. Baker, 761; Martin Driver, "Holding breath on AIP," *Jane's Navy International* 110, no. 5 (June 2005): 20.
32. Baker, 169.
33. Watts, 324-25.
34. Ibid., 30; Baker, 143; "Vessel Design and Development: Swimer (sic) Delivery Vehicle - R - 2M," *Brodarski Institut d.o.o.* [information site on-line]; available from http://www.hrbi.hr/files/File/Projektiranje%20plovnih%20objekata/Built%20objects/sWIMER%20DELIVERY%20VEHICLE%20-%20R%20-%202M.pdf;

Internet; accessed 28 February 2006.
35. Baker, 142.
36. Ministry of Defense, Federation of Russia, "Straits of Taiwan and Luzon," *Atlas of the Oceans: Straits of the World Ocean* (Saint Petersburg: Navy, 1993); 272-73.

ETERNAL PATROL

Mr. Ted Leroy Kellison
CAPT Richard H. Scales, USN(Ret)
CAPT Edward H. Mortimer, III, USN(Ret)
Mr. Robert E. Kuenne
CAPT Walter S. DeLany, Jr., USN(Ret)

TORPEDO TALES (Part2)
A FIRST PERSON ACCOUNT OF
TMC(SS) PATRICK MEAGHER, USN(RET)

TMC(SS) Patrick Meagher USN(RET) qualified and served on USS CUSK SS-348, USS ANDREW JACKSON SSBN-619B, and USS BARBEL SS-580. He served on active duty with the Submarine Force from 1960 through 1977. He is a life member of USSVI and an associate member of USSVWWII. Torpedo Tales (Part 1) appeared in the January 2006 issue of THE SUBMARINE REVIEW.

In 1973 USS BARBEL SS-580 went on a torpedo shooting spree, I don't know any other way to describe it. We started with Prospective Commanding Officer (PCO) operations in January. We loaded and shot around 30 exercise torpedoes. Mostly MK 16 Mod 8's and Mk 37 Mod 2's with a couple of MK 45 Mod 2's thrown in. I've addressed the MK 45 torpedo problem in part 1.

The MK 16 Mod 8 was the final development of the steam torpedo that burned alcohol mixed with water in an oxygen atmosphere in the combustion chamber. The oxygen was contained in concentrated hydrogen peroxide (NAVOL [1]). The oxygen was released by catalytic action in a catalytic chamber connected to the combustion chamber. The left over water was also injected into the combustion chamber to expand and cool the exhaust gas that turned turbine wheels connected to reduction gears which were connected to the propeller shafts. The MK 16 Mod 8 had started life as a MK 16 Mod 6 in the late 40's. The Mod 6 used some component parts from the MK 14 Air-Steam torpedo. The MK 12 torpedo Gyro assembly as well as the tail cone assembly, propellers, stop and charging valve assembly, and starting gear lever assembly. NAVOL used as an oxidizer was problematic on submarines. Contamination of the NAVOL contained in the energy section of the MK 16 torpedo could release massive amounts of oxygen blowing out valve assemblies in the torpedo and creating a highly flammable atmosphere in the torpedo room filled with hydraulic equipment and torpedo warheads. It's a real recipe for fire and explosion. Stability

of the NAVOL contained in a tank in the MK 16 torpedo energy section was monitored through the torpedo "A" cable by a Navol Monitoring Panel. Hourly readings were taken and recorded. You watched for a blinking light on the panel. The *blink* was caused by a bubble of oxygen passing the sensor in the NAVOL tank. If the blinks-per-minute exceeded a certain count you had to hook up a NAVOL tank disposal kit from the torpedo to the torpedo room trim line hose connection and pump the NAVOL tank to sea. The MK 16 also had a small air flask in the energy section. Air was used to operate all the valves in the propulsion system, depth and steering engines, spinning and sustaining air to the gyro, pressurize the fuel and NAVOL tanks. Therein lay the problem with the MK 16 Mod 6. The air actuated valves in the propulsion system were prone to leakage of NAVOL through out the system leading to contamination of NAVOL tank. The MK 67 Super Buoyant Exercise Head used with the MK 16 MOD 6 torpedo was over engineered. It contained a small air flask to inflate flotation bags folded into a small space with a hinged door on each side of the exercise head. It contained a pitot tube to monitor speed of the torpedo (you don't want the torpedo moving through the water when the flotation bags are deployed which could result in the bags being torn off). It also contained an attitude valve which monitored how close the torpedo was to vertical (when the torpedo slows down at end of run it sinks tail first due to weight of the engine and components in the afterbody).

The actuation of the attitude valve along with a valve connected to the pitot tube inflated and deployed the flotation bags (2).

After a dozen years of problematic use the MK 16 Mod 6 was withdrawn from service. A major Ordnance Alteration (OrdAlt) to the torpedo involved replacing all the air actuated valves in the propulsion system with explosive valves, and a battery operated timer. The explosive valves sealed the NAVOL tank from leaks solving the major problem with the torpedo. The MK 67 Super Buoyant Exercise head was replaced with a simple exercise head modeled after the exercise head used on the MK 14 torpedo increasing reliability of operation and ensuring recovery of the torpedo at end of run. The modified torpedo was reissued to the fleet in the late 60's as MK 16 Mod 8 (3).

By 1970 the MK 16 Mod 8 had finally matured into a reliable, long range, anti-shipping torpedo packing a big punch. The torpedomen liked it because of its simplified preparation and maintenance requirements compared to the MK 14 Air-Steam torpedo.

On BARBEL we routinely fired several MK 16's during weekly Op's. The firing procedure was to prepare three torpedo tubes for a salvo shot. One tube contained the torpedo and the other two were fired as *water slugs*. The atmosphere on the torpedo tube deck was always highly charged when we shot MK 16's due to the coordination required of the muzzle door manifold operator, blow and vent manifold operator, and the Torpedo tube *captain*. There were two ejection pumps, port and starboard, with three torpedo tubes per bank serviced by an ejection pump. When salvo'ing both ejection pumps were used with 3 to 4 second intervals between shots. The muzzle door operator was busy closing the muzzle door on the tube just fired; equalizing tube pressure and opening the muzzle door on the 3rd tube to be fired as the second tube was shooting. There was a tremendous amount of noise in the torpedo room as the firing valves lifted and the ejection pumps went through their strokes followed by venting off the firing air into the torpedo room at the end of each stroke. In addition there was the sound of hydraulic oil moving through muzzle door actuators, interlocks moving and muzzle door valves being opened and closed. In the midst of all the noise the phone talker nearby would also be relaying info to the control room. By late spring the torpedo gang was very skilled in MK 16 salvo firing.

I approached the Gun Boss (Leiutenant Bill Marks) with a proposal that we request permission to salvo fire two MK 16 Mod 8's. I showed him the section from SubPac Ordnance Notes prohibiting salvo firing of steam torpedoes without permission and suggested we ought to go for it. He was enthusiastic and said he would take it up with the skipper (CDR Howard Eldridge). Within a week or two we had approval.

The MK 16 Mod 8 salvo firing went off without a hitch. The only trick to it is the requirement to gage the exercise torpedo air flask at least 20 minute prior to shooting. Air flask pressure is critical for

exercise shots. You must have max pressure in the air flask to completely blow down the exercise head at end of run.

We coordinated gauging the air flasks on both torpedoes as part of tube loading procedure and with the fire control party to give them as much time as possible to get a set up on the target vessel, a DE out of Pearl Harbor. We were operating in the waters between Lanai, Kahoolawe, and Maui. Weather and sea conditions were near perfect. There was also a helicopter operating with us to monitor the shoot. We fired our usual three tube salvo this time actually shooting two torpedoes. Sonar reported two fish running hot, straight, and normal (4). The water was so calm and clear the helicopter reported sighting both torpedoes headed for the target (5). Both torpedoes ran under the target and surfaced at end of run about 500 yards beyond. The torpedo retriever backed up to each torpedo, hooked up to the nose ring and pulled it up on deck. Everyone on the boat was excited! We had salvo fired two exercise MK 16 Mod 8 anti-shipping torpedoes. This had not been done in years. The torpedo gang, two TM2's and two TM3's had a shooting experience no one else on the waterfront could claim, real bragging rights.

After the Mk 16 Mod 8 salvo firing I proposed that we shoot a MK 14 Mod 5 air-steam torpedo. I told the gun boss the torpedo gang had never shot a Mk 14 and I wanted them to have the experience. At the end of our next two week upkeep period I took the TM's to the steam torpedo shop to do preliminary adjustments to our MK 14 Mod 5. The Torpedo shop personnel did the preliminary adjustments to the MK 16 torpedo as part of the assembly routine. For the MK 14 it was firing craft personnel who performed preliminary adjustments. This included running depth and steering engine checks, running the main engine with air, charging the air flask, adding lube oil, alcohol fuel, and water. A lot more hands on for the torpedomen. They loved it! We shot the MK 14 Mod 5 the following week without a hitch.

In early summer we had another two weeks of PCO ops and again shot over 30 torpedoes. By this time we had shot over 90 torpedoes. We were the hot boat in Pearl Harbor. The torpedo gang all youngsters, all first termers had more torpedo shooting experience than many career torpedomen riding Nuc boats. I approached the gun boss again and suggested that we request to shoot a warshot

MK 16 Mod 8. We received approval to shoot the warshot late in the year. It would be the last torpedo we would fire in 1973, it would be number 118.

We had a lot of riders the week we shot the warshot including ComSubRonOne and the Squadron One Weapons Officer, Leiutenant Jerry Scott. We ran down to Kahoolawe on the surface arriving in early evening. The Gun Boss, Leiutenant Bill Lamm came down to the torpedo room and gave us the serial number of the torpedo we would shoot. TM1(SS) Warren (Pops) Pospisil had been aboard about two weeks. I had known Pops for years from his time on the SALMON and the CAIMAN. He and Walter (Ski) Slusarski installed the MK 9 exploder detonator and booster then installed the gyro and replacement pin. When we rolled the torpedo right side up we heard a clinking noise in the torpedo tailcone. I immediately knew the cause of the noise as did Pops and Jerry Scott. There was a loose rudder or elevator linkage pin in the tailcone. Pops removed the tailcone plugs to check the rudder and elevator linkage pins were in place which they were. I told Jerry Scott I wanted to pull the propellers and tailcone off to remove the loose linkage pin, after reassembly we would run the depth and steering engine checks and then complete final checks before firing. Jerry Scott departed for the wardroom to brief the skipper and the Commodore. He came back in about a half an hour and told us to proceed. We pulled the propellers, rudder and elevator linkage pins, and tailcone. We then removed the loose linkage pin, reinstalled the tailcone, elevator and rudder linkage pins and propellers. We then ran the depth and steering engine checks which were satisfactory. Jerry then departed for the wardroom to brief the skipper and Commodore on the results. He returned in about 15 minutes and told us we could complete final checks and load the warshot, which we did.

The next morning the skipper came down to the torpedo room and told me we were going to be surfaced when we shot the MK 16 warshot torpedo. I reminded him that we needed to be submerged at periscope depth for the torpedo to start when fired. I then reviewed the torpedo sea pressure switch functions with him. He left to return to the wardroom to brief the Commodore. About ten minutes later the skipper called down to the torpedo room and told me we would still shoot from the surface however we would flood the forward

group ballast tanks to get the bow below 40 feet so the torpedo sea pressure switch would operate. After the torpedo was fired we would blow the forward group. Torpedo running depth would be set for 40 feet. The torpedo gang was pissed about the lack of confidence in the torpedo preparation that was performed. We knew that decision to get back to the surface as quickly as possible was driven by a concern for a circular run with the warshot. It wasn't the skipper's decision, it was the Commodore's.

We were ready in the torpedo room. The Fire Control Party and the skipper got the boat lined up on the target cliff on Kahoolawe then flooded the forward group ballast tanks. The boat took a down angle of about 15 to 18 degrees. We heard later from the electricians in maneuvering that the screw was part way out of the water. When the boat was settled out we flooded the tube, equalized with sea pressure and opened the outer door. Next we heard the firing solenoid buzz, stop bolt roll, firing valve lift and the ejection pump stroke followed by venting of firing air. Within seconds we heard High Pressure air being dumped into the forward group ballast tanks and we were back on the surface. Sonar reported torpedo running hot straight and normal! The warshot ran for 88 seconds before detonation against the cliff. Forget all that stuff you hear on TV or in the movies of how a torpedo warhead sounds when it detonates. In reality it's a short, sharp, very loud BANG! that's it. There was a huge column of water several hundred feet high thrown up against the side of the cliff caused by the warhead explosion.

To say we were a happy bunch of torpedomen would be an understatement! We had a lot of crew members coming forward congratulating us and telling us it was a real blast shooting a warshot. The cooks had prepared a cake to commemorate the event, not only the warshot but our total for the year which was 118, more than any other boat in SubPac. We mustered the FT's and TM's, Gun Boss, Skipper and Commodore in the crews mess for photos and cake cutting. Then we headed for Pearl Harbor on the surface *standard on three.*

1973 was a hell of a year for the BARBEL Weapons Department. 118 torpedoes fired, salvo fired two MK 16 mod 8 anti shipping torpedoes, first operational test of a MK 16 mod 8 warshot in 6 years, identified the cause of the MK 45 mod 2 flex hose eater

problem, passed a MK 45 torpedo Technical Standardization Inspection with zero errors/defects, and received the Submarine Squadron one Battle Efficiency Award.

NOTES:

1. NAVOL is the Navy's term for concentrated hydrogen peroxide used with torpedoes. The term NAVOL was coined from Naval Ordnance Laboratory Project. NAVOL is a 70% solution of hydrogen peroxide in water with stabilizers added. The Navy experimented with a NAVOL-steam torpedo in the early 1930's with dramatic results. Development of the NAVOL-steam torpedo was put on hold in 1941 following the attack on Pearl Harbor in order to concentrate production on the MK 13 and MK 14 air-steam torpedoes. Development and production of the NAVOL-steam torpedo was resumed late in the war with several hundred MK 16 and MK 17 NAVOL-steam torpedoes produced. Development and production continued into the early 1950's. For additional information on NAVOL-steam torpedo development consult: US NAVY TORPEDOES, Frederick J. Milford, THE SUBMARINE REVIEW, January 1997 issue, and Hellions of the Deep, The Development of American Torpedoes in World War II, Robert Gannon, Pennsylvania State University Press, 1996.

2. A story often told at the Pearl Harbor Submarine Base Steam Torpedo Shop in the early 1960's involved the first attempt to retrieve a MK 16 MOD 6 exercise torpedo with the MK 67 Super Buoyant exercise head. The torpedo retrievers in use at that time were converted AVR's, seaplane crash boats. As modified to serve as torpedo retrievers, they had a slanted deck installed to the stern to waterline level, and the original stern planking was cutout between the frames. A winch was installed behind the pilot house to pull the torpedoes out of the water, up the slanted deck where they could be secured for return to the submarine base torpedo shops. Apparently no one thought to check the size of the opening on the stern of the torpedo retrievers prior to shooting the first MK16 MOD 6 exercise torpedo. It ran hot, straight, and normal; the flotation bags in the exercise head deployed, and it was floating in an upright position on a glassy sea. The torpedo retriever backed up to the torpedo and one of the Boatswains Mates attached a tag line to the nose ring while the crew tried to figure out how to get it through the opening in the stern with the floatation bags deployed on either side. The only solution they could come up with was to deflate the bags, which they did with a knife attached to a boat hook. Results were predictable, the torpedo sank immediately breaking the tag line on the way to the bottom.

3. Several hundred MK 16 MOD 7's had been produced toward the end of WWII. The MOD 7 was basically a much modified MK 14 torpedo using NAVOL-steam propulsion.

The torpedo gyro angle and running depth was set mechanically like all the other submarine torpedoes in use at that time. As late as 1960 there were still a number of MK 16 MOD 7's in storage at the Pearl Harbor Steam Torpedo Shop.

1. The term Hot, Straight, and Normal is used by Sonarmen to describe the initial part of the run of an air-steam or NAVOL-steam torpedo. Hot refers to the igniters initiating combustion of the alcohol-air, alcohol-NAVOL mixture in the combustion chamber. A cold shot is a torpedo run where the igniters do not function and the torpedo is running on air alone, a much different sound than a hot run. Straight refers to the torpedo running on its set gyro course to intercept the target. You always want a straight shot rather than a "circular run" where the torpedo steering malfunctions and the torpedo is running in a circle with a high probability of hitting the firing submarine. At least one submarine, USS TANG SS-306, sank herself in October 1944 with a circular run MK 14 torpedo. Normal refers to no abnormal noises emanating from the torpedo during the early part of its run.

2. The water was crystal clear in the area where we were operating with very calm conditions. The torpedoes had been set to run at 40 feet. The exercise heads were painted "dayglow" orange and were visible to the helicopter crew as the torpedoes ran toward the target DE.■

COLD WAR PHYSICIST: NICHOLAS CHRISTOFILOS

by Mr. John Merrill

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

Introduction*

Nicholas Christofilos was born in 1916 near Fenway Park in Boston. When he was seven, his parents returned to Athens, Greece, where his father, who had been proprietor of the Wellington Café in Boston, resumed ownership of a coffee house. Christofilos retained his American citizenship and returned to the United States in 1953, engaging in scientific pursuits until his untimely death in 1972.[1] In his nineteen years of participation in the United States at the cutting edge of science, he made a difference. Held in high regard, he was an international figure in the scientific world.

Two of his most imaginative defense projects known to the public are Project Argus and Project Sanguine. Project Argus in 1958, cited as the *world's largest scientific experiment*, was proposed in 1957 by Christofilos while working at the Lawrence Radiation Laboratory of the University of California.[2] This successful geophysical experiment was conducted by the Navy under the supervision of the Defense Department and the Atomic Energy Commission in August and September of the following year. The global scale endeavor involved civilian scientists from government, academia, and industry and participation from other branches of the United States Armed Forces.

In the summer of 1958, Christofilos attended a briefing by the Polaris Special Projects Office and became aware of broad,

* From 1962-1972, the author had occasion to be involved with Nicholas Christofilos in regard to the evolving Navy ELF global submarine radio communication system.

difficult, and unresolved Navy requirements to communicate from the continental United States to a deeply submerged POLARIS submarine. He proposed using electromagnetic waves in the Extremely Low Frequency (ELF) range of 10-100 Hz. The proposal provided the impetus for the initial research phase of the communication system development known as Sanguine, which later evolved into a Navy operational system in 1989. The system fulfilled certain needs of United States strategic and tactical submarines, primarily to send secure communications to a submarine at operating depth anywhere in the world.

Christofilos, considered the father of ELF communications, remained a strong advocate and partisan during the long system development until his premature death in 1972. Widely remembered by his Navy and industry associates on the ELF team, a modest memorial was established in his name with Sigma Xi. All of his scientific endeavors were large scale, on the cutting edge of science, and significant. Further, in general his work was classified. Today, some still remain so.

The January 1973 issue of *Physics Today* noted, "Christofilos was intensely proud of his American birth and citizenship. He understood well the military needs of the Nation and conscientiously devoted a significant fraction of his life to improving the US strategic posture." It seems that from the time Christofilos returned to the United States, his center of attention was science, frequently with a direct or nuanced military attribute. At the time of his passing, the *New York Times* identified him as "foremost nuclear physicist." His participation in addressing solutions to military needs during the Cold War era warrants attention to his efforts.

About Christofilos

Current media provided a variety of ways to cite his talents. "One of the most original thinkers in physics of his generation"
"An unconventional Greek Scientist named Nicholas Christofilos"
"The right kind of nuclear detonation would threaten hundreds of satellites. That is because of something called the "Christofilos Effect."

"Nicholas Christofilos suggested that a portion of the earth's interior could be used as a launching pad to propagate ELF signals."
"Nicholas C. Christofilos is the lone-wolf genius behind Project Argus, a global experiment that has been called 'the most grandiose single scientific venture in history'"
"A Plasma Physics Pioneer"

1923-1952

A boy of 7 when he went to Athens, in those years Christofilos witnessed the post-World War I scene and in 1936 the establishment of a dictatorship followed by German occupation troops (1941-1945), and civil war (1946-1949). As a young person, in addition to an interest in building radio equipment, he displayed considerable talent as a promising musician. It is notable that when the German occupation of Greece ended in 1945, Christofilos composed the music for the celebration marking the end.

Graduating in 1938 from the National Technical University in Athens with advanced degrees in electrical and mechanical engineering, he worked for Wisk, Inc., an Athens company installing and maintaining elevators in apartments and office buildings. In 1941, the Germany army of occupation directed the company to repair trucks for the military. Christofilos was assigned as supervisor of a truck repair terminal. At the end of World War II, he established his own elevator installation business.[3]

Throughout the German occupation, demands on Christofilos's time were decreased. At that point, he had no formal physics credentials. During this time and essentially alone, he began his private and continuing study of atomic physics. German textbooks were available in Greek bookstores, and his readings covered nuclear reactions, isotopes, and high voltages. The work of the Kaiser Wilhelm Institute in Berlin, where nuclear fission had been discovered in 1938, particularly interested him. This direction pointed to particle acceleration to relativistic speeds using his novel concept of *the strong-focusing principle of magnetic containment for particle accelerators*. In 1946, and with more detail in 1947, he applied for

Greek and American patents for a particle accelerator of his own design.[4]

On several occasions, during the later 1940s, Christofilos sent letters of his designs to the Radiation Laboratory at the University of California in Berkeley. The scientists here decided that the mathematics was not clear and the patent proposals were filed and half forgotten.

Christofilos continued to work on his design of accelerators to speed nuclear particles to significantly high energy levels. Then current accelerator technology used very large magnets. To achieve efficiency in the accelerator construction and to achieve very high energy levels, he developed the concept of strong focusing, reducing the need for large magnets and providing higher energy levels to the particles. A further patent application on March 10, 1950, proposed a particle accelerator with strong focusing providing energy a magnitude higher than that obtained with much larger and more expensive *weak* focusing magnets. The United States *strong focusing* patent 2,736,799 was awarded to Christofilos February 28, 1956.[5]

In the December 1952 Physical Review, several members of the Brookhaven National Laboratory proposed a strong-focusing accelerator. The scientists were unaware of the earlier work by Christofilos in developing a similar strong-focusing technique. Later, these scientists publicly acknowledged Christofilos in the July 1953 issue of the Physical Review. "Since Christophilos's manuscript is known to have been prepared in early 1950, it is obvious that his proposal antedates ours by over two years. We are, therefore, happy to acknowledge his priority."

In "A Tribute to Nicholas C. Christofilos," T. K. Fowler of the Lawrence Livermore Laboratory noted, "His early contribution to this mainstay of the accelerator art of today was all the more remarkable in that he conceived and worked out these ideas while in almost complete isolation from any modern, active, scientific community."[6]

During the following years, strong focusing was successfully used in accelerators at Cornell, Harvard, MIT, Daresbury, Hamburg and Yerevan; and in proton accelerators at Brookhaven, CERN, Serpukhov and the National Accelerator Laboratory. As mentioned above, Christofilos in 1946 also independently invented an accelera-

tor similar to the synchrotron. In 1963, the Franklin Institute awarded Christofilos for the synchrotron,[8] contributions to high-energy beams, and other achievements. Recognition and wide application of his inventiveness came after his return to the United States.

As the 1940s closed, Christofilos was unknown in the United States. His credit as an elevator engineer eclipsed his unlettered abilities as an atomic physicist. He continued to write letters suggesting ways to build an improved accelerator. The scientists at the Berkeley Radiation Laboratory still found Christofilos's mathematics crude and in replying pointed out his errors.

Later in 1952, upon reexamination of his latest letter there was agreement by the Berkeley Radiation Laboratory scientists that the Christofilos design was a major contribution to high-energy physics. Further, there was also favorable interest in Christofilos at the Brookhaven, Long Island, New York, National Laboratory, then involved with the design and construction of an accelerator 1953.

In February 1953, Christofilos returned to the United States to meet with members of the Atomic Energy Commission (AEC) and to press for consideration of his accelerator design. After meetings with AEC patent officers, in return for a $10,000 payment, a license and agreement were granted for use by the United States government and its contractors of the Christofilos "strong focusing" principle.[8]

The Brookhaven Laboratory was so impressed that he was immediately hired to work on the $29 million accelerator, based on his design, and under construction there.[9] The Brookhaven Alternating Gradient Synchrotron, a proton accelerator, was the first application of Christofilos's strong focusing. Overall, the principles of the strong focusing techniques brought government savings of $70 million.

Astron

During December 1951, in addition to the government weapons laboratory at Los Alamos, a second weapons laboratory known as University of California Radiation Laboratory, Livermore (UCRL), was started. Research and development at the new laboratory were directed to the investigation of thermonuclear techniques for weapons and other purposes. By 1956, the laboratory was heavily

involved in thermonuclear research. The Army and Navy patronized Los Alamos for their weapons while the Air Force was oriented toward Livermore.

While at Brookhaven in the mid-1950s, Christofilos's thinking returned to the concept of controlled fusion, at the time highly classified. His interest in fusion had begun eight years before when he was still in Greece. His idea considered one of the biggest problems in applied physics: how to use magnetic fields to contain high-energy plasmas and produce a controlled thermonuclear reaction. The purpose was to provide unlimited electric power from controlled thermonuclear reactions. He filed for a patent for a device to achieve this by magnetic trapping of plasma to release fusion energy.[10]

Christofilos obtained a position at the Livermore Laboratory, directing the program to produce a controlled thermonuclear reaction called Astron, supported by the AEC and the Department of Defense. Astron-related research began at UCRL in 1956.

"In November 1964, Christofilos and two colleagues reported to the American Physical Society that they had observed trapping of the electrons in the Astron. The effect lasted for a thousandth of a second at a temperature of nearly 200,000,000 degrees."[11]

It has been noted that the Defense Department's interest "was no doubt related to its long-term concern with the practicality of using intense particle beams for military purposes. In fact, the electron accelerator designed by Christofilos has played a major role in the free-electron laser program at the Lawrence Livermore Laboratory, an important component of the Reagan administration's Strategic Defense Initiative." [12] In the following years, in addition to the Astron involvement, he continued to make important contributions to the accelerator field in the development of proton linear accelerations and collective accelerators.[13]

PROJECT ARGUS

Artificial Radiation Belts

Shortly after the October 5, 1957 successful Soviet launch of the satellite Sputnik, Christofilos looked into creating an artificial radiation belt in the upper region of the earth's atmosphere with a nuclear detonation at a high altitude, about 300 miles from the

surface of the earth. The earth's magnetic field would be used to trap electrons released by the atomic detonations. These considerations were concurrent with the ongoing International Geophysical Year (IGY), July 1 1957 to December 31, 1958.

In January 1958, UCRL published Christofilos's proposal, classified because of its military applications, to use the earth's magnetic field to trap electrons injected at the proper altitude from detonated small atomic bombs. The very extensive experiment that followed to validate Christophilos's prediction of results took place in late August and September of 1958 and was called Project Argus.

Christofilos postulated that electrons from the atomic bombs trapped in the magnetic field would provide an artificial radiation belt. Understanding would be gained regarding the impact of the trapped particles in various areas of scientific interest including radio communications, space flight, and knowledge regarding the magnetic and radiation environment in the near-earth space. Christofilos's prediction about particle entrapment, proven by Project Argus, is now referred to as the *Christofilos Effect*.

The military importance of Christofilos's classified paper caught the attention of the Chairman of the President's Science Advisory Committee (PSAC). Under the aegis of PSAC, a February 1958 scientific working group convened for several weeks at the University of California Radiation Laboratory to assess the theory and its potential military applications.

Later, a presentation regarding whether the Project Argus trapping experiment should be undertaken was made to President Eisenhower's PSAC. Support for the Project was encouraged by Van Allen's recent discovery of the radiation belt of the earth. Christofilos vigorously discussed his theories about the *"Christofilos Effect"* to the Committee. On May 1, 1958 the PSAC recommendation to undertake Argus was made to the President who concurred.

Within four months Project Argus experiments took place involving the space encircling the entire earth. The operational and technological management of the project was the responsibility of the then new DOD Advanced Research Projects Agency (ARPA). As mentioned above, the Navy directed the experiment with participation by other branches of the Armed Forces. The goal of Argus was to examine the physics of the results from the three high-altitude

nuclear bursts called Argus I, II, and III. The satellite *Explorer IV* was launched successfully on July 26, 1958. Operating as planned, it provided the principal body of observations of the artificial radiation belts. Analysis of *Explorer IV* data on the natural radiation belt as well as on the artificial radiation belts from the Argus bursts propelled the entire subject to a new level of understanding and broad scientific interest.

Prior to the Argus tests that took place in late August and September, in March 1958 (as part of the IGY) earth-circling Satellite Explorer I, recently launched, monitored the detonations of atomic weapons in space over Johnston Island in the Pacific. Examination of the data from the Geiger counter on the satellite led to the discovery of the radiation belt of the earth, a massive region of space populated by energetic charged particles (principally electrons and protons), trapped within the external geomagnetic field.[15] The radiation belt was named The Van Allen Belt to honor one of the Argus Project's participating and contributing physicists, James A. Van Allen. Later in a 1960 lecture at Ohio State University, Van Allen referring to Argus said it was "one of the greatest experiments in pure science ever conducted."

Navy Project Argus Task Force

TARAWA	aircraft carrier	COURTNEY	destroyer escort
NORTON SOUND	missile-testing ship	HAMMERBERG	destroyer escort
ALBEMARLE	seaplane tender	NESHO	oiler
BEARSS	destroyer	SALAMONIE	oiler
WARRINGTON	destroyer		

Tests

"Task Force 88," a fleet of nine US Navy vessels including USS NORTON SOUND, Navy's floating missile launch pad, provided the support for warhead shots. The three tests made from this experimental guided missile ship were on August 27 and 30 and September 6 from a location in the South Atlantic east of Patagonia and south of the Falkland Islands about 1100 miles southwest of Cape Town, South Africa. The 1.7-kiloton atomic warheads were detonated at altitudes of 100, 182 and 466 miles.[14]

A modified version of the POLARIS re-entry test vehicle (RTV-30) carried the bombs from the deck of USS NORTON SOUND. The launch vehicle was a set of solid-fueled rockets used to try out components for the missile that the Navy was developing for launching from submerged submarines. The entire assembly was about fifty-seven feet tall. All three shots were successfully launched from a pitching ship in an open ocean.[15]

The atomic explosions sent electrons racing back and forth along the magnetic meridians extending about 4000 miles into space. Electrons created man-made aurora when they hit the atmosphere. Traveling with the speed of light, the band of electrons enveloped the earth in an hour and provided a man-made shell of radiation in August and September 1958.

Satellite *Explorer IV*, equipped with Geiger counters and successfully launched on 26 July 1958, provided the principal body of observations of the artificial radiation belts and natural radiation belt. Additionally, rockets sent up from the United States and other locations provided data. Worldwide conditions created by the detonations were monitored around the world in conjunction with the Geophysical Year activities.

Monitoring took various forms. For example, the Army's Signal Research and Development Laboratory installed two huge loops designed to observe magnetic waves on frequencies as low as one cycle per second. A loop in a remote location south of the Grand Canyon enclosed twenty-six square miles. Two similar loops with effective areas of twelve and twenty-three square miles were place in operation in Burlington County, New Jersey and recorded the pulses from the explosions until the completion of the Argus experiment.[16]

The results of the tests supported Christofilos' predictions. The project was accomplished under careful secrecy and it was not until March 1959 that the media, including *Business Week*, *Life*, *Newsweek*, and *Time* weekly magazines,[17] and importantly the *New York Times*, provided news of the Argus experiment in sufficient detail for the public to grasp the scale and some aspects of the importance of the effort. The *Christofilos Effect* was proven and established.

A later assessment of Argus concluded that the purpose appeared to be to assess the impact of high altitude nuclear explosions on radio transmission and radar operations because of the electromagnet pulse (EMP) and an understanding of the geomagnetic field and the behavior of the charge particles in it.

POLARIS STRATEGIC SUBMARINE RADIO COMMUNICATION REQUIREMENTS[18]

The Problem

The Navy needed a communication system to transmit command and control messages to new Fleet Ballistic Missile (FBM) strategic submarines operating in a stealth mode globally. Initial research started in 1958; for the next four years the Navy sponsored a wide range of exploratory technical efforts towards a solution for the strategic submarine communication need.

At this stage in the Cold War and until the 1970s, the concept for this communication system included the additional requirement for ability to withstand a nuclear attack at the transmission site. It was intended that the system be able to send Emergency Action Messages (EAM) after absorbing a substantial nuclear attack. The impact of nuclear bursts over the transmission path also received attention. These needs, plus global coverage, a continental United States transmitter location and the other unique requirements presented a daunting task. For more than ten years, additional challenges to the researchers arose from the secret classification of all aspects of the work.

A brief review of the requirements brings out the extent of the challenge. The technology available then compared to current

capability appears primitive. This is especially true regarding computer technology. Cold war expediency and secrecy were further obstacles. A radio communication system to match the remarkable stealth capability needs of the new strategic Polaris submarine was not at hand.

FBM Submarine
Communication Requirements (circa 1957)

Error-free one-way communication
Hard copy in a specified time
Transmitter in Continental U.S (CONUS)
No severe reduction in speed, maneuverability, or depth of the submarine
Coverage of the submarine's operating areas
Resistance to jamming
Transmitter to withstand nuclear attack

Christofilos Recommends

In the summer of 1958 at the time of the Argus experiment, Christofilos, a member of the Polaris Command Communications Committee (PCCC) attended a briefing by the Polaris Special Projects Office. There, he became aware of Navy's requirement to communicate from CONUS to a deeply submerged submarine. In August, he proposed a communication system to use electromagnetic waves in the range 10-100 Hz. Christofilos's early classical music training in Greece provided the metaphoric title for his proposal called *Clarinet Bassoon* (a low note).

In this first approach, the idea was to resonate the earth-ionosphere cavity at its natural modes. The Navy gave immediate attention to the Bassoon concept. The Navy pursued ELF (3-300 Hz) for the submarine communication system. Christofilos, considered the father of ELF communications, remained a strong advocate and partisan during the long system development until his premature

death in 1972. His membership in the PCCC brought Christofilos into contact with senior personnel from a variety of academic, industrial, Navy, and government organizations. The Committee met on a frequent basis and was apprised of the status of the evolving ELF system.

The Navy immediately took an intense interest in ELF transmission because of the following characteristics of such a system:

- Low signal attenuation in sea water
- Low signal propagation attenuation
- Comparatively low senstivity at ELF to atmospheric disturbances caused by nuclear blasts in the signal path
- Better survivability against nuclear attack (ELF transmitters and antenna arrays lend themselves to dispersion and hardening)

Early ELF R&D

Similar to all of Christofilos's interests ELF was also global in concept and on a scale of unusual magnitude. For example the first experimental transmitting antenna that was constructed in 1962 to perform ELF signal propagation measurements on land and on submarines was 110 miles long and reached from North Carolina into Virginia. Using ELF for global communications was unique. This brought with it the need to understand electromagnetic noise on a worldwide basis. Selecting a suitable location for a United States based transmitter required knowledge of the earth conductivity in many of the states. The challenges to creating and building a system were innumerable.

ELF Test 1963

In early 1963, January to April, the Navy conducted an extensive communication demonstration between a shore-based ELF (30-300 Hz) transmitter located in North Carolina and the nuclear submarine USS SEAWOLF (SSN-575) operating in the North Atlantic at a range of 2400 miles with its receiving antenna near keel depth. Signals were received at a range of 535 miles with the antenna at greater depths. During these weeks of communication tests, in addition to the submarine, fixed land, and mobile van measurements

of signal propagation were made. Atmospheric noise measurements were made in the United States, South America, and on Malta.

By June 1963, data from the submarine and land-based propagation and atmospheric noise measurements were analyzed. As a result, ELF became a candidate for a system to communicate to the Polaris submarines operating deep in global locations. Many important and detailed questions remained to be resolved by theoretical, laboratory and field efforts.

ELF System Completed

After decades of advances in the technology applicable to the transmitting and receiving needs of an ELF system, solutions were found for a wide range of problems (technical, non-technical, fiscal, political, and environment-related) and the system was completed. Transmitters and antennas were constructed in Wisconsin and Michigan, submarines were equipped, operational use established and personnel trained. This initiative by President Reagan early in his first administration provided the driving force that culminated in the operational transfer of ELF in October 1989 to Operation Commander, Naval Telecommunications Command, from the Space and Naval Warfare Systems Command.

When the strategic and attack submarine communication system became operational, it provided reception by the submarine at depth and speed. The ultimate ELF system was different from the early concepts. As previously mentioned, the system and its performance were considerably enhanced by the advent of the steadily improving computer capability as well as the creativity of the various laboratories involved. Except for the choice of operating frequencies, the Navy's operating ELF system was far removed from the early 1960s concept. Initially the system was designed for the FBM submarine. By the mid-1970s, based on data and experience from many tests aboard the strategic and attack submarines, a tactical and strategic operational concept matured.

Christofilos innovated; but the work to create a system to meet the basic requirements was a significant challenge and involved a great number of industrial, government, and academic organizations over a period of many years. ELF coming on line operationally took place almost thirty years after Nicholas Christofilos's suggestion that

ELF should be considered as a candidate for radio communication to submarines at depth and speed. The system as built was not one that Christofilos envisioned but it did operate at ELF as he originally suggested.

2004

At the end of September 2004, after fifteen years of communication with strategic and tactical submarines, the ELF system was closed down and dismantled.

Conclusion

Particle accelerators, Astron, Project Argus and the Navy's ELF program are not disparate. All have their roots in magnetic and electric fields. Further, each originated by Christofilos. Each also required unbridled thought and were on a scale that is always large and in some instances global. Perhaps the word unique would be appropriate for each of the three concepts. Certainly, Nicholas Christofilos was himself unique.

As a citizen, Christofilos returned to the United States in 1953. For the following nineteen years, his contributions to science and the nation's strategic posture were significant. His efforts bracketed most of the Cold War era.

ENDNOTES

1. I last conversed by phone with Nick at the Livermore Laboratory regarding a technical matter two days prior to his passing.
2. John S. Foster, T. Kenneth Fowler, and Frederick E. Mills, "Nicholas C. Christofilos 1916-1972," *Physics Today*, 26(1) (1973) p. 109-115.
3. Current Biography 1965, The HW Wilson Company, Bronx, New York p. 82-84.
4. Dictionary of Scientific Biography, Charles Scribner's Sons, New York 1970, p. 166.
5. Ibid; p. 166.
6. "A Tribute to Nicholas C. Christofilos," by T. K. Fowler, Association Director, Controlled Thermonuclear Research Lawrence Livermore Laboratory Livermore, California

...http://accelconf.web.cern.ch/AccelConf/p73/PDF/PAC1973_0035.PDF - 114.8KB.
7. Foster et al, *op. cit.*, p. 109-115.
8. Dictionary of Scientific Biography, *op. cit.*, p. 167.
9. New York Times, March 19, 1979, p. 16.
10. Http://www-istp.gsfc.nasa.gov/Education/whtrap1.html p. 2.
11. Current Biography 1965, *op. cit.*, p. 84.
12. Dictionary of Scientific Biography, *op. cit.*, p. 167.
13. "A Tribute to Nicholas C. Christofilos," by T. K. Fowler, Associate Director, Controlled Thermonuclear Research Lawrence Livermore Laboratory Livermore, California http://accelconf.web.cern.ch/AccelConf/p73/PDF/PAC1973_0035.PDF - 114.8KB.
14. Http://nuclearweaponarchive.org/Usa/Tests/Argus.html
15. Walter Sullivan, *Assault on the Unknown: The International Geophysical Year*, McGraw-Hill Book Company, Inc., New York, 1961, p. 152.
16. *Ibid*, p. 159.
17. Business Week, 28 March 1959, p. 32-33, Life, 30 March 1959, p. 31-34, Newsweek, 30 March 1959, p. 58-59, Time, 30 March 1959, 70-71, 16 November 1959, p. 100.
18. John Merrill, *A History of Extremely Low Frequency (ELF) Submarine Radio Communications*, Publishing Directions, LLC, 615 Queen St., Southington, Ct 06489, 2002. This version of the forty years of ELF history was written in response to a discussion in a 1993 meeting of the ELF Environment Review Committee held in Salt Ste. Marie, Michigan. At that meeting and subsequent meetings, it was concluded that a history of the ELF system and its development was lacking. In 1999, the author was invited to write the history.

THE SUBMARINE COMMUNITY

FAST ATTACKS AND BOOMERS TO RESURFACE AT THE U.S. NAVY MUSEUM

by Rear Admiral Jerry Holland, USN(Ret)

Jerry Holland has been a frequent contributor to the Naval Submarine Review. He is presently Vice President of the Naval Historical Foundation where he edited their book, The United States Navy.

The Naval Submarine League is justly proud of its monumental display *Fast Attacks and Boomers: Submarines in the Cold War* which occupied space in the National Museum of History of the Smithsonian Institution for four years after the Centennial of the Submarine Force. When that fine exhibit was dismantled, the artifacts, which belong to the Navy, were placed in storage at the Washington Navy Yard. There they will form the starting point and a major portion of the coming addition to the U.S. Navy Museum, "The Navy in the Cold War: Korea, Vietnam, and the Soviet Confrontation."

Many Submarine League members have visited the U.S. Navy Museum in the Navy Yard, one of the most popular attractions in the Washington area. The annual Fall Submarine Cocktail Party was held there for many years. The submarine exhibit in that building, while small was very popular—especially the working Type 2 periscope through which one could get a 45 degree angle-on-the-bow close aboard look at the display ship, ex-USS BARRY (DD-933), berthed along the Yard's southern side. The U.S. Navy Museum's present building, formerly a facility of the Naval Gun Factory, is full to overflowing with memorabilia commemorating the history of the Navy from the Revolutionary War and the end of World War II. The fifty years of the Navy's history since the end of World War Two needed a home, but curator's and historians were loath to reduce the exhibits in the original building to try to shoe-horn in room for a new period.

That additional space is now available in another historic building adjacent to the present museum in a structure that was the Navy's original model basin. The Navy has completed rehabilitating that building and exhibit designers, historians and curators now are moving forward with exhibits that will populate the new museum addition. This new gallery will honor those who served with the U.S. Navy of the period from 1945 through 1990. These individuals, to paraphrase former CNO and Naval Historical Foundation Chairman James L. Holloway III, "were the unsung heroes of the Cold War". The project is a joint endeavor of the Naval Historical Center that operates the Navy Museum and the Naval Historical Foundation, a privately funded non-profit organization that supports a number of efforts to memorialize the Navy's history.

Every year, hundreds of thousands of visitors learn about the rich history of the U. S. Navy when they enter the doors of the U.S. Navy Museum. While increased security measures in the Navy Yard after the terrorist attack of September 11, 2001 made entry to the museum area difficult, steps since then have substantially eased access. Today, tour buses with advanced notification can gain entry to the Yard to deliver tourists and anyone with a picture identification card can get a pass through the Yard's Pass and Badge Office. Planned is a dedicated parking lot and public access using the sidewalks of the Anacostia Waterfront Initiative. This project of the District of Columbia, when completed, will stretch from Georgetown to the National Arboretum. The Navy's portion of this public promenade along the Anacostia River has been completed. Two access points into the Museum portion of the Yard will be provided and a security system to promote free access from the Walk to the Museums is being procured by the Naval District, Washington.

The exhibits themselves will be produced by the same organization that produced the Fast Attacks and Boomers exhibit for the Naval Submarine League, Design & Production, Incorporated (D&P) of Springfield, Virginia. In addition to the submarine exhibit, D&P has produced other major exhibits for the Smithsonian, the Naval Academy Museum's display of history from the Spanish-American War through World War II, and displays at the Statue of Liberty and Ellis Island Museums.

The design team envisions the gallery being divided into four thematic sections. The first section will provide the visitor a general overview of the Cold War—very important considering today's younger generation has no recollection of this dangerous era. Particular care will be taken to help visitors understand the threat posed by the militaristic Soviet Union and its Marxist-Leninist ideology.

Since nuclear deterrence was a prime reason the Cold War did not escalate to World War III, the second section will focus on this critical aspect and the Navy's contribution. Here is where the SSBN story will unfold. The centerpieces of technical equipment will be buttressed by the stories of those who spent years at sea in a deterrent role. The nature of this silent duty that became the corner stone of deterrence will feature cameos of individuals, ships and stations. This section will showcase those leaders and technologies that dramatically advanced the Navy's global reach. Featured will be significant technocrats and leaders such as Hyman Rickover and Levering Smith.

Meriting comparable attention in the third section will be the extended operations of American attack submarines and their roles in scouting and ultimately thwarting the Soviet Navy. Since this section will cover the conventional confrontation with the Soviet Union, the SSN role in the ASW mission will be placed in context with the SOSUS network, and surface and air platforms. The exhibits will make clear that America's Cold War Sailors, such as the crews of the THRESHER and SCORPION, were at peril even when not engaged in combat operations. The Cuban Missile Crisis will be covered in this section along with the Navy's response to numerous other challenges.

The social revolutions of this period are perhaps among the most long-lasting events of this period of our history. The stories told in the exhibits will follow the racial integration that started in the late forties and show the assignment of women to leadership and seagoing billets—including command of combatants—near the end of the period. The visitor will see the incremental but steady improvements in training and quality of service life that occurred through the period.

The fourth section will focus on the instances when the Cold War turned hot. Exhibits will show how vital seapower was to the successful conduct of operations in the Korean Theater detailing the struggle to hold the port of Pusan, the decisive amphibious assault at Inchon, the withdrawal from Chosin Reservoir and the evacuation from Hungam. The Vietnam conflict will occupy significant area with details of the maritime related activities in that war.

Work on the exhibits for this new museum is proceeding funded by the Naval Historical Foundation. Unfortunately, the Foundation does not have sufficient capital in hand to do any more than provide for the initial design and development. To complete the project, the Naval Historical Foundation will conduct a Capital Campaign in the near future to raise ten million dollars to complete the design and produce the exhibits. President George H.W. Bush has agreed to serve as the Honorary Chairman of this drive which will be a one-time campaign. Members of the Naval Submarine League will be contacted as part of this campaign as donations are solicited from organizations, enterprises and individuals.

This new museum aims to honor the veterans of this conflict and to recognize the efforts of those who fought in Korea, Vietnam and elsewhere, who stood watches with nuclear weapons and who sailed in harm's way to confront the Communist threat. The exhibits will depict the evolution of the Navy into an all-volunteer force of professionals from a diversity of backgrounds and will acknowledge the contributions to the Navy made by civilian employees of the government and private industry. The new museum promises to be a worthy locale for resurfacing the submarine exhibit.■

LETTERS

SPECIAL OPS, PARAMUSHIRO JULY 1945

I was a Hospital Corpsman and for most of my time in the Navy was a Deep Sea diver as well. My limited affiliation with submarines was as an instructor at the Escape Tank in New London. As far as commands go my strongest affiliation was with the Seabee diving community. In the process of trying to nail down the history of this small community I had the good fortune to talk with a fellow who was the first Master Diver in the Seabee Diving community.

Dale Vinette served mostly with the 301 Naval Construction Battalion and in the capacity of Diving Officer for that command. In our recent conversation Dale mentioned that one of the last bits of diving duty he had was in July of 1945. He and another diver reported aboard a sub in Guam for a trip that took them to the island of Paramushiro which is in the Kuriles group north of Japan. Dale mentioned that the unique thing about the sub is that it had no armaments at all on the sub. Once on board and underway the divers were told that they would be part of a landing party on Paramushiro. Their job was to inspect any in water obstructions that the landing party may encounter and to disable or remove any obstructions. None were found. From what Dale told me the landing party also included one radioman, two Navajo code talkers, 6 Marines and five others in khakis, but with no insignia or markings. Dale surmised that the operation was to make contact with the Japanese government to try to work out a surrender. But this is only his guess as the five men in khakis kept to themselves and didn't talk to anyone but the code talkers. They were on the island for few days billeted in a *hay barn* and received two hot meals a day from the Japanese. The mission lasted about five days and they went back out to sea (in rubber boats) and were picked up by the sub. When Dale asked one of the crew the name of the boat he was told, *Sub*. Before they returned to Guam all in the party had to sign documents that they would not divulge any information about the mission for 50 years.

Dale will be 91 in the spring and since more than 50 years have passed asked if I might be able to find out something about the

submarine that took them to Paramushiro and returned them to Guam. Do you have any ideas? Or perhaps know of someone I might contact regarding this submarine and the mission it was on?

Thanks for your consideration. And even for a non-boat guy I've gotta say your site is great.

Erik Gilliam.

JOINT 598 CLASS REUNION

JOINT USS GEORGE WASHINGTON CLASS REUNION

USS GEORGE WASHINGTON (SSBN 598)
USS PATRICK HENRY (SSBN 599)
USS THEODOR ROSEVELT (SSBN 600)
USS ROBERT E. LEE (SSBN 601)
USS ABRAHAM LINCOLN (SSBN 602)

Location: August 24, 25, 26, 27, 2006, Groton, at the Groton Motor Inn & Suites

Contact:
W. T. "Doc" McCance
16 Chapman Lane
Gales Ferry, CT 06335
Telephone: (860) 464-6758
E-mail: 11doc@comcast.net
Web site: www.598Class.us

January 5, 2006

Subject: Comment on the PCO trail - CDR Mike Bernacchi, USN
Ref: NSL Review of October 2005; page 119

Commander Bernacchi in his article A LITTLE CLOSER LOOK AT TODAY'S SUBMARINE OFFICER FOR OUR SUBMARINE FOREFATHERS makes the statement that today's Submarine Officers are highly skilled in Nuclear Engineering and Navigation-
This is true: but I see a lack of an ingredient that has been lost in the Submarine Force. This ingredient is BASIC SEAMANSHIP.

The submarine officer is limited by a lack of training in seamanship, rules of the road, piloting and ship handling. It seems to me that the heavy reliance and the breakdown of the Navigation Team has resulted in some avoidable incidents.

I spend a year in Destroyers in the Gunnery Department and had the duties of Boat Officer, Division Officer, qualified as an OOD and observed the Breeches Buoy, Fueling at Sea and Ship handling, Navigation, and other Sea going operations.

In early days of Diesel Boating I had the pleasure of piloting, ship handling and that of a department head. I would never have entered a harbor without a local chart and a good feel fo the territory before relieving the OOD.

I know that the Airedale Navy had their pilots stand deck watches at sea as JOOD when the OOD was a LTJG and the JOOD was a LCDR.

I propose that short tour on a surface craft be part of the Command Path for Submariners.

As an example in the case of SAN FRANCISCO; I would have backed her back to Guam to take the pressure off the ruptured ballast tanks forward- I realize that the reverse turbine blades on the DD would have been handled with care for such a task. My nuclear only trained friends are of the opinion that you can not back a single screw vessel and maintain course- this I have learned to do success-

fully during my seatime with small craft and as Captain of 100 Ton Schooner.

As the Submariner Officer moves up the career path it is unrealistic to ask them to take command without the surface experience.

Frank A. Walker

THE SUBMARINE REVIEW

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

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The League prepares **REVIEW** copy for publication using Word Perfect. If possible to do so, accompaning a submission with a 3.5" diskette is of significant assistance in that process. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the **REVIEW**.

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

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

Articles should be submitted to the Editor, SUBMARINE REVIEW, P.O. Box 1146, Annandale, VA 22003.

OBITUARY FOR DR. DONALD MILLER

The enclosed obituary of Donald Miller outlines some of his work related to submarines. His primary lifetime efforts were submarine related. As a senior engineer at NUSC and then NUWC, his interest in his work took place not only at the laboratory but included being at sea on submarines to perform tests first hand. His leadership and administrative skills frequently took him to Washington where he contributed and had the respect of those with whom he came in contact at the Navy Crystal City offices and the Pentagon.

If it would be possible to mention Don's passing in The Submarine Review, it would be greatly appreciated. My association with him began in 1967. After he came to NUSC in 1973, we were colleagues. He was a gifted and talented person who gave broadly and effectively to all.

Sincerely,

John Merrill

Donald August Miller, 75 passed on Saturday, February 11, 2006 at Lawrence & Memorial Hospital in New London, after a sudden and brief illness.

He attended University of Illinois at Navy Pier, majoring in chemistry. In 1950 he volunteered for the U.S. Air Force during the Korean Conflict.

He resumed his college career at Northwestern University, earning a bachelor, a masters, and a doctorate in electrical engineering in 1964. He joined the former New London Sound Laboratory, the Naval Undersea Systems Center in New London in 1973, retiring in 1994. While at the *lab*, he was the program manager responsible for leading the development, test, and deployment of the operational ELF Communications System, a position he held for 21 years. He spent numerous periods underway on submarines, including runs on USS ARCHERFISH (SSN 678), USS TREPANG (SSN 674), and USS VON STEUBAN (SSBN 632), testing and demonstrating

strategic communications systems. He and a team assisted the Navy by installing a communications system for use at speed and depth that allowed then President Jimmy Carter to ride the submerged USS LOS ANGELES (SSN 688) and remain in control of the nation's strategic posture. He also served at the submarine communications technology block manager with responsibilities for the Exploratory Development Programs. He was awarded the NUSC Excellence in Management Award in 1978, the NUSC Commander/Technical Director Award in 1986, and the U.S. Navy Meritorious Civilian Service Award in 1987. In 1994, he was awarded the NUWC Submarine Communications Department *Submarine Sail* Award for significant leadership and contributions in the research and development efforts to support submarine communications into the 21st century and the NUWC *Decibel* award for significant, internationally recognized expertise in submarine communications.■

REUNIONS

USS NATHANAEL GREEN SSBN 636 Apr 29-30, 2006
Cape Canaveral, FL
POC: Tom Carr reunion636@hotmail.com
Web Site:
http://www.angelfire.com/mo3/ozarkrunner/Upcoming_Events.html

USS RASHER SS/SSR/AGSS May 7-9, 2006
Loc: Silverdale Beach hotel
POC: Nelis Vander Pol 5607 NW Bryan Road, Bremerton, WA 98312
Phone: 306-377-1750 E-mail: vansrus@att.net

USS CAIMAN SS-323 May 15-19, 2006
Flagstaff, AZ
Loc: Radisson Woodland Hotel, 1175 West Route 66, Flagstaff, AZ 86001
POC: Doug "Smitty" Smith, 360-377-4763 E-mail: dbfrider@comcast.net
Web Site: http://www.flamincaiman.org

USS SEA POACHER SS-406 May 18-21, 2006
Virginia Beach, VA

USS BOSTON SSN-703/CA-69/CAG-1 Jul 13-16, 2006
Chicago-Oak Brook, IL
POC: Arthur L. Hebert, PO Box 816, Amherst, NH 03031-0816
Phone: 603-672-8772
Web Site: http://www.ussboston.org

BOOK REVIEWS

SILENT STEEL
THE MYSTERIOUS DEATH OF THE NUCLEAR ATTACK SUB USS SCORPION

By Stephen Johnson
John Wiley & Sons, Inc., 2006
292 pp - $25.95, IBSN 10 0-471-26737-6
Reviewed by RADM Ray Jones, USN(Ret)

Rear Admiral Tom Evans provides a great insight to this book in his remarks contained on the book's jacket: "Stephen Johnson has crafted a forensic masterpiece that leads the reader back through time to unravel the gnawing enigma of the tragic loss of the nuclear attack submarine USS SCORPION. Sifting through a maze of conflicting theories, he meticulously lays out a tale of undersea detectives searching for conclusive evidence to one of the most baffling mysteries of the cruel sea."

The book provides a very interesting in-depth review of the loss of SCORPION and the results of the investigations that followed the ship's loss. It includes personal looks at many of the key people serving on the ship and those that conducted the many investigations held after the accident. Through all this the author weaves a good story, and keeps the reader's interest.

I was unable to find any unturned stones in the book as to what may have caused or contributed to the ship's demise. I would recommend this book to all submariners, especially those now serving on submarines. Having served in the Submarine Force during the tragedy, and implemented the many safety related changes that occurred after the incident, there are lessons still to be learned or understood through reading this comprehensive review of the accident.

The book was a quick and intriguing read. I am at a disadvantage in that I never served on a SKIPJACK class submarine. Therefore there may be technical errors about the ship of which I am unfamiliar. I must admit that I was unaware of a lot of information presented in the book. I was most concerned to learn about the continued

postponement of repairs to SCORPION's emergency blow system. A fact I find most disturbing.

The author attempts to be unbiased, and usually portrays both sides of the issues. The bias appears to me in the amount of space the author gives to the various points of view. Submariners may be disturbed by how the author chooses to describe events or situations. However to readers not part of our service, most remarks probably will seem reasonable statements based on what is presented in the book.

The inclusion of personalities and their stories adds a good dimension to the book. In my judgment those who are most critical of the ship are overplayed. The insights of a few young, inexperienced, disenchanted crew members are not balanced by other very experienced submariners who were interviewed by the author.

What is not accurately portrayed is the fact that the SUBSAFE program, despite its difficulties in full implementation, immediately and significantly increased submarine safety. Operational necessities of the Cold War did place tremendous demands on the Submarine Force. During this period difficult decisions regarding the implementation of the SUBSAFE program had to made. The reader is left with the feeling that the leaders of the Submarine Force relegated safety to a low priority, and allowed unsafe changes to the program. The SUBSAFE program was changed to allow submarines to operate under very specific operational limits. These strict limits were carefully developed by NAVSEA, and were to ensure ships remained in a safe operating envelope. The Submarine Force is a *can do* service, and takes extraordinary measures to meet commitments, but never to the point that overall ship safety was placed in jeopardy.

The author's conclusion that "the SUBSAFE program became its own worst enemy" leaves the reader with the wrong impression of this highly successful program. Certainly those that managed the SUBSAFE program had a difficult job in determining when and where these modifications would occur. However, the operational restrictions imposed were aimed at providing the necessary margins of safety for those ships without the full SUBSAFE installations. The overall safety of the Force was greatly improved by this program, which included a wide range of safety improvements to both equipment and operating procedures. The fact that, in hindsight,

more could have been done on SCORPION should not be taken that the program was seriously flawed, and perhaps, as implied by the author, actually reduced submarine safety.

The book fails to reflect the strong safety culture of the entire Submarine Force, but rather implies that crew members were totally safety minded, and those in responsible leadership perhaps were suspect. The author made the statement: "Any dissent was muted by the culture of audaciousness that permeated the Submarine Force." In my 34-year naval career in submarines I never once experienced such a culture. My experience found that a profound safety culture permeates all that design, manufacture, maintain, schedule, command, and operate these ships.

In the end the reader is left with unfulfilled expectations. The Navy's formal court of inquiry found no conclusive evidence for the loss of SCORPION, and respectfully neither does the author. No postulated scenario or incident provides the complete answer. Readers are left to make their own conclusions. I am sure most readers will develop their favorite theory.

The book weaves a complex story, and keeps the readers interest throughout. Unfortunately, the reader is left with the notion that this tragic loss has served no purpose, and is soon to be totally forgotten. What is missing is that the *not knowing why* contributed significantly to increased submarine safety in that her loss caused every aspect of submarines and their operations to be closely re-examined and improved.

The lessons learned from this tragic event are still taught to every submariner, both officer and enlisted. The fact that the absolute reason for her loss is unknown provides a continuing reminder that submarine safety requires constant vigilance by all of those who serve on or support these ships. This enigma is SCORPION's legacy.

The author leaves us with the most appropriate monuments to SCORPION's crew as being " their shattered ship and the memories of those that knew them," and does not include a legacy for the ship. As devastating as this terrible accident was, its impact has produced a better Submarine Force. In many ways USS SCORPION's legacy has ensured that today's submarines are not only the most capable in the world, but also the safest.■

Chapter 1
"BORIS"

by CAPT T. J. Smith, USNI(Ret)

Editorial note: CAPT Tom Smith has written a submarine memoir UNDERSEA STEALTH: Submarining in the Cold War, from which this chapter has been excerpted. Publishing an excerpt, vice having a book review done, is an experiment in getting a work before our readers so they form their own opinions.

Capt. Smith graduated in 1953 from the U.S. Naval Academy. He served aboard two destroyers, four submarines (including Executive and Commanding Officer tours) and was Executive Officer of a deployed submarine tender (Holy Loch, Scotland). He served on submarine squadron and group staffs and also on the staffs of the Chief of Naval Operations, the Secretary of Defense and the Naval War College. He retired from the Navy in 1979. He and his wife, Eleanor, reside in Williamsburg, VA.

Situation

Area: Mediterranean Sea
Fleet: Sixth
Mission: Covert Soviet Surveillance
Area of operation: Gulf of Hammamet, Tunisia
Fleet unit assigned: USS BLENNY (SS-324)
Date: November 1966

General Area of Operation Environmental Data

Depth of water: 120 feet (average)
Wind velocity and direction: 15–18 knots, 270 degrees (west)
Sea state: 1 (three feet, slight chop)
Visibility: Unlimited, morning haze
Sunrise: 06:30 (mean time)
Sound velocity profile: Isothermal to periscope depth

Own Ship Data
Submerged: Periscope depth (56 feet)
Speed: 5 knots
Course: 270 degrees (west)
Battery Capacity: 90%
Weapons Readiness Data: Warshots, Forward Torpedo Room: Tube loaded Four MK14-5A, Two MK37-1
Warshots, After Torpedo Room: Tube loaded Two MK14-5A, Two MK37-1
Sixth Fleet Operational Intelligence: Minimal (initial only); None provided after deployment
Sixth Fleet Guidance: None provided after deployment
Rules of Engagement (ROE): None

USS BLENNY (SS-324) has been on its own for almost three weeks, covertly surveying three Soviet naval vessels. During this period of time, we have received no intelligence data as to the possible purpose of the three Soviet warships, no specific guidance, and no rules of engagement (ROEs) that would guide our actions. We have been told simply to "gain all possible intelligence and to remain undetected." This is really all the guidance we need, but based on our observations, we have developed our own ROEs for contingency planning, which we call "What Ifs": What do we do if the Soviets do something?

This is not the first time that BLENNY has been on this type of covert operation, but this one makes us feel somewhat abandoned from a support aspect, especially earlier, when we had to evade an Italian warship that entered our assigned surveillance area unknown to us. Why weren't we told that he would be in our area? Which raises another obvious question: Who is in charge of this operation?

In a covert deployment such as this we are under strict radio silence, which precludes us from transmitting at any time and for any reason. *Strict radio silence* needs no interpretation and we don't attempt any. We have been told in general terms what we're to do. We, therefore, assume that we have all the information we need and that if there is anything of significance, then it will automatically be passed on to us. Having said the above, then why weren't we

informed about the Italian warship that entered the area and that we had to evade?

We do have authorization, however, to break radio silence and transmit on one condition and one condition only, and that condition has not been met in the three weeks that we have been closely watching the three Soviets in the shallow waters of the Gulf of Hammamet off the east coast of Tunisia in north-central Africa.

Through the number 2, or attack, periscope, I looked at a Soviet warship that we named BORIS. As Commanding Officer of BLENNY, I have ordered my crew to battle stations, and during our current periscope approach we were simulating the procedure for firing two warshot torpedoes at BORIS, which would easily send him to the bottom.

Why were we making this simulated torpedo approach? Simply because it would sharpen our skills with a real potential adversary as a target—and we might have had to take him on at some future date.

Our tactics and fire control solution for attacking BORIS were textbook and simplicity in itself. Four basic unknowns need solving before a submarine can successfully attack a ship with torpedoes. The target's speed, course, and range, or distance from the firing ship to the target, plus the true target bearing from the firing ship to the target must be determined. These data are not always easy to obtain, but BORIS's lack of movement simplified the data-gathering and solution process significantly. BORIS had no way on, which meant that he was not moving. Therefore, target speed was zero. The first unknown was solved.

We solved his course, or direction of movement, by applying his *angle-on-the-bow* to his true bearing from us. Angle-on-the- bow (AOB) is the aspect the target was presenting to us, measured in degrees from his bow to his stern, or from 0 degrees to 180 degrees. The number of degrees is preceded by *port* or *starboard*, depending on which of the target's sides we were looking at. Tradition calls a 0 AOB a *down the throat* shot. Conversely, a 180 AOB is an *up the kilt* shot. We were slowly closing BORIS on a course of 270 degrees (due west). We maneuvered so that BORIS's AOB was *starboard 90*. This position presented his whole starboard side, his full hull length, to us, thus providing the largest possible target to shoot at. We were now dead on his starboard beam. With this aspect, BORIS

had a heading or course of 000 degrees (due north). The second unknown was solved.

An accurate target range was readily and covertly obtained through an optical range finder (stadimeter) built into the attack periscope. An optical range can be obtained during a three-second periscope observation. The third unknown was solved.

True bearing to the target was automatically provided by the attack periscope when the crosshairs were centered on the target. It was obtained at the same time as range. The fourth and final unknown was solved.

Data received were entered into the MK4 Torpedo Data Computer (TDC). A green light winked, indicating that the inputs had generated a proper firing solution. We were ready.

The TDC then computed an input to the torpedo known as *torpedo gyro angle*. A gyro controls the torpedo's course, and the appropriate gyro angle was fed electrically into the torpedo. When the torpedo is launched, it runs straight for a short distance and then turns left or right to the value of the computed torpedo gyro angle. Torpedo gyro angle was thus the lead angle the torpedo took in order to intercept a moving target. Torpedo gyro angle in this case was zero as, again, BORIS was not moving and we could shoot along the target's true bearing to hit him.

We were deliberately approaching BORIS from seaward, or from the east. It was morning, and an hour-old sun was still low in the sky and to our advantage—behind us. If BORIS had glanced in our direction, he would have been looking directly into the sun's glare. Three-foot waves and a light chop also helped mask our attack periscope. BORIS's two companions at this time were not close by, which was very much in our favor. We were ever mindful of them, and they bore continual watching, but they did not represent a threat as they were currently quite distant and our present course increased or opened our range to them.

The shallow water in our area (about 120 feet) was, however, a constant worry as we had essentially lost a prized capability of a submarine: being three dimensional. We had lost our ability to *go deep* and rapidly get away from potential problems—or, for that matter, real problems.

BLENNY was ready to shoot from a fire control solution aspect, but we needed to get a little closer to BORIS in order to be within effective torpedo range. At 5 knots we were slowly closing and would be within range in about a mile, or 2,000 yards. At this speed we would traverse the 2,000 yards in 12 minutes. An ideal firing range, in this case, was 1,500 yards, or three quarters of a nautical mile.

There was obvious tension in the boat. Conversation in the conning tower consisted almost solely of my periodic command to raise the attack periscope to take an observation on BORIS in order to update range and bearing. A quiet fire control party indicates an efficient and knowledgeable organization. BLENNY had that organization. A periscope observation took about three seconds once the periscope was fully raised until it was on its way down. The verbal commands were necessarily terse and simple. "Observation number 2 scope, up scope! Bearing, mark! Range, mark!" Then slap up the periscope handles as a signal for the periscope assistant to lower it and lower it smartly. Three seconds—or you need more practice. As we closed the range and BORIS filled more of the periscope's field of vision, we increased our depth a foot at a time in order to minimize the amount of periscope exposed above the surface. Stealth is a submarine's trademark, and we used stealth to the fullest.

We could sink BORIS from our current position with a MK37-1 relatively long-range wire-guided torpedo, and we were prepared to do so; but our weapon of choice was an old-time, reliable, heavyweight MK14-5A torpedo, which was faster and had a much larger warhead, but was hampered by a shorter range. We thus continued to move closer and to shorten the range to 1,500 yards.

BORIS had an opportunity to detect our presence but he would have had to be constantly in a high state of alert readiness, which was not generally the norm or a posture he would have had in effect in his current role. Opening the outer door of a torpedo tube in preparation to fire was a relatively noisy evolution. We were close enough to BORIS that he could have detected this transient and identifiable noise and perhaps have rightfully concluded that he was not alone and was, in fact, in harm's way. A torpedo tube outer door can be opened in less than five seconds—not much time for BORIS

to react even if he had detected the evolution. But regardless of any action on his part, the next thing he would hear, almost instantaneously and very loudly, would be two torpedoes heading toward him at 45 knots and dead on his starboard beam. He would hear them running for exactly 63 seconds and then he would be deaf forever. He had no chance for survival.

I ordered the helmsman to come right, change course to 045 degrees, and increase speed, but only slightly, as we had no desire at our shallow depth to make noise by a physical phenomenon known as *cavitation*, which is produced by a propeller rotating at high speed and at shallow depth. Cavitation, like a torpedo tube outer door opening, is a dead giveaway as to what produced the noise. We obviously chose to remain anonymous and thus headed away from BORIS to the northeast and out into the Mediterranean and deeper water. I had the word passed to *secure from battle stations* and there was an almost audible sigh of relief throughout the boat, and rightfully so.

This was the second *attack* that we made on BORIS, and perhaps the reality of what we could do and what the consequences would have been permeated our thoughts.

As previously stated, we had received no guidance as to what to do if BORIS decided to take action—and he was capable of some pretty impressive action. It was also not logical for a covert-on-the-scene U.S. submarine to ignore the potential that BORIS possessed. Something either was not right or had been poorly managed, and we were right in the middle of it. We were 99.99 percent convinced in our own minds that BORIS was a *flag-waver*. He wanted the Sixth Fleet and NATO to know that he was a relatively capable entity and that he was sitting smack-dab in the middle of the Mediterranean Sea for everyone to look at—hopefully, from his perspective, in awe.

On BLENNY and without the niceties of rules of engagement, we had carefully formulated that BORIS would have had to meet six of our self-developed rules before we would deal him a critical blow—and then we would possibly still have a great amount of doubt. In our last two practice torpedo approaches, BORIS at both times violated only two of our six self-designed rules. Far from enough reason to pull the trigger. Had we perhaps been overreacting? Some would say that we had, but is it wrong to be prepared?

Absolutely not. Is it wrong to be prepared and overly react? Absolutely yes. We had been 100 percent prepared, but our common sense and judgment factors had also been running at 100 percent, and we were pretty much convinced in our own minds as to BORIS's purpose. Or were we? A flicker of doubt, but not much more. History tells us, though, about the Trojan horse. History also tells us that there was no possibility of Japan bombing Pearl Harbor, but the events of 7 December 1941 happened anyway. History tells us of any number of events that were thought to be improbable but occurred nonetheless.

Who was BORIS and what was he doing? What was his potential? Why were we on BLENNY concerned about him and why was the Sixth Fleet similarly concerned?

We have to cover a 36-year period of time before these questions can be answered, and then only partially.■

NAVAL SUBMARINE LEAGUE HONOR ROLL

BENEFACTORS FOR MORE THAN TWENTY YEARS

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NORTHROP GRUMMAN CORPORATION - NEWPORT NEWS
NORTHROP GRUMMAN CORPORATION
- OCEANIC & NAVAL SYSTEMS
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L-3 COMMUNICATIONS CORPORATION
MATERIALS SYSTEMS, INC.
MCALEESE & ASSOCIATES, P. C.
OIL STATES INDUSTRIES/AEROSPACE PRODUCTS DIVISION
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ADDITIONAL BENEFACTORS

APPLIED PHYSICAL SCIENCES CORPORATION
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BUSINESS RESOURCES, INC.
DIRECTED TECHNOLOGIES, INC.
DRESSER-RAND COMPANY
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eMAGIN CORPORATION
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NAUTRONIX MARIPRO INC.
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PINKERTON GOVERNMENT SERVICES
PRIME TECHNOLOGY, LLC
RADIAN MILPARTS
SUPERBOLT, INC.
WHITNEY, BRADLEY & BROWN, INC.

REUNIONS CONT'D

USS WILL ROGERS SSBN-659 Jul 20-23, 2006
Loc: To be determined in the Groton/Mystic CT area.
POC: Arthur B. "Arch" Achtemeier, ET1(SS), (66-72), 900 S. Odgen St., Denver, CO. 80209 (303) 733-8834
E-mail: arch659@msn.com

USS TIRU SS-416 Aug 17-20, 2006
Loc: Red Lion Silverdale Hotel, 3073 NW Bucklin Road, Silverdale, WA 98383
POC: W. Earle & Sandra Smith, 7169 SW Dunraven lane, Port Orchard, WA 98367
Phone: 360-876-0255, e-mail: 2006reunion@usstiru.org, Web Site: www.usstiru.org

598 Class Reunion Aug 24-27, 2006
POC: Doc McCance, 16 Chapman Lane, Gales Ferry, CT 06335, Phone: 860-464-6758

USS QUILLBACK SS-424/USS TRUTTA SS-421/USS PICUDA SS-382
Sept. 6-10, 2006, North Little Rock, AR, POC: Lee Davenport, 705 Ladon Street, Haughton, LA 71037, Phone: 318-949-4826,
E-mail: Davenport 2652@bellsouth.net

USS ALBACORE (AGSS-569) Sep 21-24, 2006
Albacore Park, 600 Market Street, Portsmouth, NH 03801
POC: jack Hunter (401) 849-7282 E-mail: hunter5982@earthlink.net
Web Site: http://www.ussalbacore.org

DOLPHIN CALENDAR CONTEST

The 13 winning entries will be published in the 2007 Dolphin Calendar for all to enjoy! Contest rules follow.

For more information contact your local Dolphin Calendar Chairperson or contact:

Michelle Rogeness
Dolphin Scholarship Foundation
5040 Virginia Beach Blvd. Suite 104-A
Virginia Beach, VA 23462
(757) 671-3200 dsfprojects@exis.net

Entries must be postmarked no later than May 31, 2006

Dolphin Scholarship Foundation

Cartoon Calendar Contest

- A total of thirteen (13) drawings will be selected for the **2006** calendars. A $25.00 cash award and a complimentary copy of the large and small calendars will be awarded to each winning artist.

- Drawings are to be of a humorous nature depicting life in the Submarine Service.

- All drawings must be originals in black ink on white paper (8 ½" X 11") in "Landscape Format". **Copies will not be accepted.**

- All drawings must be accompanied by the following information printed on the back of your entry.
  1. Artist's name
  2. Rank/Rate (Dependents should also include the name, rank, and duty station of their sponsor)
  3. Children should include their age.
  4. Duty Station
  5. Mailing address and telephone number.
- All drawings become the property of the Dolphin Scholarship Foundation and are non-returnable.

Send drawings to the following address:

Dolphin Calendar Cartoon Contest
Dolphin Scholarship Foundation
5040 Virginia beach Blvd., Suite 104-A
Virginia Beach, VA 23462
Entries Must Be Received on Premises by May 31, 2005

For more information contact DSF at (757) 671-3200 or
dsfprojects@exis.netd
Dolphin scholarship rules