THE SUBMARINE REVIEW
APRIL 1995

A Quarterly Publication of the Naval Submarine League

EDITOR'S COMMENTS

Since this is the year and the season in which Congress is to make a budget decision critical to the future of United States' undersea warfare power, it is fitting that the features in this edition of the **REVIEW** focus on the issues involved. This is a complex matter at a time of national cutbacks because the upcoming decision has to do with funding the third SEAWOLF at about $1.5 billion plus providing over $1 billion for R&D and advanced procurement of the New SSN class. It's a two-barreled shotgun that we're facing and we need to dodge budget-cutting blasts.

To lead off, COMSUBLANT's address to a meeting of the Submarine Industrial base Preservation Council provides a concise statement of the need to build submarines now, just when it appears to some that all threats to American interests died with the Berlin Wall. He does so in terms of a military need for submarines, the necessity of maintaining the industrial base, and the financial logic of not postponing today's problem until an even more expensive tomorrow. Vice Admiral Emery's summary is followed by a statement of need for the New SSN from Rear Admiral Chuck Horne, a surface officer of some renown in littoral warfare. Admiral Horne's endorsement of the concept and design is a strong one and deserves careful consideration by those now embarked on such a momentous decision.

The third in this feature series is a report to the League membership of the Navy's position and actions on both sides of the year's submarine request—the SSN 23 and the New SSN—by Rear Admiral Dennis Jones, Director of OPNAV's Submarine Warfare Division (N87). A number of members have asked about both the direction and the substance of the Navy's Submarine Program and, as any who know submariners of any ilk can testify, there is no end of sure-fire suggestions. Several have written thoughtfully, questioning various aspects of the Program, however space does not permit us to print them all. One particularly cogent piece by Mr. Steve Stone of Mississippi surveyed the salient issues from a layman's viewpoint and asked about optimum force size, ship design concepts vis-a-vis a high-low mix and reconfigurability, the reality of submarine missions, and the long-term need for the building infrastructure. To address the body of interested questions from those not in the direct Pentagon action loop, **THE SUBMARINE REVIEW** asked Rear Admiral Jones to outline where we are and where we're going—his article provides the Navy's logic for its submarine requests to Congress, and describes the importance of their decisions.

In addition to the *optimum submarine for the future*, two other matters always in the forefront of submarine community discussions are (a) *the way it was in the old boats*; and (b) *why can't the Submarine Force adapt to new ways faster*. Because the **REVIEW** is for the whole submarine community of strategists, tacticians, operators, maintainers, developers, builders and the all-important interested observers, we try to present articles and arguments for all shades of concern. This issue attempts one way to do that with a wide range of opinion and reporting. We proudly present herein: some history of technology, some technological history, updates on new foreign submarines, reports of foreign research, comments about old missions, and thoughts about new missions. In addition, there are practical suggestions from hard-won experience, policy questions from on-the-line operators, far seeing hardware concepts, force structure advice, and even some added thoughts about someone previously lauded in these pages for his contributions to undersea warfare.

For those looking for anecdotes (and who doesn't seek some relief from all the serious stuff) and sea stories we can offer several; from the WWII era through the late Cold War. Two more speeches on the inactivation of proud boats by ex-skippers round out our serving of reflections and sentiment. Then there are the two series pieces: a bibliography of torpedo information by a most knowledgeable researcher, and a war patrol from a hero in the true submarine sense of the word. We should all learn from George Street's perseverance in the search and audacity in the attack.

This survey of the horizon of submarining is meant as a call to any out there who believe that their particular interest is being slighted—in the slightest. Please send us a note and tell us your concern and/or complaint. We have gotten some, and they serve us well in directing us along the road to giving you a better magazine, and the community a more representative voice. Thanks.

Jim Hay

Naval Submarine League Symposium Registration

Remove this page and fill in both sides (703) 256-0891

CUTOFF DATE

Symposium and Banquet Reservations are required by midnight, Thursday, May 31, 1995. There will be no refunds for cancellations after June 1. Please assist our limited staff by booking early. First come, first served.

RESERVATION - 13TH ANNUAL NSL SYMPOSIUM

June 6 & 7, 1995

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THE SUBMARINE HERITAGE MEMBERSHIP PROGRAM

CAPT John Shilling, USN(Ret.)
Membership Chairman

The League membership has been in a *steady state* mode for the past couple of years. Today, more than ever before in the history of the Submarine Force, we need to be **growing** to increase our sphere of influence in support of a strong Submarine Force.

We need to deliver the submarine message to people who care about the country's defense but lack the understanding of the submarine's role in the new concepts of littoral and regional warfare. What can you as a member do to educate others and enlist their support?

Our **SUBMARINE REVIEW** reflects not only current submarine issues, but more importantly, covers the traditions and history of the Submarine Service, a heritage that each of us helped create. We can be proud of our contributions as members of the U.S. Navy's Submarine Service. Of necessity, many of our deeds have been kept under wraps for security reasons, and even our families and close civilian friends have little understanding of what we were doing during our long deployments at sea. The articles and letters in the **SUBMARINE REVIEW** help preserve the heritage and thus create advocacy.

To this end, you will find at the back of this issue, a new form of gift membership, entitled the **Submarine Heritage Membership** which will be dedicated in honor of your service to the Navy as a submariner. The opportunities for this gift are limitless—birthdays, graduations, reunions, etc. for family and friends. It will be given in your name with an appropriate announcement concerning your service. Let's take this opportunity to begin building our own *grass roots* constituency and at the same time share with those closest to us some of the experiences of life under the sea. ■

<u>REMARKS TO THE SUBMARINE INDUSTRIAL BASE PRESERVATION COUNCIL</u>

by VADM George W. Emery, USN
COMSUBLANT
The Washington Court Hotel
Washington, DC
7 February 1995

Good evening and thank you. It is a pleasure to be with you this evening because I get another chance to talk about one of our national treasures, the Unites States Submarine Force.

I realize that you all are here because you are concerned about submarines and that you have indeed heard at least some of the current saga of the submarine, but I think it's worth reflecting on again this evening.

What I want to do is describe a little bit about why I feel the United States needs submarines and highlight the basic issues that face the force this year.

The entering argument to our naval defense needs is that we are an island nation, dependent upon the free flow of ocean-going commerce to sustain our way of life. Following that thought is that commerce will not flow freely unless we keep the oceans free for our use, that we remain strong enough to prevail where another nation would deny our use of the oceans or would deny the flow of our commerce. We have chosen to meet our threats beyond our shores, not waiting until the problem reaches the mouth of the Chesapeake or the Golden Gate, but instead taking on would-be challengers forward, across the seas that surrounds our nation. <u>Forward...From the Sea</u> is our naval strategy for making this happen.

Our nuclear submarines are a key element of this strategy. The inherent stealth, mobility, firepower and endurance they bring to a battlespace allows them to dominate many mission areas in their own right as well as contribute in a big way to overall force effectiveness. Today Joint Task Force Commanders deploy with submarines integrated within their battle forces that contribute to a wide range of missions. For example: the Tomahawk cruise missile allows the Commander the delivery of a low risk strike engagement. Special Forces can be covertly delivered and recovered for a variety of purposes. Countering a submarine threat is still best done with the Commander's submarines. Covertly planted minefields can be laid with impunity. Surface ships can be attacked at long distance with cruise missiles or up close and personal with torpedoes. Forward presence is enhanced by the submarine's unique ability to control its visibility. Surveillance, indication, and warning allow data collection that is often available from no other source. We used them to help defeat Iraq, restore democracy in Haiti, support operations in the Adriatic, and counter drug operations as well. Today's Joint Task Force Commanders recognize that the submarine is an extremely versatile platform and use them accordingly.

The questions facing our country today are two: first, whether or not we will retain our submarine warfighting dominance; and second, whether or not an industrial base capable of producing advanced technology submarines will survive. Other nations are building nuclear submarines, some of which are every bit as quiet, or quieter, than the ones we have today. Some nations are building or buying conventional submarines, which will potentially allow them to wield affordable superpower influence. Today roughly 600 submarines are operated worldwide by over 40 nations. Since 1990 the number of countries with an indigenous industrial diesel submarine construction capability has grown by five as Australia, Brazil, Turkey, South Korea and India have joined the ranks.

As a military commander, I can tell you that I have missions waiting for advanced submarines today. The unanswered question is whether we will have the submarines we need tomorrow. And the answer to that question centers, of course, on their affordability.

Our answer to the questions, the Navy's plan of action is twofold:

- build the SSN 23, the third and final Seawolf class submarine
- commence low rate production of the New Attack Submarine (NSSN).

There have been some 10 studies of the nuclear submarine industrial base conducted between 1992 and 1994 that have shown this plan to be a fiscally responsible means of maintaining the ability to build submarines in this country.

Why should we build the SSN 23? First, and most importantly from my viewpoint, it gives us a military capability I need today. Secondly, it capitalizes on the $900 million already invested on the project and maximizes the affordability of the New Attack Submarine. Thirdly, SSN 23 serves as a construction bridge to allow retention of both perishable industrial skills and a perishable vendor base needed to support a future building program.

Why should we build the NSSN? For the same reasons we need SSN 23. Because new submarines of potential adversaries are getting better, eroding the substantial advantage that we once enjoyed in stealth.

The question of what to build to recover that advantage—more Seawolfs, more 688 Los Angeles submarines or the NSSN—is both a business and military one.

We have improved our 688 submarines to the point that the margin for further improvement of that platform in quietness or capability is very nearly gone. There are capabilities in areas such as communications, special warfare, and mine countermeasures that need improvement in view of currently available technology and the Navy's shift in emphasis to littoral engagements. Additionally, an **affordable** submarine with the requisite technical characteristics and capabilities is essential if we are to meet force level needs of the future.

In view of these factors the right submarine to build is **neither** another Los Angeles class submarine nor another Seawolf, but rather a more affordable submarine with Seawolf quietness and advanced systems.

An affordable submarine is likewise essential if we are to sustain the submarine industrial base, an industrial base that has no civilian equivalent, and an industrial base supported by unique vendors. *[Editor's Note: See Figure 1.]*

<u>Vendor base</u>. That, of course, means you. All of those 10 or so studies I mentioned earlier repeatedly concluded that you all will have a rough time staying in business if you don't get some business. The studies also say that if you get out of the submarine business, that the cost of getting back into the business will be high; perhaps so high that neither you nor the country can afford to ever start again. That makes sense to me. Correct me if I'm wrong, but it seems to me that if you have to wait six years between job orders, those jobs will be pretty expensive.

That's the time period we are looking at if the SSN 23 is not authorized in 1996. The last year we authorized construction of a submarine was 1991, when both a Trident and the SSN 22 were authorized. We need the SSN 23 authorized in 1996. We need the NSSN program as funded in the President's FY96 budget and the associated FYDP.

The Submarine Force is downsizing, just like the rest of the Navy, just like the rest of the armed forces. But as with the other services, too much downsizing will impact our ability to carry out our assigned missions. *[Editor's Note: See Figure 2.]*

If we were to rob Peter to pay Paul, we could refuel some of our older submarines and slow the rate at which the force level declined.

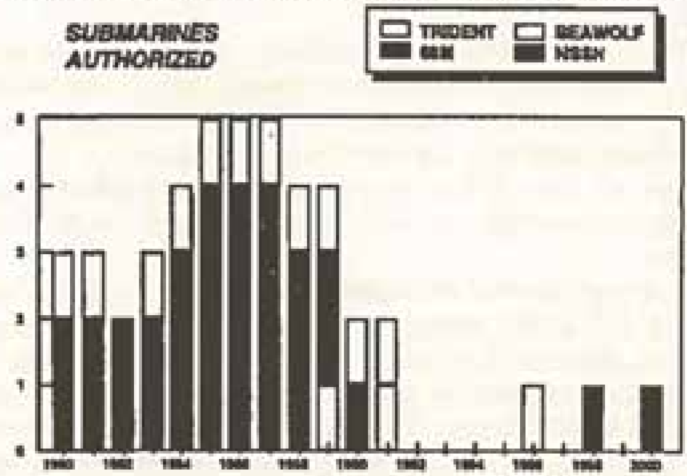
If we were to rob Peter again to pay Paul we could do some research and maybe extend the life of our older submarines to postpone the numerical crisis for a few years. But the fact remains that the relative quality of these forces will decline compared to those being built by other nations. The fact remains that the government's budget is a *zero sum* budget, and therefore money we use to maintain older submarines will not be available to invest in more capable submarines needed in the future.

Further, without a building program, I fear there will be no industrial base to get us started again when this country finally decides we need to build them.

I believe that our national dominance in the undersea battle-space is at stake. I am fully engaged in keeping my military and civilian commanders aware of this issue and briefing them on the potential consequences. I am convinced we need this submarine's military capability. I am convinced we need this submarine as an industrial bridge to the NSSN. It makes good military sense; it makes good business and fiscal sense.

Thank you. ■

SNAPSHOT OF THE INDUSTRIAL BASE

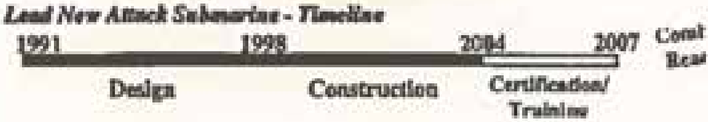


PLAN OF RECORD

Why build submarines now?

Projected Force Structure without New SSN

Lead New Attack Submarine - Timeline



THE REAL NEED FOR THE NEW ATTACK SUBMARINE CLASS

by RADM Chuck Horne, USN(Ret.)

[Editor's Note: Rear Admiral Chuck Horne is a surface warfare officer who has specialized in littoral warfare as Commander of Swift Boats in the Vietnam conflict, Commander Mine Warfare and Commander Naval Forces Korea.]

Statement of Need

The United States needs an affordable submarine class that, in addition to being as quiet as the SEAWOLF (SSN 21) and as capable in open ocean performance, is conceptualized for, designed for, and optimized for littoral warfare, to implement the presence, crisis management, and battlespace dominance requirements of "Forward...From the Sea".

Affordable

Industry and the Department of Defense have worked long and effectively to make the New Attack Submarine 30 percent more affordable than continued Seawolf production after the SSN 23, the needed *bridge* to the new class. To do this, they made some carefully considered tradeoffs. For example, appreciating that every increase in speed requires a concomitant increase in shaft horsepower three times as great, they relaxed the maximum speed requirement and thereby decreased the size and cost of this new submarine class significantly. Other examples include smaller but more flexible weapons stowage and a reduction to four torpedo tubes.*

Equally Quiet

There were no tradeoffs in quieting, however. Thanks to additional technology, the New Attack Submarine will be equal to the Seawolf class in this respect. This is vital because of the quietness of the new generation Russian submarines (improved

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* "New Attack Submarine (NSSN) Independent Characteristics Review", May 1994, prepared for the Assistant Secretary of the Navy (Research, Development & Acquisition) by the New SSN Independent Review Group (INRG).

Akula and Severodvinsk classes) and of the new diesel submarines being acquired by many regional navies.

First Class to be Designed for Littoral Warfare

In addition to optimum performance in the classic *Hunt for Red October* open-ocean arena, the New Attack Submarine will incorporate new capabilities specially designed for littoral warfare. With premier performance in the littorals as their major objective, the top technical people in the Department of Defense developed a wide range and depth of enhancements, including:

- Built-in enhancements for antisubmarine warfare, special operations, and mine warfare;
- Built-in enhancements and growth potential for magnetic stealth;
- Major improvements in shallow water antisubmarine warfare, including lightweight wide aperture array sonar;
- Enhancements for incorporating unmanned underwater vehicles (UUVs) and the quantum leap in surveillance and mine avoidance/clearance they introduce;
- Vertical launch systems for Tomahawks;
- Modularity for flexibility and evolution.

Significant Contributions

With an affordable and quiet submarine capable of top performance in both open ocean and littoral waters, the United States will have a powerful new asset for deterrence, crisis response, and winning wars. As and when future regional conflicts occur, the New Attack Submarine will be a vital contributor in the joint mix of U.S. forces. Like the knight of the chessboard, it will be a powerful and unique platform that can do things no other platform can do! Its significant contributions run the gamut from critical covert surveillance and direct battle group support, to offensive mining, special operations, antisubmarine warfare, surgical Tomahawk strikes, and more.

Needed Now!

For these reasons—submitted by a non-submariner—as well as to preserve the fragile and unique industrial base and achieve the Joint Staff-mandated force structure of 10-12 submarines as quiet as the Seawolf by 2012, the United States needs the New Attack Submarine class. And the sooner the better!

■

U.S. NAVY SUBMARINE FORCE

Where We Are and Where We Are Going

by RADM D.A. Jones, USN
Director
Submarine Warfare Division
Office of the CNO

The new and uncertain security environment of the United States, and indeed the world, that has followed the fall of the Berlin Wall and the demise of the Soviet Union, demands that we more frequently review where we are and where we are going with the nation's military strategy. A key element of this current and future strategy is of course the role of the Navy's Submarine Force. In this article, I hope to articulate the Navy's position as it has developed following such reviews. I believe it is important that those who faithfully support the Naval Submarine League have full access to the logic that has produced the Navy's current position.

Why Are Submarines Important?

First of all, the United States is an *Island nation*. As such, our country will continue to need a strong Navy to maintain the national security we enjoy. The Submarine Force will likely be an even more important part of this strong Navy team in this new era—an era that increasingly calls for us to be forward deployed, ready for combat, and defending our interests abroad on a daily basis.

Throughout the Cold War, the SSN's primary mission was to hold at risk the Soviet submarine force. The operative word here is primary, because SSNs have always been superb multi-purpose warships that require minimal defensive systems, can operate unsupported for extended periods of time in areas without air superiority, are impervious to ballistic and cruise missiles threats, can plant mines or locate and avoid minefields, can dominate undersea and surface adversaries, and can conduct land attack with both precision munitions and/or special operations and Marine reconnaissance forces.

Since the Cold War ended, the priorities for SSN employment have been revisited. These inherently versatile warships are being asked to fulfill more of the roles that kept them busy as far back as World War II, and some new roles that have grown out of this new multi-polar world. A partial listing of current and future missions includes: Carrier Battle Group support, Amphibious Ready Group support, Marine Expeditionary Forces support, strike warfare, surveillance, anti-submarine and anti-ship warfare, special operations/reconnaissance forces support, mine and countermine warfare, indications and warning, combat search and rescue, and forward presence. Whether independently or in consort with other forces, the SSN can provide the Joint Task Force Commander maximum flexibility in accomplishing assigned missions. It is also important to understand that these are not missions that we just talk about. Submarines are forward deployed, around the world, involved in many of these missions as this article is being written.

For example, SSNs remain on station, unknown to adversaries for extended periods, monitoring activity and providing real time information. Armed with this information, the United States can respond diplomatically in a timely manner to prevent conflict, while the SSN continues to measure the results of these actions. If diplomacy or deterrence fails, the SSN is positioned to respond militarily. Our attack submarines represent a capability against which there is very little defense.

I must emphasize that the heritage of the Submarine Force is one of versatility and readiness. Whether in war, crisis response or peace, submarines have consistently supported American foreign policy by providing the nation's leaders with a non-provocative, yet eminently lethal warfighting and peacekeeping force. There is no reason to believe this requirement will change in the foreseeable future. Therefore, maintaining and protecting the technological edge of our Submarine Force is of vital national interest.

Three Challenges

So as I look at what submarines are doing today and what we will be faced with tomorrow, I see three primary operational challenges: to preserve tactical superiority over Russia's increasingly advanced nuclear submarine force, to minimize the regional instability caused by the proliferation of advanced diesel submarines and to modernize all our SSNs to support the newly emphasized mission areas. I will address each of these briefly.

While the surface fleet of the former Soviet Union has rapidly deteriorated, this has not been the case with Russia's submarine force. Their research, development and construction programs remain aggressive. They have placed a national priority on submarines, and have succeeded in putting nuclear attack submarines to sea which are quieter and harder to find. Without implying sinister intent or purpose on their part, we, as a maritime nation must remain committed to not ceding undersea superiority to them or any other power.

The threat is not limited to Russian or nuclear submarines though. Of particular concern to our Navy is the increased proliferation of advanced diesel submarines. Today for example, there are 57 diesel submarines under construction. A majority of these will be exported. Several third world countries, most notably Iran, have made significant strides in submarine operational proficiency in recent years. This experience, coupled with these technologically advanced weapon systems and platforms, poses a significant threat to military and commercial shipping operating in the confined littoral regions and ocean choke-points of the world.

In addition to these specific threats, our Submarine Force must be ready to support all of the other missions which comprise our "Forward...from the Sea" strategy. We need to optimize the versatility of our ships for regional warfare, while still retaining deep water capabilities.

The evolution of these challenges naturally demands that the Navy reevaluate the capacity of its Submarine Force. The Improved 688 class submarines are capable of satisfying all the mission requirements today, but they were not optimized for regional conflict and are being challenged from a quietness standpoint in deep water. The threat was considerably different when they were designed. The first 688 class SSN was commissioned in 1976. The U.S. build 62 of these ships at a high rate over a 20 year period, and in the year 2000, they will make up almost the entire attack Submarine Force. With the new century, these ships will begin to reach end-of-life at a rate of two to four per year. So there is a requirement for improved performance and an eventual replacement. The Seawolf and the New Attack Submarine classes provide that improvement and respond to the challenges.

The Navy has therefore committed itself to a recapitalization methodology, while downsizing to a much smaller force. The key to the success of this recapitalization plan was the decommissioning of all 637s and some of our older 688s in order to support this new generation of SSNs. By the year 2000, the downsizing will be complete and we should be well on our way to stable low rate production of the New Attack Submarine in order to maintain our force at the prescribed level and preserve the ability to meet the nation's needs well into the future.

Why SSN-23?

The path to the accomplishment of this plan, and thus the appropriate response to the challenges that I have described, is not as easy as the simple statement suggests. Force level reduction and transitioning from the high rate of submarine production characteristic of the decades of the '70s and '80s to the low rate production goal for the New Attack Submarine brings us to our current situation of a seven year gap in submarine authorization and the need for SSN 23. To properly represent the concerns and intentions of the Submarine Force, the history must be understood and the case must be made for the third and final SEAWOLF platform.

The lead ship of the Seawolf class, SSN 21 was authorized in October 1988. By early 1990, the Seawolf program was envisioned as a 29 ship class, to be built at a rate of three ships per year, and industry was gearing up to produce the components necessary to meet this requirement. By the spring of 1990, the Warship Review Study cut the class in half. In October 1990 the second ship of the class was authorized and in October 1991, the third ship was authorized. Then in January 1992, the Seawolf program was terminated after SSN 21. By May 1992, SSN 22 was restored by Congress and in late 1992 and early 1993, Congress, in response to the Submarine Industrial Base Studies, authorized funds to sustain the industrial base. One of the challenges in the coming months is to achieve the authorization of SSN 23 in fiscal year 1996.

There are three compelling reasons for completing SSN 23. First, it is the right military decision. The Seawolf class submarine not only addresses all current warfighting needs, but introduces capabilities and technologies that are lacking in today's forces and needed for the future. With its superior speed and payload, the Seawolf is ideally suited to deliver a rapid and decisive military response in the open ocean or littoral. The acoustic quieting achieved in this ship will preserve U.S. dominance of the undersea battlespace that has been increasingly challenged by the advanced, high quality submarines already being built by the former Soviet Union. The Russians today have six nuclear submarines at sea with quieting on par with our 688I class submarines, with an additional five under construction. Acknowledging this threat, the Joint Staff has called for 10-12 submarines of Seawolf level quieting by 2012. We need SSN 23 to help achieve that goal. In addition to acoustic quieting, Seawolf provides a reduced magnetic signature, making it less susceptible to mines and shallow water detection, improved electronic surveillance capabilities and the next generation sonar suite; all of which contribute to the missions assigned today and expected tomorrow. Seawolf can do every mission better than 688I

Building the third Seawolf also represents a responsible fiscal decision. Prior to terminating the Seawolf class and during the subsequent period of program restructuring, approximately $380 million of Seawolf class components were purchased. Additionally, $540 million directed by Congress for *SSN 23 or some other project to preserve the industrial base* has been responsibly directed toward the acquisition of SSN 23 components. As a result of this prudent allocation of resources, the remaining cost to build SSN 23 is about $1.5 billion. This is comparable to the cost of building a new 688I, and we get a far superior ship for our money.

SSN 23 construction not only makes sense from a military utility and cost standpoint but has also been proven through repeated studies to be the most cost effective method for retaining the skills required to build quality submarines. Among the alternatives considered, SSN 23 has been identified as the *only* feasible bridge to the 1998 start of the New Attack Submarine. The submarine industrial base is comprised of three major skill and labor elements: those involved with designing and building submarines, the non-nuclear submarine unique vendors and the nuclear vendors. While New Attack Submarine development/advanced procurement will support critical design and nuclear vendor skills, the SSN 23 is the only project available between now and 1998 that preserves the production skills of the shipbuilder and non-nuclear submarine-unique vendors. All other options considered include too much risk in maintaining or rebuilding these unique skills and facilities. The production activity over the next decade has been stretched to the breaking point. Any further disruption or alteration of the planned build profile could irreparably jeopardize industry's ability to deliver needed submarines in the future.

In summary, the decision to build *SSN* 23 is prudent because it provides unequaled military capability through its superior stealth, speed and payload; it takes advantage of funds already appropriated procuring the ship at a costs comparable with an Improved 688 class; and it preserves the nation's ability to build *high tech* submarines—providing stability during industry restructuring and transition to stable low rate production.

<u>How Many Submarines?</u>

Anticipating authorization of the third Seawolf and transition to stable low rate production of the New Attack Submarine, a natural follow-up question is often, "How many submarines will be enough?" Once again, the simplicity of this question does not capture the full scope of the issue. As I have already stated, submarines contribute far more to national security than just ASW. Thus, it is not enough to simply count the number of submarines in any given opponent's inventory and multiply by some weighing factor to decide submarine force size.

During the Cold War the opponent was well known, submarine requirements easily defined, and their contribution well documented. The end of the Cold War, with its subsequent reduction in global tension, has not produced a concomitant decrease in submarine utility. In this period of reduced potential for major global conflict, we have seen a dramatic rise in tension and conflicts that respect no boundaries. This proliferation of *hot spots* has increased the number of locations demanding SSN unique capabilities. Increasingly, the SSN is the lone U.S. representative monitoring the activities in regions of potential conflict.

In view of these developments, both the Joint Staff and the Secretary of Defense commissioned task forces to study the question of "How many submarines?" While the total number and the range of the two studies vary, both studies overlap at the number 55, with a high of 67. Actual deployment data during the last year would indicate that unless the requirements change—and I do not expect they will—the number to fulfill all missions currently assigned is close to 66.

However, the fact is, that calculating the long term number of submarines is the wrong thing to concern ourselves with at this time in history. When we deal with numbers of submarines, there are two more important issues that we should pursue on a timely basis. First, we must get the New Attack Submarine into predictable and committed low rate production as soon as possible, so we can reduce the cost to a level that we can afford to build multiple ships per year in the long term. Second, we should strive to meet the Joint Staff requirement of 10-12 Seawolf-like stealth submarines operational by 2012. In order to do this, we need the third Seawolf (SSN 23) authorized in 1996, start building the New Attack Submarine in 1998, and then produce these ships at the planned rate.

New Attack Submarine—The Right Ship

The New Attack Submarine is the right submarine for the future, a fact which has been reinforced by multiple studies. Historically, *warfare challenges* acted as the only innovation catalyst for weapon system design. Today, other factors have become equally predominant in driving new designs. In the case of the New Attack Submarine, three innovation drivers were at play. First, it was clear that this submarine would need to be more affordable—and the mandate for affordability promoted innovative thought in requirements setting, design, construction, and other technology applications. We have considered both initial construction cost and life cycle cost as a primary innovation driver. Using this approach, and by judiciously reducing the high end speed and the weapon capacity, we have produced a design that will cost about 30 percent less than a Seawolf, yet still deliver needed warfighting capability.

As we look at affordability for the future—or life cycle costs—there is increased importance placed on building a flexible platform—one that could easily change with future technology. This is the second basic tenet of the new design. The New Attack Submarine takes the technological advances of the Seawolf and applies them over the spectrum of warfare requirements, yielding a submarine which is not only matched to the missions we expect, but equipped with the flexibility and adaptability for missions not yet thought of. Bold measures are being designed in to achieve this flexibility—such as a reconfigurable torpedo room, modular isolated deck structure, an open architecture combat system and the use of commercial off-the-shelf technology. The New Attack Submarine is also being designed to be able to take advantage of new commercial technologies as they evolve.

The last innovation driver takes us back to the original impetus for new weapon systems—military requirements. The face of submarine warfare has changed since the Cold War and for the first time, we can optimize the versatility of a ship for regional warfare—while still retaining deep water capabilities. The New Attack Submarine is being specifically designed for the types of threats we anticipate and are currently experiencing in the littoral regions of the world. For example, the New Attack Submarine will be able to lock out nine Special Forces personnel at a time, and will carry the new swimmer delivery system. It will also be much quieter, both acoustically and electromagnetically, which is extremely important when dealing with the advanced diesel submarines and sophisticated mines that are rapidly proliferating to these potentially volatile areas. The New Attack Submarine's sensor systems will be substantially improved, and it will be able to incorporate state-of-the-art technology into its onboard systems. The designers have also restored the vertical launch system, giving it increased strike capability over the Seawolf class.

Simply put, the New Attack Submarine will be: more **capable** by retaining all key warfighting characteristics and being optimized for regional warfare; more **flexible** for future adaptation by responding to changing technology, threat and missions; and more **affordable** by prudently relaxing top end performance characteristics and using design innovations to reduce production and life cycle costs. The New Attack Submarine is the best balance between cost and capability and unquestionably the right side for the future.

Conclusion

As I see it, the SSN is destined to remain a vital part of our national defense in the foreseeable future. Our challenge is how best to invest today's scarce resources to meet tomorrow's threat. The Navy's program for funding the third Seawolf in 1996 and starting production of the New Attack Submarine in 1998, with an aggressive program to *right-size* the current SSN force, best satisfies the competing requirements of this challenge. This program will get us to stable low rate production of a submarine that is exactly the kind of affordable, multi-purpose warfighting platform the United States will need well into the next century. ■

SUBMARINE VS. MINES

by CAPT James H. Patton, Jr., USN(Ret.)

In the October 1994 issue of Naval Institute Proceedings, Ensign Jim Crimmins had a marvelous *Capstone* essay titled Mine Warfare and Submarines. In writing that, he managed to capture the essence of a vital issue that repeatedly *surfaces*, so to speak, at high level gaming of regional conflicts such as the annual GLOBAL series at the Naval War College in Newport.

Specifically, the sequence of arrival of U.S. mobile forces (primarily naval) at the littoral of a suddenly emerging *crisis* are SSN(s) within a couple of days, a battle group inside of a couple of weeks, and amphibious assault forces some time later. Unfortunately, when adversarial defensive mining has been employed (or even implied) during this period or before, the *risk management* realities of U.S. involvement in regional conflict loom large. The need for *traditional* sea mine localization and neutralization with uncertain assets from an uncertain location then inserts another large *time constant* issue into the presence and engagement equations. This easily injected impediment can often undo or significantly degrade the intrinsic advantages offered by mobile *From the Sea* power projection.

As Ensign Crimmins so properly highlighted, the key to untangling this operational *gridlock*, is that the first warships on the scene, the SSNs, be an integral part of the mine warfare *solution*.

However, *conventional wisdom* (almost always being an oxymoron—being neither) steps in at this point to point out that submarines are *historically* particularly vulnerable to mines, and cannot be jeopardized at this point due to their expense and the extreme U.S. public sensitivities to losses of platforms and people in conflict abroad. At this point, as always, it is advisable to review entering assumptions of the paradigm in question.

Many submarines have indeed been lost to mines—German U-boats in the North Sea and its approaches in both WWI and WWII, and U.S. platforms in and about Japanese home waters in WWII—most to moored contact mines. However, closer examination reveals that the great majority of these were lost while they were, in fact, operating as a particularly vulnerable *surface ship*—one designed that if *holes* (vents) were made in the *outside* (ballast tanks) of the vessel, it **should** quickly submerge—however, in this case with an OOD on the bridge and an open bridge hatch.

When this submarine is completely *involved* in its medium, though, it is an entirely different story. The ballast tanks are already full, and a *hole* in them raises some interesting (but not insurmountable) future operational problems, but does not equate to a platform kill. Furthermore, for those who would step in at this point with "Ah-ha" that the *bottom* vice *moored* mine hasn't been considered, the *kill mechanisms* of that insidious weapon should now be addressed.

Bottom mines *kill* essentially the same way that a perfectly delivered and fuzed torpedo does when fired against a surface ship. They (it)) explode *under* the hull, lift the middle part of that horizontally oriented and hydrostatically supported structure out of the water, at which point both ends fall off. This damage mechanism isn't available against a totally submerged object. Many readers will remember that there was some concern as to whether the half-tonnish TNT equivalent Mk 48 warhead would be effective against such as the Soviet OSCARs and TYPHOONs, where detonation would occur at the outside of the ballast tanks a few tens of feet from their pressure hull. As the ultimate argument against the effects of a 300-500 pound bottom mine somehow initiated a few *hundred* feet beneath a submerged SSN, consider the fact that the Navy has **purposely** detonated 5-6 tons of high explosives about 100 yards from submerged and manned SSNs just to see what circuit breakers would pop open and what equipment foundations needed strengthening so that they could be redesigned. This shouldn't be taken to mean that crew members weren't well advised not to have any loose dental fillings during this deliberate test, and also goes a long way to explain even a retired submariner's obsession with secure and proper stowage of things.

In any case, having defined a rather limited risk to the submarine, compared to a surface craft *if* a bottom mine were initiated, let us now address the available fuzing mechanisms which *could* trigger the mine.

	contact	acoustic	magnetic	pressure
floating	VL	N/A	N/A	N/A
moored	L	L	L	N/A
bottom	N/A	VL	M	VL

Table 1: Submarine Mine Activation Hazard as a Function of Type and Fuzing

Table 1 provides a matrix of essentially most mine types and fuzing options where moderate (M), low (L), very low (VL) and not applicable (N/A) are purely qualitative (and subjective) evaluations of relative hazard. It is to a large degree self-explanatory, and although what goes without saying should, the floating (illegal-but!) and most third-world moored mine variants (exceptions such as the U.S. CAPTOR are submarine-specific, relatively expensive, and appear not to have yet proliferated to any significant extent) can be essentially discounted, considering the operating domain and the modern *small object locating* sonars now at sea on U.S. SSNs and noted so well in Ensign Crimmins paper. As he also noted, organic remote or tethered sensors would be an enormous help, and are under development to provide enhanced capabilities for detection of the family of bottom mines.

But, if an SSN does inadvertently expose itself to a bottom mine:

- The ship would be a sound-quieting nightmare indeed if it were to initiate an acoustic sensor.
- Perhaps might provide an adequate signature to a magnetic mine trigger now, but should not in the future as we move from *deperming* to *degaussing*.
- Is absolutely **invulnerable** to that bane of minesweepers, the *pressure* mine—which requires a large displacement volume hull interacting with and at the air-water interface.

With all this *good news*, however, it must still be kept in mind that the SSN *is not* a **minesweeper**, but merely a platform who, during the Cold War and the realities of shallow water operations in support of the Maritime Strategy, was forced to develop a credible ability to detect and avoid mines in a relative sense, not necessarily *localize* them in an absolute sense, since navigational uncertainties could easily be a mile or two. That part of the *Revolution in Military Affairs* which now enables the new mission of detection, localization and **reporting** are vastly improved navigation (i.e., the Global Positioning System (GPS) plus or minus tens of feet) and far superior connectivity through better communications equipment and procedures (to include Link 11). It is indeed thinkable that the battle group and/or amphibious ready group will have a detailed knowledge of opposing minefields many days before their arrival.

Also, in spite of the reclama that the SSN is not a minesweeper, the Submarine Force's ongoing relationship and exercises with Special Forces provides an enviable capability for *unseen selective neutralization* of some number of mines that are really *in the way*. Although Special Forces are not usually permanently attached to deployed submarines, their equipment is often pre-positioned aboard, and it only remains to pull off some distance to receive a covertly *air-delivered* team of swimmers.

Conclusion

In admittedly redundant summary, it's beginning to be a common event among those who *game* future defense contingencies in a post-Soviet world. A *situation* develops with little *strategic warning* and proceeds to deteriorate rapidly. U.S. forces begin the process of mustering and moving, and among the more flexible of these, a carrier battle group (CVBG) or two are vectored towards the problem. Almost invariably, nuclear attack submarines either attached to the battle group, enroute for duty with the battle group, or otherwise deployed, are detached to proceed independently to the scene at high speed as the eyes and ears of the CVBGs. The *show stopper* for rapid and effective military *From the Sea* response occurs, however, when mining of the littoral is observed or suspected.

The *advance party* of SSNs in the reconnaissance and surveillance role is reminiscent of 19th century employment of cavalry ashore, and is in fact not far removed from that concept in a larger sense. The significant modern advantage is that technology now permits a superb degree of connectivity, and current General's Lee are spared the anxieties and worries about where J.E.B. Stuart is as he circumnavigates the Army of the Potomac. It was certainly among the roles and missions of these swift and stealthy scouting forces to note and report (and sometimes deal with) hazards along the route. We should expect no lesser tasking of today's swift and stealthy naval counterparts. ■

HMS GOTLAND - THE IDEAL SUBMARINE FOR THE LITTORAL AND OCEAN WATERS

by CAPT Jarl Ellsén, R.Sw.N.(Ret.)

February 2 at the Kockum's shipyard in Malmö, Sweden, a new class of diesel submarines was launched and christened by H.M. the King as GOTLAND, named after the largest island in the Baltic. Sweden, using submarines in their naval arsenal since Stockholm built SHARK in 1904, has, like the U.S. Navy, maintained a more or less continuous development of submarines ever since. For instance, the years immediately after WWII, the Royal Swedish Navy wanted to evaluate the true experience of modern submarine warfare. As in many other navies, the German Type XXI class gave most of the inspiration for the submarine of the 50s, the Shark (Hajen) class, launched 1955-57.

Of course the Gotland class, like the other 12 Swedish subs now operating, are mainly designed for littoral, and even shallower, waters with acoustically disturbed water conditions as is the case in the Baltic and the western approaches to the Swedish coast.

However, with the new UN and NATO policy, Partnership for Peace, which the Swedish government has fully accepted, Swedish weapons can be deployed far away from own coast. This may mean shallow or deep blue waters. The GOTLAND has been so designed. But let us first look at the boat itself.

The Boat

Gotland is a multi-purpose submarine for attack, surveillance, mining and ASW. It is developed from the Västergötland class (as was the Australian Collins class), but with a better endurance and fit for autonomous and stealthy performance. More qualified sensor capacity and air independent machinery has resulted in a relatively larger boat, but by international standards it is still a small one.

GOTLAND is a conventional single hull boat with the pressure hull divided by a tank section into two watertight compartments. The forward upper section contains crews quarters, electronics room, galley, mess and the control room. The tank section is also used as a platform for the URF (DSRV) and includes the escape tower.

For safety and environmental reasons there is a special electronics room for vital parts of the weapon systems. A large part of the upper space holds the control room, which also contains combat information and fire control functions. It also contains the wireless center and ship technical, diving and maneuvering panels. On the second floor: forward torpedo room, forward battery, spare torpedo arrangements and auxiliary departments.

Most of the space aft is occupied by propulsion and Stirling engines as well as by ship technical functions. Before description of the propulsion system let us have a look at the boat's main data:

- Displacement: 1500 tons (like the WWII fleet subs)
- Length: 196.8 feet
- Diameter: 20.3 feet
- Propulsion: Diesel-Electric, Stirling-Electric, skew-back propeller, speed 20+ knots (see below)
- Weapons: Tubes for heavy weight (21") and light-weight (16") torpedoes and mines
- Complement: 25 (compare with the old fleet boats!)

Weapons, sensors, tactical displays, shock resistance arrangements and signature reduction techniques are of state-of-the-art technology and commensurate with modern threats. The entire design is characterized by cost effectiveness. The habitability standards are high, especially due to the small crew, automation and remote control of functions on board. Thus the crew's quarters are divided into 2- or 4-man cabins.

The functions of the submarine platform are controlled, managed and monitored from three consoles, all incorporated in the ship's monitoring system. The maneuvering control console contains:

- Course and depth control
- Equilibrium control (weight vs. displacement. Improved and very silent system.)
- Longitudinal weight balance (trim system)
- Main motor speed control.

The diving and damage control console is also in the control room controlling:

- Diving and surfacing
- Snorkeling preparations and snorkeling monitoring (not very often used, see below)
- Monitoring and control of hull integrity.

It is very important that all automated functions have redundant controls. The ultimate operating mode is local manual control, which can be quickly engaged if a dangerous situation should arise. This is also applicable to the steering system which will be dealt with below under *Steering*.

The Combat System features the latest design and among other things, determines target positions and movements based primarily on sonar data for subsequent engagement by launching weapons and guiding them to target destruction. The major elements are sensors, processing units, presentation units and data transfer units. The system is capable of long range detection of targets.

Included in the system is the target motion analyzer (TMA), a function which determines position, course and speed of several selected targets. The new TMA function is optimized for bearing information only, which provides the means for determining target data purely in a passive and stealthy mode.

Instruments, computers and other equipment are not entirely of Swedish design. Subcontractors all over the word have been evaluated and those providing the optimum performance have been selected.

Weapons

The principal weapon system for the Gotland class is the new heavy weight torpedo (Torpedo 2000), produced by Bofors Underwater Systems in Motala, Sweden. It is a high-speed, long-range weapon with a unique thermal propulsion system. The Tp 2000 calibre is the well proven 21" and it is a homing torpedo with a wire communication system between the torpedo and the fire control system.

The GOTLAND is also equipped with the new Bofors light weight multi-purpose torpedo, Torpedo 43X2, the result of a continuous development from the first homing ones of 1965.

Incidentally, the first torpedo purchased in 1875 by the Royal Swedish Navy was a 14" torpedo from the inventor—Robert Whitehead's factory in Fiume, Italy—but since 1910 all torpedoes have been designed and manufactured in Sweden.

Propulsion

The propulsion system consists of two energy producing diesel motor generators (MTV) as well as an electric propulsion motor. Storage of energy is accomplished, by normal means, with two accumulator batteries.

The Swedish Navy has had a productive cooperation with the French electric firm Jeumont Schneider and their subcontractor Merlin Gerin for some years, the latter is a specialist in making the main switches and control systems. The motor system is totally computerized, has a fault finding computer with printer at the control panel and all equipment is designed for quick and easy maintenance within easy reach. Needless to say it is a very silent system.

Ships' service power is provided either by the diesels or, from GOTLAND's captain's point of view, more importantly, by the Stirling machinery. The Stirling engines give energy to the boat's power economy and also to the generators when operating at low speed.

The Stirling system consists of two 4-cylinder Stirling external combustion engines—with one generator each. The engines run on diesel oil, and instead of air-injection, oxygen is used. The oxygen is in liquid form and is stored in tanks, so called LOX-tanks. The stored oxygen has a temperature of minus 162°C, which is why the LOX-tanks are well insulated.

More than six years ago the Navy installed the first test Stirling engine in the submarine NÄCKEN, which had to be extended 45 feet in length. Although it is a quite new concept for submarine use, it has functioned extremely well, therefore it was a rather easy decision to make it a standard on the new constructions.

The fighting value of NÄCKEN, GOTLAND and their successors has increased to such a degree that you can say it is doubled compared to other diesel submarines. Another comparison is that the Stirling motor section in the boat represents the same amount of energy as five submarine batteries, while no reduction of other energy sources have been made.

Why did the Royal Swedish Navy choose the Stirling system in the first place? There are, as surely is well known to the **SUBMARINE REVIEW** readers, other AIPs under development in Europe. The Stirling engine is a very old concept, in fact it was the invention of a Scottish priest in the middle of the 19th century. Adopting it for submarine propulsion is the fruit of 40 years hard work.

The Swedish Navy realized in the middle of the 50s, when USS NAUTILUS and her successors had shown the new way of pushing submarines forward, that a type of AIP was necessary for the submarines of the future. It soon became clear for the Baltic waters that an AIP design was preferable to a nuclear design, for obvious reasons. One of the first attempts started was to develop a diesel engine of a circular motion type (in German: *kretslauf*). The safety problems turned out to be rather difficult, although a propulsion plant in full scale was running in a Swedish laboratory.

Next the Navy invested in fuel cells and the large firm ASEA in middle Sweden—nowadays ABB (ASEA Brown Bovery)—started to work on this concept. Many problems arose and in the end it was decided that the fuel cell was not the cost-effective solution the Navy was searching for.

In 1987 Kockum-Stirling presented an AIP that was, as is mentioned above, installed in the submarine NÄCKEN. It became a success from the very beginning. At this writing, Stirling AIP is the only one operating in a commissioned submarine anywhere in the world.

<u>Steering</u>

The maneuvering and steering system with an X-rudder is something that the first Swedish *Albacore shaped* submarines of the Sea Serpent class had. The first one was launched in 1967. The main principle of the X-rudder system is that all rudder planes are working in any maneuver in all dimensions, thus giving the maximum steering effect. This is especially valuable when operating in very shallow waters, when it is possible and necessary to steer by inches from the bottom.

In fact Kockums obtained the original idea from the Albacore's X-rudder, which, however, was constructed for extremely high speed. The test results of USS ALBACORE in 1962 proved this configuration to be far superior to anything previously tested in way of rudder arrangements concerning maneuverability, heel angle and emergency maneuvers.

However, by this time the U.S. Navy had already built and launched 15 SSNs and 11 SSBNs all based on the Albacore hull form, but without the cruciform rudder arrangement. It is supposed that under these circumstances there would seem to be little point in changing the designs, but perhaps if the test results had been available a couple of years earlier it is probable that all nuclear submarines would have had X-rudders.

Vice Admiral Emery, COMSUBLANT, says in his paper from the NSL 1994 Symposium that, in order to minimize depth excursions from control surface casualties, when SSNs are operating in littoral waters, they should be fitted with split stern planes, obviously a good solution for the cruciform rudder systems. For the Swedish, and also the Dutch Walrus submarines, the X-rudder system gives, as the Swedish Navy thinks, the ultimate solution to that problem.

Kockums has had the system under continuous development since the Sea Serpent class with some cooperation first by ASEA, later by the SAAB Aircraft Inc. and for the GOTLAND by the Dutch firm van Riehtschoten & Houwens. All three firms delivered a sophisticated steering panel (SAAB also provides that for the Collins class submarine).

When talking about these steering arrangements one special question naturally comes up: safety! What happens when one or more rudders fail for some reason as in a depth charge attack? Does the system then collapse? Or what happens when the computer gives up? In case of failure, the X-rudder system can quickly be engaged in a manual control mode, where it is possible to handle each rudder separately. There are also other safety devices with several hydraulic systems and it is possible to maneuver the boat from the steering panel by using only two rudder planes.

These different safety systems in the Swedish submarines are often exercised in damage control drills and, after nearly 40 years of experience, the crews have full confidence in the reliability of this steering system. On GOTLAND the rudder planes are made of plastic (GRP) to a special Kockum design. Additionally, these rudders are more robust to shock, and simpler to maintain. The constructor is Karlskronavarvet AB, shipbuilders of a large number of warships, in later years many of them of GRP. Detonation tests against the GOTLAND type rudders have been successfully made.

Deployment and Operations

The Baltic is an inland sea and represents a limited area with short coast-to-coast distances, easily surveilled by sensors ashore, at sea, and in the air, as well as by electronic and communications intelligence systems. For national security reasons, this sea has always been an important area and war theater for the countries concerned.

Through the centuries Britain, Russia, Germany and Sweden have tried to control some sort of Mare Nostrum in the Baltic. When Russia moved her positions westward to the coasts of the Baltic countries, Swedish defence policy planning immediately reflected it and a particular stress was laid on certain areas of Sweden. Today there exists some sort of military calmness and, in a way, some state of stability in the Baltic.

Although Sweden, like most other democracies, is cutting its defence budget, it is the consensus of the Swedish people that it is advisable to keep a certain guard for the future, like getting and keeping weapon and defence material that will take a considerable time to provide. Examples are aircraft, tanks, missiles and submarines. The last named are especially suitable to keep a sharp guard on what is going on in the Baltic and the Western surroundings.

Here the environment for submarines is very favorable because the rocky bottoms along the Swedish and Finnish coasts make specific conditions for acoustic propagation extremely favorable. The lack of strong currents and tide permits very high navigational accuracy for submarines. Also the lack of really rough weather permits a very accurate depth control close to the surface. This is necessary during summertime in order to get a good covering layer.

Thus ASW is very difficult in the Baltic mainly because of the acoustic propagation and bottom conditions, but also because of the anti-ASW threat. Performing ASW operations with surface units in the Baltic in time of war is dangerous due to aircraft and submarines. However, definite underwater contacts from underwater craft have been established on several occasions in the hunts for foreign intruders in Swedish waters during the last decade. The submarines were and are important parts of the special ASW task forces. Using the best instruments and devices that money can buy, considerable experience has been gained in ASW in the Baltic. Recent R&D has established new knowledge of propagation in the Baltic.

The last decade's development in sonar technique has led to increased ranges for submarine passive detection, especially in the Baltic. Passive ranges in the Baltic against cavitating surface targets exceeds 100 NM. In the archipelago, however, the ASW is different and much more complicated. Equipped with the new long range guided and homing torpedoes these submarines represent a very potent attack component in the Swedish defence forces. That is why in the budget cutting process the 12 submarines continue to survive.

Modern Swedish submarines are all equipped with the latest sonar sets such as flank array sonars (FAS) and cylindrical hydrophone array (CHA) as well as sensors and sets for own noise and enemy sonar search.

The sonar system is the most expensive and complicated system onboard. This places large demands on the construction of the boat, and explains why considerable resources and engineering have gone to create the most cost effective submarine system.

Also much work has been done to make this submarine more quiet than before. Many old and new methods have been developed, such as double elastic fitting or a *split suppressed bottomplate*, and more effective liquid sound suppressors.

Long range surveillance with the possibility of a heavy surprise punch gives the Swedish Navy the opportunity for forward deployment at an early stage of a conflict. An enemy cannot move out of his bases without being detected by the submarines, reported and, if necessary, attacked without knowing from where or by whom.

To reach this type of total surprise will in a considerable way be the fruit of the new long endurance submarines. ■

RESEARCH SUBMERSIBLES IN RUSSIA AND UKRAINE[1]

by Michael J. DeHaemer

[Editor's Note: Dr. DeHaemer is the Director of the Japanese Technology Evaluation Center/World Technology Evaluation Center at Loyola College, Baltimore, Maryland. On the faculty of the Sellinger School of Business and Management at Loyola College, he is the Chairman of the Information Systems and Decision Sciences Department. Dr. DeHaemer is a retired submarine officer and commanded USS SIMON BOLIVAR (SSBN 641).]

About the time that the states of the former Soviet Union became more open to the West, U.S. agencies, principally the National Science Foundation and Advanced Research Projects Agency, commissioned a study of undersea technologies in Europe. The World Technology Evaluation Center (WTEC) of Loyola College, which with its companion Japanese Technology Center (JTEC) has conducted more than 30 technology assessment studies, was chosen to review the state of the art in the broad field of undersea technologies in Russia, Ukraine and selected sites in Western Europe. As the Director of WTEC, I was privileged to organize and participate in the study.

This paper summarizes the findings of the panel of experts for Russia and Ukraine from a general perspective, then discusses the state of specific technologies with a sampling from a few of the institutes that were visited. I will submit a follow-up article for the **SUBMARINE REVIEW**, which will discuss projects that were observed in Western Europe. Information for obtaining the complete report of the WTEC panel is given at the end of this paper.

A team of 10 individuals representing academe, consulting, industry, and three federal agencies operated in four subgroups to

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[1] This research was sponsored by the National Science Foundation (SNF) and the Advanced Research Projects Agency under NSF Cooperative Agreement ENG-9217849, awarded to the International Technology Research Institute at Loyola College in Maryland.

visit 20 sites in Russia and 5 sites in Ukraine.[2] Because of the constraints of time and geography, the locations that were selected were grouped in the vicinities of Moscow, St. Petersburg, and Nizhny Novgorod in Russia; and in the vicinities of Kiev and Sevastopol in Ukraine. About 40 percent of the institutes visited were conducting basic research, another 40 percent were sites of engineering development or applied research. In addition there were two academic institutions, two bases for oceanographic operations, and three newly formed trade associations that had been spun off from the basic research laboratories.

At the time of the study, either from a concern for commercial (or national) secrecy or an inability to see any advantage in spending time and resources, there appeared some reluctance to accommodate the visiting panelists. In a few cases, touches of Cold War suspicion remained, but hospitality was never lacking. On the other hand, some of the visits in Russia and Ukraine were made quite interesting because the WTEC panels' visit coincided with the hosts' decisions to declassify several active projects. WTEC panel members were aware of complementary work in the United States that remained classified.

In general, the quality of the sites that accommodated the WTEC panel was impressive. Panelists saw several gems of unique and impressive facilities during a large number of laboratory and industrial tours. WTEC's subpanel was the first group from the West to visit the formerly closed city of Sevastopol and the research submersible operating base there. WTEC's representatives were welcomed with ceremony and enthusiasm (toasts of vodka and bilge water) and made honorary *hydronauts of the Bentos 300*, a submersible laboratory. As another example, the Lazurit Central Design Bureau in Nizhny Novgorod displayed 19 models of submarines and submersibles that were previously

[2] The following made up the WTEC panel on Research Submersibles and Undersea Technologies: Richard J. Seymour (Chair) Texas A&M University; D. Richard Blidberg, Northeastern University; Claude P. Brancart, Draper Laboratories; Larry L. Gentry, Lockheed Missiles and Space Co., Inc.; Algis N. Kalvaitis, National Oceanographic & Atmospheric Administration; Michael J. Lee, Monterey Bay Aquarium Research Institute; RADM John B. (Brad) Mooney, Jr. USN(Ret.); and Don Walsh, International Maritime, Inc. In addition, Norman Caplan, National Science Foundation, and the author as Principal Investigator for the study accompanied the panel.

unknown to WTEC's experts.

General Observations

It was evident from the world class facilities at many sites that undersea and oceanographic science and technology had been given stature in the organization of the Soviet Union. A number of real research strengths have resulted, which are summarized in Table 1. A shortfall in computing power, isolation from Western sciences, inexperience with capitalism, and compartmentation due to new national borders give rise to some serious limitations for research infrastructure which are summarized in Table 2.

The effects of defense conversion activities were evident at most of the sites the WTEC panel visited in Russia and Ukraine. New companies or trade groups in these countries, lacking previous experience in, or close ties to, free market activities, appeared to have difficulty deciding on appropriate civil applications for their extensive defense technology. Both Russian and Ukrainian scientific institutions were attempting to convert to commercial objectives. Usually these emphasized the development or protection of marine resources, such as oil and gas in the Arctic, fishery monitoring, ocean pollution monitoring; and improvement of environmental conditions, such as removal of chemical and radioactive pollutants from the oceans.

There appeared to be a lack of realistic strategic planning for many of the institutions that were clearly trying to cope with diminished government support for basic research and a declining advanced development support because the military industrial complex that had been the customer was shrinking exponentially. The panel observed, for example, a surprisingly large number of agencies in Russia designing or proposing tourist submarines in competition with each other for a world market that is already close to saturation.

Thus, in the economic chaos of the new states of Russia and Ukraine, many valuable assets for the advancement of undersea technologies, both human expertise and world class research plants, are in danger of being lost.

Russia and Ukraine possess impressive, and in some cases unique, facilities for physical testing. One example is the Krylov Institute, St. Petersburg, which displayed a 2.4 meter diameter titanium sphere that was certified at Krylov to a Russian Registry test depth of 4000 m. These facilities are underutilized and offer opportunities for Western nations to have the advantage of world class laboratory testing at a very low cost.

Table 1

Research Strengths of Russia and Ukraine

- Test Facilities
- Oceangoing Research Vessels
- Highly Educated Engineers and Scientists
- Manned Research Submersibles
- Efficient Computer Code
- Strong Theory, Analysis, Creativity
- Fabrication and Materials (i.e., welding and titanium

Table 2

Research Infrastructure Limitations in Russia and Ukraine

- Limited access to world class professional journals
- Compartmentation of science after USSR breakup
  - Difficult communication to former colleagues
  - Difficult to move scientific equipment across borders
- Limited access to computer hardware
- Limited knowledge of how to do business with the West
- Limited knowledge of technology development in the West
- ECONOMIC PROBLEMS: low funding, lack of hard currency

Researchers in Russia and Ukraine have extremely limited computing facilities compared to Western engineers in the undersea technologies field. As a result, Russian and Ukrainian researchers have taken a strong theoretical or analytical approach to most problems, which appears to have been very valuable. It has resulted in an ability to write extremely efficient computer code to facilitate numerical analyses and signal processing on limited computer platforms—a strong skill set that exists among researchers in Russia and Ukraine.

Russian and Ukraine possess extensive fleets of seagoing research vessels capable of long voyages. These vessels possess start-of-the-art facilities for conducting oceanographic investigations. The P.O. Shirshov Institute of Oceanology (Moscow) operates six submersibles and 10 research ships. The submersibles include the MIR-1 and MIR-2 which may be the best equipped deep ocean systems that are now available. Except for a few vessels that are under contract to Western nations, the Shirshov's vessels are largely inactive at this time.

Russia and Ukraine have adopted a philosophy of including human presence in nearly all subsea geophysical and oceanographic investigations. They have produced an impressive variety of manned research submersibles that also are largely unused at this time. Eleven of the 25 sites that WTEC visited were involved in manned submersibles. The beginning of research on autonomous vehicles in Russia means that country has, in effect, largely skipped over the development of the conventional cable-controlled remotely operated vehicles (ROVs).

The WTEC panel principally visited government institutes. In a few cases, it was possible to visit newly formed commercial companies that were associated with the institutes through shared personnel and development facilities. It became obvious that one way to cope with shrinking budgets and frozen salaries of the researchers was the attempt to commercialize the expertise of the institute through start-up companies that were organized in new regional trade associations. One example is the International Centre of Research and Technology Development, TECHNOPOLE, that represents a cluster of start-up companies that have spun off from the Atoll Scientific Research in Dubna, Moscow. Advanced acoustic system hardware and analysis software were developed at Atoll, which are now being marketed commercially.

The breakup of the Soviet Union has had a strong impact on the technology infrastructure. Communications among various groups is unclear. Also, the method for moving from concept to final prototype was controlled very completely in the past, and the resources needed to accomplish a development effort were planned and in place. It seems that this is no longer the case and it will be a while before such an infrastructure evolves in this new environment. Table 2 suggests a list of factors that impact adversely on the scientific infrastructure.

Observations of Specific Technologies

Sensors and Instrumentation. The deep ocean submersibles MIRs, which are operated by the Shirshov Institute and were built by Rauma in Finland, have extensive sensor, instrumentation, and manipulative capability, and are considered by some scientists to be the best equipped and most capable research tools in current operation for deep sea (6,000 m) research.

Although Russia and Ukraine have developed limited remote sensing capability for ocean studies using Lidar and acoustic Doppler current profilers, these designs are not unique and are within the current international state of practice. Designs for multi-purpose airborne lasers systems to detect oil spills and ocean thermoclines were discussed in both Russia and Ukraine. The two countries are also marketing oceanographic instruments, such as conductivity, temperature, and depth meters (CTDs) and current meters. One instrument is capable of measuring CTD at speeds to 15 knots with depths to 1500 meters, enabling surveys over large areas. The ROS Company, Dubna (near Moscow), exhibited components and a display for a seabed passive sonar system—frequency from less than 1 Hz to 5 kHz, with a sensitivity of 250 microvolt/pascal. The company believed it could deliver a system for less than one-fifth the cost of a similar one produced in the West.

Instrumentation (TV cameras, soil and sediment samplers) to inspect the sunken Soviet Submarine KOSOMOLETS was developed by Russia's Central Design Bureau (RUBIN in Moscow) for use by Intershelf on ROVs from the two MIRs. The Kurchatov Institute (Moscow) developed gamma ray spectrometers to identify Cs-137 for the same expeditions.

Energy, Hydrodynamics, and Propulsion

Energy. The spectrum of energy systems ranged from small simplified nuclear reactors to conventional lead-acid batteries that were designed for use in the numerous manned submersibles. In Russia, the most impressive directions were nuclear power systems (first developed for military submarines) and fuel cells (first developed for the space program). The Lazurit Design Bureau (Nizhny Novgorod) discussed a proposed 6,000 kilowatt unattended nuclear reactor to be placed on the Arctic seafloor to support a submerged oil and gas complex. Other advanced nuclear power designs would be used in submerged service vessels and a submarine OCEAN SHUTTLE. While the fuel cells were of conventional design, several had been built and many hours had been logged in spaceflight conditions.

Hydrodynamics. As might be expected, Russia and Ukraine have an extensive family of organizations and institutions concerned with hydrodynamics. The Hydromechnics Institute of Kiev, Ukraine is an example of a well equipped basic research lab in this domain. Multiple tow tanks supported research of oscillating wing propulsion systems, including clusters of the wings for submerged vehicle towing, A most unique and exciting project was an enclosed pressurized tank to support the study of underwater ballistic projectiles. Steel projectiles of about 1.4 cm in diameter by 10 cm in length are explosively launched to speeds approaching or exceeding Mach 1 in water. As a vapor cavity forms around the projectile, resistance/drag drops to a very low value. Sufficient velocity remains after transiting about 50 meters in the tank for the projectiles to penetrate about .75 cm of steel into the stop plate at the end of the tank.

Propulsion. At Bauman Institute (Moscow) and Krylov Institute (St. Petersburg), there was some mention made of work they were doing in propulsion for high speed submarines, but no documentation was provided. The Kurchatov Research Center (Moscow), teaming with other research labs, is doing work in magneto-hydrodynamic propulsion (MHD). A prototype in a laboratory using cryogenically cooled superconducting magnets moves water through a tube, resulting in a propulsive force with no moving parts.

Manned Submersibles. There is great interest among ocean engineers and ocean researchers in Russia and Ukraine in developing manned submersibles and tourist submarines. Several visited activities, mostly those that have been either involved in manned submersibles or military submarines in the past, now have tourist submarine plans on their drawing boards. The WTEC group was surprised by the variety and number of manned submersibles that were in operation now and that were planned for the future. The existing manned submersibles are fundamental, low cost, uncomplicated, reliable, tested and available. Ocean researchers are enthusiastic users who are quite satisfied with the capabilities of these tools.

The ability to use and fabricate titanium in undersea vehicles in Russia and Ukraine is advanced.

The acceptability of Russian Registry Certification by Western insurance companies needs to be examined carefully before contracting for use of manned submersibles built in the former Soviet Union.

Academically, industrially and operationally, the existing manned submersible base in Russia and Ukraine is truly impressive and has great potential.

Unmanned Submersibles. Russia's present position relative to the Western world is difficult to establish. The country's low cost ROVs are dated technology. However, the operating techniques of Russia's 6,000 m ROV systems have much to offer. There is nothing technically exciting about their unmanned systems, primarily because the nation's efforts have been concentrated on manned systems.

Acoustic Applications

Understanding of Basic Theory. The researchers participating in the discussions were very clearly aware of the basic principles of the technology with which they were involved. Possibly the limitation of computer capability and the need for efficient problem solving has forced this need for in-depth basic understanding. This is clearly different in the United States, where computer capability and the cost of people can force development to proceed along lines where an engineering solution is more important than reaching a total understanding of all aspects of a problem.

Application Ideas. Acoustic applications were discussed at 17 different organizations. There was R&D on acoustic arrays, transponders, transducers, sonar imaging systems, communications, position navigation, parametric sonar, acoustic releases, acoustic current meters, and acoustic Doppler current profilers (ADCPs). There were several interesting discussions about new applications under consideration, such as sonar emission tomography to detect fish shoals or pollutants, special design acoustic emitters for seismic operations, low frequency active arrays for detection of oil and gas or for accurately locating the position of a well drilling head. some of these ideas appeared to be novel, and had not been considered in the United States, at least in circles represented by members of the WTEC team. It may well be that the new freedom to determine research directions has allowed researchers to consider novel applications of technology. It may also be that having to compete in a world marketplace demands new and novel products and ideas.

System Engineering. Labor and materials are still cheap in Russia and Ukraine, and the availability of micro-electronics is limited. This has led in the past to an emphasis on manned underwater vehicles (UVs) rather than unmanned units. Manned UVs are easier to integrate and maintain, and use low-cost labor to good effect. This trend will probably continue into the near future, until the industrial sector begins to mature and costs drive it toward unmanned systems. In the West, the high cost of labor and the risk of litigation and insurance penalties have driven scientists toward unmanned solutions. However, the same cost of labor has made sophistication and high technology expensive. The United States has improved performance and minimized man-dependency, but in some cases has violated the basic rules: *keep it simple* and *sufficient is good enough*.

Engineering in Russia and Ukraine may be behind that of the West in sophistication in some cases, but not necessarily in results. Some engineering and integration achievements there include the following:

- Numerous and very good research test facilities.
- Short development spans based on a theory of *build it, field it, and then improve it*.
- Avoidance of the *analysis paralysis* that slows progress in the West.
- Lack of preoccupation with aesthetics; systems are built stout to last, and simple for easy maintenance.

Conclusion

There is, in both Russia and Ukraine, a genuine desire for cooperation and collaboration. Motivation for this is obvious since funding and equipment are lacking. More importantly, however, is the perception that technologists in Russia and Ukraine truly believe that cooperation and collaboration will bring new insights and further advance their technological interests. The individuals involved in the visits were very talented technical people. Much would be gained by the synergism resulting from true cooperation. Cooperative ventures are sought at all levels from joint research to joint business ventures. Table 3 summarizes the types of joint venture possibilities that exist.

Members of the WTEC team recognized that solutions to technological problems had been implemented on computer hardware of limited capability. Emphasis was placed on efficient algorithms and clearly understanding the principles of the problem. Many can remember how their first efforts at applying microcomputers to instrumentation forced the use of machine languages and complex interface programming. This is not unlike what seems to be the norm in Russia and Ukraine today. The benefit of this has been to develop unique solutions to complex programming problems. In this respect there may be much of value to learn from the countries of the former Soviet Union.

The current environment in the former Soviet Union is allowing technologists the freedom to choose their own research directions. In addition, many technologists are starting small businesses to privatize their talents and products. This has not been possible in the past since funding and resources were directed at specific projects planned outside of the various institutions. It is clear that this new freedom will allow researchers to consider directions that were not available in the past.

Many applications of technology that were reported were both interesting and novel. It must be understood, however, that the actual maturity of those applications is not clear. Many of the technological concepts discussed were in their conceptual stages only. With limited financial resources, it is unclear just how many of those applications will come to fruition. It was not clear at times whether a concept being discussed had yet moved to hardware or prototype development stages, whether it had been evaluated in a real world setting, or whether it had already become available as a product. However, many of the applications discussed could well be moved into viable products readily sought after in the world marketplace.

Table 3

Opportunities for Research Cooperation and Business Ventures
Joint Business Ventures
• Submersibles for science
• Systems and submersibles for commercial service and exploration
• Deep submersibles (6,000 meters+)
• Monitoring and remediation of hazardous materials
Joint Research Ventures
• Acoustics and optics
• Physical oceanography
• Vehicle hydrodynamics
• Advanced materials for subsea applications
• Low cost, high quality research labor
• Low cost research facilities
Resale of Russian and Ukrainian Products
• Oceanographic sensors
• Manipulators
• Salvage equipment
• Low cost alternate to various equipment in the West

The observed trend is for members of universities and governmental agencies to form private ventures in an effort to generate needed funds. There are many ventures formed to develop tourist submarines. This is disappointing because the world market for tourist submarines is already nearly saturated. Another trend is for foreign firms to form teaming agreements with individuals and facilities to conduct business on a worldwide basis. The Intershelf Company of Russia demonstrates this trend. Russia must overcome the credibility and logistic support gap before it can compete in the world markets for underwater unmanned systems. Although prices are currently quite low, this may be a short term situation that will eventually change to correlate more closely to Western prices.

Many of the panel's observations can be assumed to represent only the general state of the art in the research and development laboratories in Russia and Ukraine. There are almost certainly more advanced facilities that the panel was not able to visit. Future visits by anyone interested in this field should allow adequate and deliberate time for technical discussions with the actual professionals involved in moving applications from concept to reality.

REFERENCE

WTEC Panel Report on Research Submersibles and Undersea Technologies, R.J. Seymour (Ed.), Loyola College in Maryland, Baltimore, 1994, 315 pages.[3] ■

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[3] ISBN number of the report is 1-883712-33-5. The report may be read electronically on the World Wide Web at http://itri.loyola.edu. Hard copies may be obtained through the National Technical Information Service (NTIS) of the U.S. Department of Commerce as NTIS Report #PB94-184843. Call (703) 487-4850 for information.

THE BUILDING OF AUSTRALIA'S COLLINS CLASS SUBMARINES

*by Dr. Dora Alves**

[Editor's Note: Dr. Dora Alves is an Asia-Pacific specialist who was born in England and educated at St. Anne's College, Oxford University. She holds graduate degrees from American and Catholic Universities. She has visited and lectured frequently in the area of her specialty, directed the Southeast Asia-South Pacific strategic studies course in the Industrial College of the Armed Forces, NDU, and edited International Essays and the Pacific Symposia. She is the author of books on Australia defense and the Anzac alliance.]

The Australian decision to build the six submarines of the Collins class *in country* represents the largest and most complex technical undertaking in Australian history. Indeed, beyond China, India, and Japan, it is difficult to identify an Asian state that has produced—albeit with major foreign assistance—a weapon system as complex as a modern military submarine.

The Australian government's decision to build submarines *in country* was highly controversial. Previous Australian undersea craft had been procured from Great Britain. A requirement for only a few submarines and the need to train submariners in Britain and to obtain weapons and other submarine equipment from other countries, made the potential viability of the program doubtful.

But it has been successful!

The first Collins class submarine, now being readied for trials at Osborne, on the Port River about half an hour from the city center of Adelaide, South Australia's capital, will not be the first submarine commissioned into the Royal Australian Navy (RAN). The RAN has had submarines since February 1914 when two British-built E class, the AE1 and AE2, joined the fleet. The first of the Oberon class, which the Collins class will replace, was

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* The opinions, conclusions, and recommendations expressed in this article are solely those of the author and do not necessarily represent the view of the Department of Defense, any other U.S. government agency, or any agency of a foreign government.

commissioned into the RAN in 1967.

When in 1987 the Australian government decided to build six diesel submarines in Australia, its goals were to increase defense self-reliance and to enhance industry's ability to produce, support, and maintain weapons systems at competitive prices.[1]

Competition was fierce among the Australian states submitting bids to build submarines by November 1986. South Australia, with a good record in defense industry, and New South Wales, traditionally the shipbuilding state, fought hard. Both states had Labor governments at that time. The task force put together in South Australia with the support of South Australian Premier John Bannon was successful with its proposal. The Australian Prime Minister, Bob Hawke, made it clear that he wanted the widest distribution practicable of subcontracting among the states—a politically sensitive issue.

The Australian Labor government endorsed the Department of Defense recommendation of the Swedish Kockums Type 471/U.S. Rockwell International team, and endorsed Adelaide as the construction site. The Australian Submarine Corporation (ASC), a consortium created for the submarine project, claimed costs at Osborne, the new *greenfield* site, were 25 percent less than in comparable European yards. The Swedish model was selected over competitors from Britain, France, and Germany—the last to the end a very close rival. Kockums has built submarines for the Swedish Navy since 1915 and was interested in establishing a base in Australia to attract work in Southeast Asia. Originally, Kockums AB was a 52.5 percent shareholder in ASC but was required to sell down its shareholding by the end of 1990 to 49 percent. The other shareholders are the Australian Industry Development Corporation (AIDC), a semi-governmental body that helps foster industrial development through loans and equity contributions, and the building materials firm of James Hardie Industries.

The South Australian task force, claiming that Adelaide was the perfect location geographically, industrially, and logistically, was helped by the South Australian government's support for the building of the largest shiplift in Australia and the construction of the large coastal ferry ISLAND SEAWAY. This provided experience in computer aided design and manufacturing methods analogous to those needed for the Collins class.

ASC's managing director, Dr. Don Williams, described the consortium as a ship assembler and integrator that aimed at having subcontractors achieve 85 percent of the program. "We bring it together, we assemble it, we integrate it, we test it, and we deliver it," he said. From the start it was acknowledged that integrating the combat system would be a major challenge. In addition to Rockwell (Rockwell Systems Australia, in conjunction with the parent company in the United States), most of the software was written by Computer Sciences of Australia. There was no Australian precedent for the application of integrated logistic support (ILS). ASC is integrating the work of domestic producers and overseas worldwide leaders in their fields as well as hundreds of subcontractors and suppliers.

ASC acquired Carrington Slipways of Tomago near Newcastle, New South Wales, as an extra source for hull assembly, and O'Connor Engineering Adelaide (now ASC Engineering) to control outfitting and gain experience for the whole-life support of the submarines. Kockums-ASC employs about 1,000 workers—a boon to Adelaide in the current recession—and is ambitious to market high technology shipbuilding worldwide. In 1990, 40 ASC operatives worked on the Kockums shop floor in Malmo, South Sweden, learning *how the work is done and why it is done like that*. The Australians typically worked three months with their Swedish opposite numbers. At the Kockums plant in Malmo the design team and the shop floor are integrated with as many people as possible being rotated through the drawing office. Kockums emphasizes workers' autonomy, with everyone doing a range of jobs—a contrast to the conservative, often rigid demarkations of Australian unions.

South Australia's selection to build the Collins class was influenced by its good record in industrial relations. Nonetheless, construction work at Osborne was halted in March 1988 by what The Australian newspaper termed "bloodymindedness of the Australian union movement". Work stopped before submarine building was due to begin due to labor's resentment at ASC's acceptance of only three unions. Fourteen other unions were reported to have wanted involvement in the lucrative construction project.

Australian shipbuilding trades' powerful unions have a long history of disrupting work in Australia's shipyards. In October 1991, the Industrial Relations Commission ordered 60 strikers back to work after a demarkation dispute. Boilermakers and welders of the Metals and Engineering Workers Union were told to negotiate with the Federation of Industrial, Manufacturing, and Engineering Employees Union whose members worked for the subcontractor. In February 1993 work on the first submarine hull stopped for 42 days following a two week ban on overtime by the Automotive, Metal, and Engineering Union. This time, using tight production schedules to enforce demands, the union refused to accept that 18 quality control technicians were salaried workers. The costs of the delay were borne by ASC and the time was made up. The consortium plans to launch one Collins class submarine every 18 months to 2000.

The new submarine's modular construction allows components from a number of sites to be assembled by ASC. The hull is in six principal sections, each substantially outfitted before assembly. The first two sections were built in Sweden, but all the sections and platforms for the remaining five submarines are being built at Osborne. The first Swedish built section reached Australia in mid June 1992 after an eight week voyage aboard the heavy lift ship PROJECT ORIENT. The two deck structure contained the control room, galley, and berths.

A number of Australian research industrial facilities are working on the Collins class. The engineering work done at the Woomera rocket range that was wound down in the 1960s was the genesis of the Defence Science and Technology Organisation (DSTO). The engineers and scientists of DSTO contribute to sustaining existing defense platforms and procedures and extend the life of platforms and equipment. The Gulf War taught the lesson that most modern weaponry is ineffective without the technical know-how to keep it operating, as Saddam Hussein demonstrated. Now the southern hemisphere's largest defense research and development center , DSTO is investigating how the wake of a submarine can be reduced. Dr. Graham Furnell of the Materials Research Laboratory, DSTO, states that the wake of a submarine traveling at average speed at depth can be detected 50 meters above and below the craft. Also, while towed sonars normally have the diameter of a cable, the Collins class will have a DSTO-developed fiberoptic array incorporating hydrophones that, with their protective coating, will have the diameter of an antenna wire. DSTO is also working on a algal bioreactor to purify the air in the submarine that will be smaller and more efficient than present chemical reactors. The RAN specifies that it must be capable of removing 2.4 kilograms of carbon dioxide per hour even during periods of strenuous activity on the part of the crew. To this end, experiments are being conducted with the alga Dunaliela salinas. The DSTO Maritime Operations Division is at work at the acoustical range about 100 km from the West Australian base at HMAS Stirling near Freemantle. Noise, sea states, currents, and wind levels are being investigated to provide data for the design of a system to measure noise levels from submarines and lead ultimately to making the new diesel submarines quieter.

The Collins class should be exceptionally hard to detect by active sonar as a result of Dr. David Oldfield's work on anechoic tiles. Anechoic tiles were first used by the Germans in an effort to defeat British Asdic (sonar) in the Battle of the Atlantic. Unable to obtain the technology overseas for a modern version, DSTO designed its own. Oldfield's tiles are designed specifically for the Collins' shape and for warm water.

Although most of the work on the Collins project is done by Australians, the submarine's construction has involved some 550 subcontractors and 30 countries, giving Australia the benefit of technological transfer and skills growth. In late October 1988, Rockwell Electronics Australia was awarded the contract to supply the internal and external communications systems. Work is being done at Lilydale, Victoria, in cooperation with local partners and British Aerospace Australia. Rockwells' managing director, Don Boyce, points out that of the 400 technicians employed all but five were Australian. Another early participant was Cincon, Cincinatti, which provided two integrated software packages for manufacturing and financial control. The database was designed to grow as the project became more complex bringing together a new design, a new manufacturing facility, and 500,000 components. The system was upgraded to extend ASC's corporate systems to subsidiaries in different parts of Australia.

In the spring of 1989 the major Australian company Pacific Dunlop and German's leading battery manufacturer, Varga Batterie AG, took equal shares in Pacific Marine Batteries. A new $A6.5 million facility was built, scheduled to produce one battery a year from 1993 through 1998. Pacific Dunlop personnel were trained in Germany. The masts contract was won by Riva Calzoni of Italy. To meet Australian content specifications, a separate contract was negotiated with Australian Defence Industries (ADI)

Ltd., Maribyrnong, Victoria.

The $A140 million contract for the propulsion system was won by the French company, Jeumont Schneider, which is working in cooperation with 12 principal Australian partners. Jeumont supplies eight navies with underwater propulsion systems. The first diesel engine was built and tested extensively in France. The French company later said it was impressed by the Australian ability to integrate new technologies in a project that is international in scope. Jeumont is now looking at a *marriage* of French and Australian strengths.

Broken Hill Proprietory (the well-known BHP) at Port Kembla and Bunge International Steels at Unanderra, New South Wales, are producing special steels using techniques provided by Sweden. Highly skilled welders went to a technical college to learn to use the special steel and to achieve military specifications. New skills have been created by ILS contractual obligation. It guarantees that the Collins submarines would go to sea 80 percent of the time, while the Oberon class have only a 50 percent availability.

Despite all the media and political naysayers, the COLLINS' launching on 28 August 1993, was on time and on budget, which is rare for a first-in-its-class of this magnitude. Two days later a defense marketing pact was signed in Stockholm. The Swedish Defense Minister Anders Bjorck said the Memorandum indicated Sweden's preparedness to take part in further joint ventures, adding that Sweden hoped that sophisticated defense products, not only submarines, could be built cooperatively in Australia and marketed in the region.

The resignation of ASC's managing director, Dr. Don Williams, after the launching was seen by a number of commentators as indicative of the consortium's turn in another direction. His skills in heavy engineering and financial and industrial relations management achieved a triumph; emphasis would now be on submarine sales that would ensure revenue and enhance regional defense cooperation. Rear Admiral Oscar Hughes, the RAN's original Collins project director, who has now retired, saw a future for Australia as a focal point for regional submarine programs. Potential joint ventures that might involve full or part construction in Australia would likely be smaller than the Collins. Malaysia, Taiwan, Thailand, and Singapore are considering submarine purchases. Australian industry and trade, aware of the advantages of economy of scale, are very supportive of export.

Government-to-government and navy-to-navy relationships will be crucial in the regional marketing process. However, Australian Democrats, who have an impact out of proportion to their numbers, claim that increasing submarine strike power in other nations would be like planting a time bomb in the region.

The submarine project has had to overcome defects and delays. In late 1992 there was a flurry of media comment when the Australian National Audit Office reported that deficiencies in the original contract and Department of Defence project management had allowed ASC to extract a big price increase from the government. The charge was vehemently denied by the RAN project director, Rear Admiral Oscar Hughes, who expected to be within budget at the completion of the project. ASC's Don Williams considered the assessment ill-informed.

Six months after the formal launching, the Australian Minister for Industry claimed that anonymous letters were being sent to media outlets about defects in the submarines. The Federal and State Governments and the RAN stated that BHP had delivered a defective load of steel and that surface imperfections were being tested, and that there was no question about the structural integrity of the welds. Problems with software had already been acknowledge by ASC when these came to light in the final testing. Rear Admiral Oscar Hughes' successor, Commodore Geoff Rose, dealt with adverse comments on 17 July 1994. Saying that he had spent a lifetime in submarines and "couldn't believe the fuss being made," he dealt with the alleged defects one by one. On 19 July, Senator Robert Ray, the Minister of Defence, announced that software problems for the fully integrated combat and command systems would delay sea trials until the end of 1994. The computer equipment would be gradually improved as the trials continued. The RAN has no intention of rushing the project. The RAN's concern is to get it absolutely right for the first submarine and that concern will be reflected in the delivery time for following submarines.

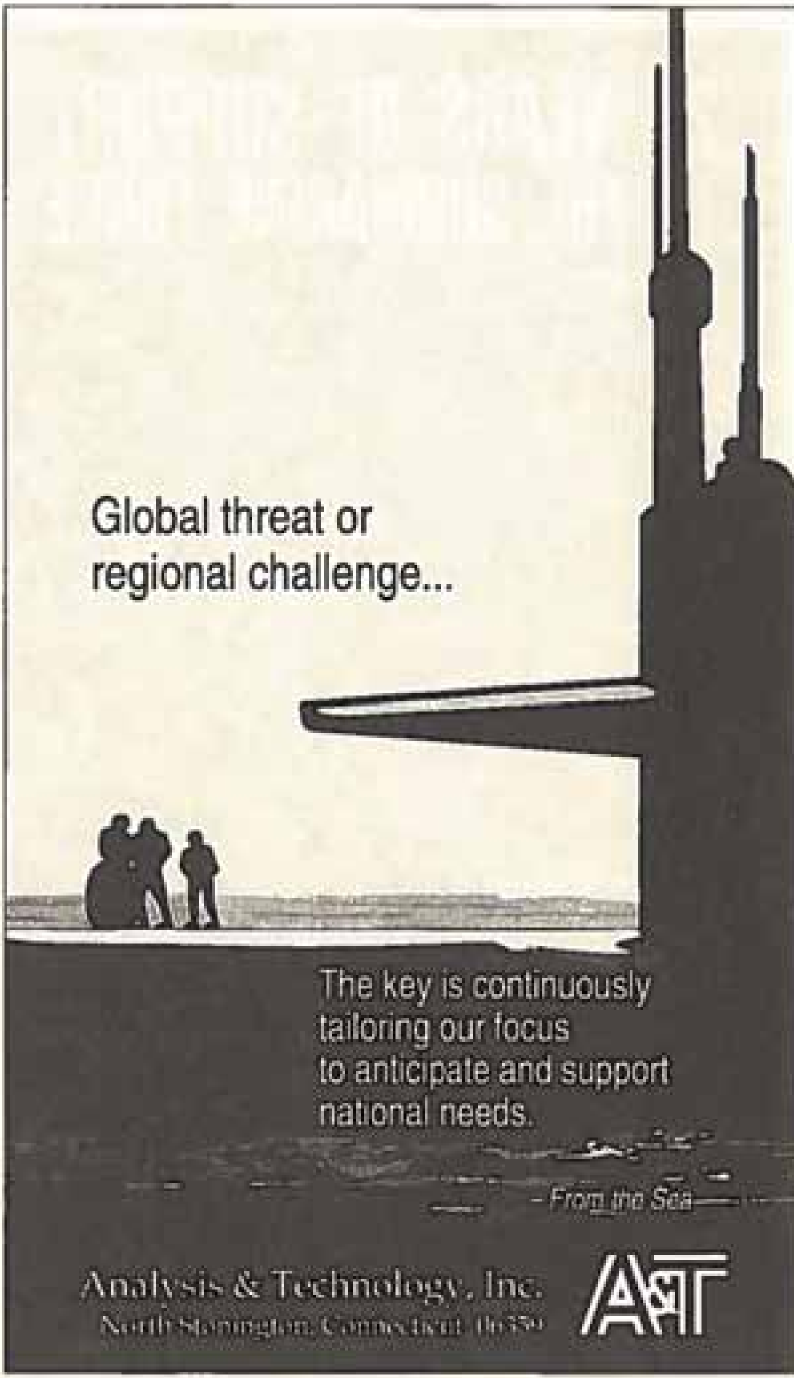
The readiness of some commercial and political critics to denigrate the submarine project may reflect an element of *sour grapes* at the allocation of the contract, or it may reflect the conviction that what is imported is bound to be superior, or possibly, as ASC's Williams asserted, it is part of the national psyche to predict, even delight, in failure. On the other hand, the hope was expressed in the Financial Review, "In the past 30 years we have thrown off the oppressive cultural cringe that used to drag down the arts in Australia. May the economic cringe be the next to go."[2] The enterprise of building the submarines—and the ramifications—has succeeded beyond expectations. The real problem is in the level of defense spending which never achieves the commitments of the White Papers. The 1976 commitment was dropped in the second and subsequent years and the 1987 commitment, a minimum of 2.6 percent of the gross domestic product (GDP), did not survive a year. Defense expenditure is now 2.3 percent of GDP. Competition among the services for scarce funding makes it unlikely that the RAN, which is building new frigates as well as the submarines, will get the two additional frigates that were an option in the original contract, and considered necessary by the RAN to support its "two ocean" operational concept.

The COLLINS, the largest, most powerful diesel submarine in the world, provides an option to strike offensively at an adversary and has an advantage over other platforms in such roles as ASW, maritime strike, and intelligence collection-surveillance. The Collins class submarines are an integral part of the broader defense policy leading to reduced dependence on overseas imports and fostering Australian expertise that can lead to regional stability.

NOTES

1. Senator Robert Ray, Minister of Defence, "Defence into the 21 Century", statement in the Australian Parliament House, 30 May 1991.

2. Peter Roberts, Australian Financial Review, p. 2, 30 August 1993.


Global threat or
regional challenge...
The key is continuously
tailoring our focus
to anticipate and support
national needs.
- From the Sea
Analysis & Technology, Inc.

THE EARLY DAYS OF SUBMARINE SINS

by CAPT C.C. Brock, USN(Ret.)

[Editor's Note: Captain Brock was in the Office of Naval Research (ONR) from 1956 to 1959. He made five submarine war patrols in the Pacific during WWII, and served aboard six different submarines and under two Medal of Honor winners. He was Plans Officer for COMSUBLANT (1961-63). His commands included the submarine BECUNA (1954-56), SUBDIV 62 (1963-64), USS CHILTON (APA 38) (1964-65) and SUBRON EIGHT (1968-69). He retired July 1, 1972 after a two year tour as CNO Budget Officer, followed by one year as OPNAV's first Director, Fiscal Management Division, responsible for all Navy appropriations except RDT&E.]

In 1957 the USSR achieved a huge psychological warfare victory when they were the first to place a satellite, SPUTNIK, into orbit. In 1958 the United States achieved a similar victory when NAUTILUS and SKATE were the first ships to reach the North Pole. In 1959 USS GEORGE WASHINGTON (SSBN 598) was underway to inaugurate the era of the submarine ballistic missile. This article will describe some of the previously unrecorded history of smaller events which supported these larger achievements.

The corporate history of Autonetics (formerly North American, now Rockwell International) contained in the recent publication of Steel Boats-Iron Men (1994) made me fully aware for the first time of their super critical contributions to the success of the U.S. submarine service over the past 36 years. From NAUTILUS to the present day they have been the sole supplier, with a few minor exceptions, of all inertial navigation equipment installed in our submarines at a cost estimated to exceed $2 billion. It seems worthwhile to provide my own experience during the early research and development of inertial navigation in submarines and the key roles played by several individuals in that history.

This chronology began 40 years ago in 1954 when ONR, considering Autonetics to be the world's leader in its field, contracted with Autonetics to conduct research in gas bearing gyros, then thought to hold great promise over the ball bearing variety because of their lower drift characteristics. My Naval

Academy classmate, Dominic Paolucci, then a PhD. candidate in mathematics, was the Scientific Officer for the contract. That Autonetics has maintained that leadership over the years is both highly noteworthy and exceptionally commendable.

There were numerous other projects under Dominic's guidance at the time, but most of them in the navigation field were closely coordinated with and jointly funded by ONR and the USAF Research and Development Command, represented in an inestimable way by Major Len Sugerman. To my knowledge, this gentleman was never adequately recognized by the Navy for the invaluable and unselfish assistance which he gave to us. Perhaps this article will shed some light upon the significance of that assistance.

I relieved Dominic as Senior Submarine Project Officer, Undersea Warfare Branch, ONR in June 1956 after a CO tour in BECUNA. The Branch was involved during the summer with conducting Project NOBSKA at Woods Hole, an ASW meeting of the Committee on Undersea Warfare (funded by ONR) of the National Academy of Sciences, and to which a number of leading scientific people in the country had been invited. Fortunately, Dr. Ed Teller, who needs no introduction, was there; and, in answer to a question totally unrelated to ASW, stated that it was feasible to build a one megaton warhead of about 600 pounds within five years. The impact of this statement was understood immediately and translated within hours into an estimated missile envelope of about 25,000 pounds and a 1200-1500 mile range, using liquid propellant. A future solid version would prove to be somewhat heavier.

The earth shaking tremors of the future Polaris program had begun. Less than four months later, on about December 10th, it was approved by the White House and SecDef. Less than four years later, Dr. Teller had beaten his own estimate but with a warhead having a somewhat lesser yield, and GEORGE WASHINGTON was already on her first deterrent patrol. That timetable still boggles the mind.

Also, in the summer of 1956 Commander Bill (Andy) Anderson came to town as PCO of NAUTILUS. We had served together on SARDA and in the spring of 1957 he made me aware of his desire to explore the Arctic under the ice pack. In discussing the problem with Dr. Don Pickrell, who had led the gas bearing research work at Autonetics, Don disclosed that the USAF Navaho cruise missile program was being terminated, and several of their

N6A pure inertial platforms were surplus with no known future use.

Unlike other systems at the time, these platforms could remain locally level with respect to the earth and were largely insensitive to the effects of latitude in their performance.

This information from Don, also a neighbor, was followed shortly by dinner at our home in Bethesda with the Andersons and the Pickrells. That evening after dinner, Andy, Don, and I were in agreement to use the N6A if USAF could make it available to us. I was thankful for Don's power of persuasion and Andy's good judgement in adopting a course which promised to greatly enhance the navigation and safety of NAUTILUS during their anticipated trip or trips to the Arctic.

Within a few days Len Sugerman was able to give me the assurance that USAF would release two, perhaps three, N6A systems to the Navy for submarine use. Pat Hannifin, at the Navigation Desk in BuShips at the time, followed through promptly with the necessary contractual agreement. At this point Tom Curtis of Autonetics was named Program Manager for the NAUTILUS project with responsibility for its success or failure, and was the major contributor to its successful deployment.

It was then up to Autonetics to reprogram the missile computer from the Navaho's Mach 3 plus environment to the more benign one of the submarine. At this time the Navy equipment was designated as the N6A-l in order to avoid confusion with the continuing USAF programs.

A few months later, in the summer of 1957, NAUTILUS made her first Arctic exploration. Andy states that this experience emphasized his need for an inertial navigator before making a second trip. At one point he had been reduced to a magnetic compass and fathometer for his navigation aids and had to abort the trip after reaching within 180 miles of the Pole.

Meanwhile, testing of the N6A-l had begun at Autonetics, followed by further testing at MATLAB, final successful testing at sea on COMPASS ISLAND under the guidance of Virgil Perkins and Tony Schwab of Autonetics and installation on NAUTILUS in April of 1958. From dinner to dockside delivery of the N6A-l at Electric Boat, all of these actions had been completed in less than a year's time.

NAUTILUS' second Arctic deployment soon followed and resulted in their historic 1,830 mile Pacific to the Atlantic crossing via the Pole. Concurrently, a second N6A-l had been installed on

SKATE for their voyage from the Atlantic and subsequent surfacing at the North Pole.

Andy still remembers the thrill of seeing the N6A-l chalk up the instantaneous event when they pierced the Pole, and the celebration of the entire crew. Under the pack they had only a manual DR and the position information from the N6A-l.

When they emerged from the pack and obtained a sun fix for the first time in several days, Andy estimated that their inertial generated position was only a few miles out. As he said at the time, to Navigator Shep Jenks, "Fandamtastic". Also to be remembered are those two Autonetics pioneers, Program Manager Tom Curtis and George Bristow, the only manufacturer's reps that Andy took along for the trip to run and evaluate the equipment.

Shortly after the public announcement of NAUTILUS' arrival at the Pole in August of l958, I received a telegram from Autonetics stating "CONGRATULATIONS, THE WORLD WILL NEVER KNOW". My failure to file the telegram for posterity is due, most likely, to my total absorption in the selfless world of researchers who merely sought results.

I was privileged to know many great minds during that period who were somewhat possessed of an exciting idea, the nuclear submarine. The best of them were marked by their humility, modesty and kindness. It was especially rewarding for me to meet them more than half way, and Don Pickrell was among the very best.

Also, in the spring of l957 Autonetics research and testing of the gas bearing gyro for ONR was coming to an end and the System Design Study for its application in an inertial navigator was due for distribution by late spring. Extensive testing of the gyro itself had demonstrated superlative performance over a considerable period of time, and its low drift characteristics made it the only gyro capable of meeting the SINS performance specification for the Polaris weapon system.

During this same period ONR implored the Special Projects Office to put Autonetics in business, at least as a backup to Sperry, then the prime contractor. This was the very heart of the weapons system, and submariners have always known the importance of backups to critical systems. We were ignored for over six months.

Finally, in November of l957 I received an inquiry from Captain Lew Schock, then the sterling and forthright head of the Navigation section at Special Projects Office, and #l man in the

USNA Class of 1935, who asked how long it would take to put North American (Autonetics) in business. My cryptic reply was, "A telephone call". To whom? Don Pickrell, then on assignment in Washington. Time consumed: perhaps five minutes.

Special Projects added money very quickly to the ONR contract to get the work underway, and then cut over to a production contract a few months later.

Eighteen months after this initial approval by SP, the first two Mark 2 SINS were delivered dockside at Electric Boat for GEORGE WASHINGTON's first scheduled sea trials, with Jim Osborn as CO and Pat Hannifin as his Exec. The substitution of velocity meters in lieu of distance meters was essentially the only production change made to the research system design study. For me, this was the unmatched performance in all of my Navy experience by such skillful, knowledgeable, and dedicated people at Autonetics.

There are two footnotes to this early history.

Beginning in the 1950s and continuing for several years, ONR funded, together with the USAF and Len Sugerman, a basic research program in the electromagnetic suspension gyro (EMG). This research was conducted under the direction of Dr. Bob Kuhlthau of the University of Virginia Physics Department. Because the theoretical accuracy of such a gyro was limited only by Brownian noise, the prevalent view at the time, great hope was held for its development as the ultimate gyro. By 1959 the gyro being researched by Dr. Kuhlthau envisioned a solid ferrite sphere spinning at about 18,000 rpm.

According to Dr. Kuhlthau they never reached the point of building a model or prototype of such a gyro. Rather, they were compelled to terminate their research in the early 1960s because they were unable to develop a ferrite material having the prerequisite zero hysteresis loss. Perhaps some day some other research will discover the material needed to build a perfect gyro using an electromagnetic suspension.

Concurrently with the research at the University of Virginia, and with my memory refreshed by Len Sugerman, I recall that ONR, quite probably with USAF support, sponsored the basic research and feasibility work of Professor Arnold Nordsieck at the University of Illinois in the electrostatic suspension gyro (ESG). This research exhibited great promise when it was completed about 1959.

USAF sponsored the development of such a gyro in the 1960s with Professor Frank Bell at University of California, Santa Barbara and then to AC-Delco at nearly Goleta, but the aviation application was never applied, most likely because of a high cost to benefit ratio.

Whereas Nordsieck was the father of the ESG, the Navy's godfather seems to have been Lew Schock at SP who funded Honeywell, with some USAF support, for its development in the early 1960s. This gyro would have used a hollow beryllium sphere, also spinning in a vacuum at a very high RPM, in which development Autonetics declined to participate because they believed that the hollow sphere would lack the requisite dimensional stability for its performance. Rather, they felt compelled to develop their own gyro, using their own funds, having a much smaller solid sphere spinning at 216,000 RPM, and which eventually achieved a ten fold reduction in drift rate. Autonetics own studies had begun in 1959 and in 1970 had demonstrated the feasibility of their own design and its accuracy for long term navigation.

Despite its promise in the early 1960s, the technology of the ESG laid dormant for the next decade. Honeywell's early ESG seemed to offer only a marginal improvement in drift rate; and the stellar performance of Autonetics' gas bearing gyros continued to meet SP's requirements for both Polaris and Poseidon. The impact of Trident, however, with its more rigorous specifications, served to bring the ESG technology out of the closet.

Soon to follow in 1974 was the final shootout, not at OK Corral, but testing on land and sea, between the two competitors using an ESG of different design, Honeywell and Autonetics. The latter emerged the clear victor and, to their everlasting credit and that of Program Manager Buzz Sawyer, have built their ESG for the Navy for the past 20 years as an integral part of submarine SINS equipment.

The second footnote provided by Don Pickrell responded to my query about the subsequent history of the gas bearing gyro, sponsored initially by ONR. His reply was that they (Autonetics) had won the Minuteman contract largely because of their proposal to use the gas bearing gyros in the guidance package. Having little or no friction, the gyros could run all the time and always be ready to fire without warmup. Thus, the Navy made a real contribution to the highly successful Minuteman program, repaying USAF, in part, for their crucial loan of the N-6As.

In recent conversations with Don he has emphasized that his own memory is not flawless. He remembered that there were many superlative professional contributors to their gyroscope designs which made their submarine programs so successful. He has singled out such people as John Slater, Walt Ebert, Joe Boltinghouse and Stan Cogan as typical heroes, while hoping not to slight any one of many others also typical heroes.[1]

I share Don's views completely and would be remiss if I failed to acknowledge the very fine guidance and support received at ONR from my submariner superiors: Captains Charles B. Bishop and Charles B. Momsen, Jr.

My own limited knowledge and experience in this highly technical field were acquired largely from my assistant at ONR during my service there from 1956-1959. An exceptionally bright young man, he was Lieutenant Ray Haugner, USNR, a University of Illinois graduate who had many gifted and cultural attributes, and was greatly admired by the Brocks. I deeply regret that we lost track of him after he left ONR in 1958 to work for Bill McLain and Howie Wilcox at NOTS, China Lake, for whom Ray and I shared deep respect.

Had he lived, I am certain that Dom Paolucci, the progenitor of this history, would have joined me enthusiastically and proudly in this accolade to the many fine people at Autonetics under the leadership of President John Moore, Vice President Fred Eyestone, Chief Program Managers Al Grant and George Leisz (later Vice President), and their successors, without whom the recent 40 year history of the U.S. Navy submarines might not have been recorded quite so successfully.

It may be fairly concluded that the early cooperation of the Navy, Air Force and Autonetics led to results of substantial benefit to the United States.

The author wishes to acknowledge the extensive contributions made by four individuals in the preparation of this article. The first is Dr. Don H. Pickrell, Jr. of Yorba Linda, California who was a key leader for many years at Autonetics in their inertial navigation and guidance field. The second is Captain William R.

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[1] The Godfather of all the history related in the preceding article was Dr. Charles S. Draper of MIT who conceived the idea of a ship's inertial navigation system for submarines, who began work on it about 1951 and demonstrated its feasibility about 1954.

Anderson, USN(Ret.) of Great Falls, Virginia who was Commanding Officer of NAUTILUS for their historic transpolar trip in the summer of 1958. The third is Colonel Leonard Sugerman, USAF(Ret.) of Las Cruces, New Mexico. The fourth is Don MacKenzie, whose book Inventing Accuracy, MIT Press 1990, reviewed by the author at the insistence of Colonel Sugerman, was found to be an invaluable source for any serious historian. Also contributing were Dr. A.R. Kuhlthau of Charlottesville, Virginia, Rear Admiral James B. Osborn, USN(Ret.) of Summerville, South Carolina, Captain William E. (Pappy) Sims, USN(Ret.) of Annapolis, Maryland, and Joseph A. Cestone of Sumner, Maryland. The serious technician is referred to the Journal of the Institute of Navigation, Vol. 25, No. 3, 1978, pp. 310-322 entitled "The Evolution of SINS in the FBM Program" by McKelvie and Galt of Autonetics. ■

**** IN REMEMBRANCE ****

Carmelina "Nickey" Atkins
(NNS Launching Coordinator)

RADM Roy S. Benson, USN(Ret.)

EMCM(SS) Victor Church, USN(Ret.)

LT Arthur C. Hickey, MC, USN(Ret.)

Chester L. Long

RADM Harvey E. Lyon, USN(Ret.)

RADM Henry S. Persons, USN(Ret.)

Howard R. Talkington

CAPT Louis T. Urbanczyk, USN(Ret.)
Founder, League Counsel

RESTORATION OF THE TDC MARK III ABOARD USS PAMPANITO

by Terry D. Lindell

The Torpedo Data Computer (TDC), Mark III aboard USS PAMPANITO in San Francisco has been successfully restored to operating condition. The TDC is the electro-mechanical analog computer that solved the torpedo targeting problem in the fleet submarines during World War II. The restoration project took over 18 months to complete, and was done with the support of Russell Booth, director of the USS PAMPANITO museum. We believe that restoring this historically significant device to an operating condition is the best means of preservation. The TDC Mark III computer is one of the two remaining examples of the TDC Mark III still installed in a museum fleet submarine.

How It Worked

The TDC was unique in World War II. It was the computational part of the first submerged integrated fire control system that could track a target and continuously aim torpedoes by setting their gyro angles. The TDC Mark III gave the U.S. fleet submarine the ability to fire torpedoes without first estimating a future firing position, changing the ship's course, or steering to that position. Instead of hoping that nothing in the setup changed, a fleet submarine with the TDC could fire at the target when the captain judged the probability of making hits to be optimal.

In World War II a torpedo's gyro angle was set mechanically while it was in the tube. A shaft, known as the spindle, slipped into a socket near the housing of the torpedo's course gyroscope. When the fire control system rotated the shaft, the gyroscope rotated. After being fired, the torpedo traveled on a straight course for a known distance called the reach. A delay in the release of the torpedo's gyro steering mechanism by a threaded shaft determined the magnitude of the reach. Once engaged, the steering mechanism brought the torpedo to a new course based on the angular offset of the gyroscope.

The Mark III computer consisted of two sections, the position keeper and the angle solver. The position keeper tracked the target and predicted its current position. To do this, the position keeper automatically received input of the ship's own course from the gyro compass, and own ship's speed from the pit log. The position keeper had hand cranks on its face that set the target length, estimated speed, and angle on the bow. It also contained a sound bearing converter that calculated the target's location based on sonar measurements.

The position keeper solved the equations of motion integrated over time. The result was a continuous prediction of where the target was at any instant. Successive measurements of the targets' position were compared to the position keeper predictions and corrections for error were introduced with the hand cranks. The predicted target position became more accurate as more measurements made the corrections smaller. It was typical to get an accurate track on the target after about three or four observations under good conditions.

The angle solver automatically took the target's predicted position from the position keeper, combined it with the tactical properties of the torpedo, and solved for the torpedo gyro angle. Values calculated from this solution were returned to the position keeper in two feedback loops. The gyro angle automatically went to each of the torpedo rooms and set into the torpedoes continuously. The TDC controlled both torpedo rooms and all 10 torpedo tubes at once.

The U.S. Navy thus had a system that would point the torpedoes at a target as the fire control problem developed. The TDC Mark III was the only torpedo targeting system of the time that both solved for the gyro angle and tracked the target in real time. The comparable systems used by both Germany and Japan could compute and set the gyro angle for a fixed time in the future, but did not track the target. Thus the idea of the position keeper, and its iterative reduction of target position error was unique to the U.S. Navy, and represented a distinct advantage.

TDC Development History

The U.S. Navy contracted with the ARMA Corporation for the first TDC. The first Mark I was installed and tested in USS SEAL in 1938. The Mark I was a large device, and could not fit in the small space available in the fleet submarine's conning tower. Instead it doubled as the navigator's chart table in the control room, and had to be cleared off when running an attack problem because the dials showing the calculations were under the glass table top.

To install a Mark I in the submarine's control room required it to come in pieces, and be reassembled in place. To make up for the computer being in the control room, an electrically controlled remote plotter in the conning tower kept the captain up to date on the attack. The captain and the executive officer running the computer would *yell at each other* through the open conning tower hatch. The Mark I worked, but was too big. Plotting the development of the attack in both the control room and the conning tower split up the attack party and limited their effectiveness. It became apparent that a truly integrated system had to fit in the conning tower. ARMA only produced 28 Mark I machines. Before the end of production the design of a smaller machine started.

During the same period, the Ford Instrument Company developed an alternative model, the TDC Mark II. Its use overlapped that of the Mark I developed by ARMA. Designed by the head engineer of Ford, William Newell, the Mark II machine featured a very innovative mechanical solution for the targeting problem. This permitted the device to be small enough to fit in the conning tower where the action was. Ford was too busy with surface fleet computer contracts to even consider bidding on a contract for the Mark II model. It appears that only 12 Mark II TDC computers were built.

Before Mark I production was over, and not knowing of the Mark II project, ARMA accepted a contract for the development of the TDC Mark III. This device was very successful and turned out to be the major submarine computer in World War II. As the U.S. entered the war most of the earlier models of TDC were replaced with the TDC Mark III as machines were available and submarines came in for refit. A testimony to the significance of the design was that during the entire war period only five alterations were made to the original TDC Mark III design.

From personal interviews and memoirs of submarine captains, one is left with an impression of respect and appreciation for the TDC Marks I and III. Even early in the war when the torpedoes failed to explode, they were usually on target. A Japanese captain after the war recalled that in the beginning U.S. submarines made their ships *look like porcupines* with impaled torpedoes, and that they knew right away when the exploder started working. *[Editor's Note: Early in WWII the Mk 6 magnetic exploder, in use with the standard Mk 14 torpedo, failed to perform as designed and it was not deactivated for almost two years (eight months later in the Southwest Pacific theater).*

About a year after the end of World War II the TDC Mark IV was introduced as a field installed upgrade kit for the existing Mark III systems. The modification added a third piece called the Receiver Section, inserted between position keeper and angle solver. This new attachment worked as a master switch between all of the submarine's sensors. It also simultaneously indicated all of the sensor readings, available at any instant from radar, sonar and optical, permitting a cross reference check.

The Mark IV upgrade also expanded the range of torpedo tactical settings available by changing some gearing. This directly accommodated the new, slower electric torpedoes. Prior to the Mark IV upgrade the TDC Mark III had to be set up to indicate twice the speed and half the range of the true solution for these slower shots. Most of the fleet submarines still in use after the end of the war were upgraded to the Mark IV TDC. Because this was the pool from which most of the fleet submarine museums came, there are now only two unmodified TDC's Mark III left installed in submarines.

USS PAMPANITO went into moth balls only two months after the end of World War II. It remained in this state for 15 years, well after the TDC Mark IV upgrade program was over. As a result it never received the upgraded Mark IV TDC. The only other museum ship with an unmodified original Mark III TDC installed is USS BOWFIN on display at Pearl Harbor.

TDC Restoration

This restoration effort would have been impossible without the TDC Mark III manual available in the PAMPANITO's library. There are only seven known copies of this ordnance pamphlet (OP 1056). The manual for the TDC Mark IV (OP 1442) is even scarcer, with only two known original copies in existence. In addition, the access to other PAMPANITO volunteers like fleet submarine veteran Joe Senft, familiar with fleet submarine wiring, was invaluable.

The TDC Mark III handbook gives a detailed account of its theory, and examples of how its parts work. There is a detailed discussion of how to dismantle and reassemble a TDC. Along with the detailed diagrams and pictures, are the directions for checking, servicing and operating the TDC.

The first order of business was to restore AC shore power to the TDC heater circuit. All TDCs have an electric heater to maintain an even temperature of 74 degrees inside the position keeper case. This prevents the buildup of moisture and maintains the mechanical tolerances required for accurate operation.

Hundreds of gears, shafts, bearings, and closely machined surfaces must match each other perfectly for the TDC to work. Every moving shaft and gear runs on finely made miniature ball bearings. The surfaces of the integrator wheels look like mirrors because of their finish. Indeed, first hand accounts of the building of these fine machines verify that most of the sub-assembly fitting was done by skilled machinist's hands. The required fit and touch of each sub-assembly *must be as soft as a baby's behind*.

After manually checking the machine's operation, the next problem was lubricating a machine that had not seen an oil can in 30 years! We were able to obtain a copy of OP 3000—U.S. Navy Lubrication from the library of USS COBIA in Manitowoc, Wisconsin. This document has a table that converts the 1944 Navy lubrication numbers used in the TDC manual into the names of lubricants available today. A large number of Gier tubes feed oil by capillary action into key places inside the very close recesses of the TDC. Lubrication was introduced over a period of several months to assure that the oil had time to penetrate, by capillary action, the fairly long distances into the machinery.

The single largest challenge to the restoration of the TDC was providing electrical power. Connecting AC power to the heating circuit is simple compared to starting the machine up. The TDC uses two power sources. One source is DC 115 volt at 10 amps required to run the time motor in the position keeper section. The angle solver section must also have single phase 115 volt AC 60 cycle power for the follow-up heads that make up the feedback loops.

Restoring power required that someone understand the wiring of PAMPANITO's IC switchboard. Over the years much of PAMPANITO's wiring has been modified. There are few wiring diagrams, and no way to know what the original intent of the builder was. Much of the restoration time was spent wedged behind PAMPANITO'S IC switchboard tracing wires and checking continuity. Fortunately, PAMPANITO's cabling systems have well-preserved circuit number tags which speeded up the task. Slowly, an IC switchboard wiring diagram was developed.

Power for the TDC time motor on PAMPANITO could come from three separate sources, and one of those sources was an AC to DC selenium rectifier stack. Although age had long ago caused the selenium crystals to break down, it was possible for Joe Senft to replace them with a solid state device that easily fit into empty space in the power supply cabinet. After considerable testing of the remaining wires, and some repair to the original circuits, we were able to provide both AC and DC power to the TDC for the first time in 40 years.

Operating the TDC

After carefully testing the mechanical travel of the TDC, and years of input crank fiddling by the well-meaning curious, the machine was well out of alignment. The TDC is a classic example of two electromechanical feedback circuits connected to each other. As the position keeper computes the current position of own ship and the target, the results are forwarded to the angle solver as rotating shafts. The angle solver in turn computes the gyro angle and a projected pseudo run for the torpedo to hit the target. The results of the calculated torpedo's run are fed back to the position keeper as a new input. In this way the TDC iterates the solution of two differential equations with two unknowns.

Once DC power was applied to the time circuit the time motor started to compute the progress of an imaginary target represented by the current settings of the hand cranks. Adding AC power caused the machine to start computing the total solution. Because most of the mechanism was out of alignment many of the dials started to rapidly turn in every direction at once. In a few seconds the dials started to slow down, and in a few seconds more they started to seek equilibrium.

Once the machine settled into a steady state the *generating* light came on and the machine began to track a solution. This was quite remarkable after so many years of inactivity! In order to test the accuracy of the TDC, we upset the most extreme test problem available in the manual. This is where the target and submarine are approaching each other at high speed. We shut down the machine and set the initial measurements into the hand cranks.

Upon starting up the computer with these extreme initial conditions loaded the TDC did remarkably well. Most of the variables change at a high rate of speed as the target and submarine pass each other. It is fascinating to watch the machine compute continuous solutions to simultaneous differential equations that have rapidly changing variables. The TDC kept up with the problem's rates, and produced a result that was acceptably close to the required answer. It is most amazing when one realizes that this machine is mostly wheels, gears, and shafts, and pre-dates the invention of the digital computer.

What is Next?

The project on USS PAMPANITO is far from over. We plan to complete the restoration of the balance of the fire control system. This includes rebuilding the gyro angle indicating and setting regulators (GISR—also known as *Mickey Mouse* because of how it looks) in each of the torpedo rooms that act as output devices for the TDC. These devices receive the electrical gyro angle order generated by the TDC. The machine converts the order into rotation of a jack shaft. This shaft is geared to axles that run up the inside of the torpedo tubes and turn the torpedo gyro angle setting spindles. The GISR does this with a 1 HP motor that uses 40 amps of 110 volts DC.

In order to operate the GISR we will have to build new power supplies for PAMPANITO that replace the missing battery. In addition, tracing the wires for the much longer runs between the conning tower and the torpedo rooms will present a challenge. There are junction boxes in each compartment for both the DC power and the computer generated signal. All of these connections must be identified and tested before connecting power.

We are also developing a museum display of the World War II fleet submarine fire control system. There are 10 interested museum locations around the country that have vintage torpedoes on display with no explanation of how they were targeted. We hope to cooperatively develop a display explaining this remarkable system to the general public. Only then will we have accomplished the mission of illustrating this historic machine and its effect on history.

Finally, we are attempting to develop a book on this subject. Computational mechanical analog computers had a very short history. They were only prevalent for the 50 years between the turn of the century and the invention of the digital computer at the end of World War II. These devices played a significant role in most of the historical events of the period. The fact that they were built changed the rules. By understanding these devices we can start to see how the ability to compute with a machine fueled the desire for even more machines with greater abilities. ■

SUBMARINE SONAR SYSTEM CONCEPTS FOR LITTORAL WARFARE: ONE PERSON'S VISION

by G. Clifford Carter[1]

Abstract

This article describes submarine sonar concepts for use in littoral waters. Included are sonars for use in, on, or with an innovative submarine sail. The new sail is envisioned for submarines beyond the new attack submarine (NSSN), although some of the sonar concepts could be backfit to NSSN, 688 or SEAWOLF Class. The new concepts are a result of a *clean slate* look at future submarine sonars for littoral waters. Certain of these concepts will undoubtedly be accepted and others altered or discarded as more formal, detailed cost and effectiveness studies are conducted.

> "What we anticipate seldom occurs; what we least expect generally happens." Benjamin Disraeli[2]

Background

With the end of the Cold War, the U.S. Navy laid out a dramatic new strategy. The essence of this strategy was documented in late 1992 in ...From the Sea. The strategy was finalized after extensive senior (military and civilian) naval staff participation during fiscal year (FY)[3] 1992. At this time the Navy was also completing its FY 1994 budget for submission to the Department of Defense (DoD) and Office of Management and Budget prior to submission by the President to the Congress in early 1993. Because the strategy was well thought out, well stated, and had broad support, it survived the transition from the Bush to Clinton administration and has been adopted by Secretary of the

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[1] The views expressed here are those of the author.

[2] Quoted by RADM Thomas Brooke in USNI Proceedings, March 1994.

[3] A list of acronyms is provided as an appendix.

Navy John Dalton[4] and Assistant Secretary of the Navy Nora Slatkin.[5] While this strategy had been public for some two years, the significance of this *paradigm shift*[6] became clear to the Undersea Warfare Research & Development community while executing the FY94 budget, defending the FY95 budget and preparing the FY96 budget.

Having contributed to the collapse of the former Soviet Union, the United States now enjoys the freedom of the open ocean. As ...From the Sea states, "With the demise of the Soviet Union, the free nations of the world claim preeminent control of the seas..." Moreover, for the foreseeable future, the focus of the U.S. Navy is to project power ashore *from the sea*. The coastline areas are referred to as *littoral* areas. They are often, but not always, shallow water areas.[7] In these areas of the world, the DoD is beginning to envision new submarine sail concepts for submarines beyond the Navy's new attack submarine (NSSN). Naval organizations, universities, and contractors are conducting initial submarine sail studies and developing sensor suites for littoral warfare; some of these are located on a new innovative submarine sail. As will be described, these new sonar suites are needed

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[4] In the August 1994 issue of the USNI Proceedings, Secretary Dalton stated that "We embrace the concept of ...From the Sea and applaud the direction that it takes the naval service".

[5] N. Slatkin, *Undersea Warfare: An Acquisition Strategy to Meet New Dangers*, Sea Technology, January 1994, pp. 30-34.

[6] What follows is an example of a *paradigm shift*. For instance, because accurate time keeping was key to accurate navigation (in particular, determining longitude), the revelation of how to keep accurate time was a capital offense in the British Navy. Many years later, digital quartz technology replaced mechanical devices, making accurate time available at low cost; indeed thousands of people lost their jobs making finely crafted watch main springs.

[7] Note shallow water and very shallow water mean different things to different readers. To acousticians, shallow water is often defined in terms of wavelengths or bottom interactions; for others, it simply means a particular depth. For example, divers without underwater breathing apparatus think of 20 feet as deep, but for a submarine with a nominal 30 foot hull diameter, 20 feet is very shallow. At 100 Hz, 150 feet is only three wavelengths, so an acoustician might well consider 150 feet shallow.

because "mastery of the littoral should not be presumed. It does not derive from command of the high seas. It is an objective that requires our focused skills and resources."[8]

This article discusses the author's conjectures of possible submarine sonars for use in littoral waters, including their relationship to innovative submarine sail concepts. Sonars are vital to a submarine's success, but the paradigm shift that requires submarines to be fully integrated participants in the battle force means that submarine sonars must become more than just devices located on submarines. While the main objective of a new submarine sail is to improve communications, sonar performance is dependent on sail design. A new sail has the potential to improve submarine sonar in two ways. First, sonar performance of sail sensors can be improved. Secondly, with high data rate (HDR), real-time communications, sonar can be linked to offboard sensors and assets with cuing for improved sonar and combat system performance.[9]

Submarine Operations in the Littoral Environment

The nuclear submarine offers stealth, agility, and endurance for joint littoral operations. It can maintain a forward presence and be first on scene. The submarine can be covert and nonconfrontational. It is an ideal naval platform for providing the National Command Authority (NCA) with indications of upcoming hostilities. It complements other national assets by providing warnings of such activities as ships leaving port, underwater mine laying, the presence of underwater minefields and intercepted naval and coastal message traffic. This is the indications and warnings, or I&W, mission. With proper communications suites (especially HDR antennas), the submarine can transmit intelligence

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[8] "...From the Sea"

[9] To a lesser extent, sonar performance of non-sail acoustic sensors can be changed (perhaps improved) by changing (improving) hydrodynamic flow around the submarine, thereby reducing flow noise and distortion. We speculate that changes would be mainly to hull arrays but could include both existing and future sensors, such as, sphere, towed arrays including future MultiLine Towed Arrays (MLTAs), the Wide Aperture Array (WAA), the Advanced Mine Detection System (AMDS), Noise Augmentation Units (NAUs), noise monitors and ice-penetration sonars.

back to the NCA and receive detailed tasking for the next phase of operations.

With speed and stealth, the submarine is well positioned to covertly insert commandos or so-called Special Operations Forces (SOF) *from the sea*. The SOF, headquartered in Tampa, Florida, operates as a fourth branch of the DoD: Army, Air Force, Navy, and SOF.[10] The SOF is a truly joint command with components from the three services, including the Navy's Sea Air Land commandos (SEALs). Navy SEALs can be inserted and extracted from submarines using surface launched combat rubber raiding craft, subsurface launched wet swimmer delivery vehicle, or by subsurface launched dry, long range advanced swimmer delivery system, now being developed. The SOF ashore can provide intelligence and laser designation of key defensive radars and command control targets. During insertion and extraction of Navy SEALs, the submarine could be close to the surface and to the shore. This proximity might place the submarine in shallow water, say, less than 20 fathoms[11] at speeds of less than three knots for prolonged periods. During these near-stopped, shallow water operations involving stopping and maneuvering, it is the author's opinion that towed arrays will not be deployed and the needed vertical aperture of multiline towed arrays (MLTAs) will not be available. Moreover, the near surface position of the hull and WAA sonars (above the layer) will limit sonar performance to acoustic sources above the layer and severely restrict performance against sound sources (such as adversarial submarines) below the layer. These environments and scenarios favor offboard sensors close to the source because of propagation loss; because of the multiple acoustic rays in the shallow water waveguide, they also favor vertical sonar arrays that deploy below the layer and form narrow beams that can capture vertically separated acoustic rays while simultaneously discriminating against noise. Of course,

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[10] See John M. Collins, *Special Operations Forces*, CRS Report for Congress 93-697S, July 30, 1993.

[11] For those who question whether the submarine will operate in shallow water, ADM (then VADM) William Owens stated on May 11, 1993: "Thirty or more days before the landing is scheduled, the submarine could already be there in the 70 or 80 feet of water."

detailed studies and analysis must be conducted to assess the cost and effectiveness of innovative sonars designed to operate in such complex environments.

If operations require, the submarine will be ideally suited to (covertly) initiate a submarine launched cruise missile (SLCM) attack *from the sea*. Such a SLCM land attack can disrupt enemy shore based anti-air radar, as well as command, control, and communications centers, thereby clearing the way for joint carrier based air attacks, land based U.S. Air Force stealth air attacks, and landing Marines ashore. However, the complexities of such attacks require large volumes of data (called air tasking orders) that can take hours to be downloaded to the submarine *shooters*. To be an effective player in this mission, the submarine must be able to receive large volumes of message traffic, including last minute updates.[12] As envisioned, this will force the U.S. submarine to keep a large sail-mounted receiving antenna exposed above the water, potentially decreasing submarine stealth. Further, the *shooter* may be constrained to a fixed geographical *launch basket*. Clearly, these key joint operations will place new loads on the submarine combat (or command and control) systems and may restrict the maneuverability of the submarine. Restricted maneuverability, in turn, limits depth excursions and lead/lag legs historically used for target motion analysis making rapid localization sonar extremely important. Such constraints will force changes in methods for layered ship self defense, anti-submarine warfare (ASW) and anti-surface warfare (ASUW) operations and restrict the sonar performance if only conventional, submarine based sonar sensors are relied upon.

Littoral operations will have profound implications on future submarine sonar systems. Sonar and combat systems must be enhanced to operate effectively in littoral waters, and this must be accomplished in an increasingly tight fiscal environment. In addition, deep water, open ocean dominance must be retained. This involves conventional and evolving sensors, processing,

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[12] As VADM George W. Emery, USN, COMSUBLANT, stated on May 10, 1994: "Our (referring to the submarine force) ability to strike targets ashore must also keep pace with the rest of the Navy ... Communications is a critical area for integrated operations with submarines and other forces, joint and allied. The key problem here is achieving the higher data rates and compatibility with the rest of the fleets because of the limitations of submarine antennas."

displays, training and command and control for ASW and ASUW.

Submarine Sonar Forcing Functions

Three forcing functions for submarine sonar when the submarine operates in the littoral include:[13] intelligence gathering, the environment, and submarine posture.

First, intelligence gathering will require that the submarine (1) sonar act as a sensor for the Joint Task Force (JTF) Commander and that (2) sonar/combat system integrates and fuses received signals from: (a) offboard sensors such as unmanned underwater vehicles (UUVs), (b) bistatic active sonar, and (c) national (satellite) assets with downloaded (minefield) intelligence. Note, for intelligence gathering involving minefields, localization accuracy drives submarine sonar (size and location) requirements. For example, accurate determination of underwater mine depth nominally requires a sonar with vertical aperture. Furthermore, minefield intelligence requires (two-way) communications and connectivity with JTF and perhaps NCA, to identify lanes for Marine Corps fares to go ashore.

Secondly, environmental conditions in the littoral vary widely as a function of space (i.e, geographical location) and time (of day and season). For example, sound propagation is dominated by temperature versus depth profiles. Storms, typically in the winter, tend to mix up the top part of the water column causing an isothermal layer that profoundly affects sound propagation. On a daily basis, biological scatterers tend to feed at different times of day, moving about within the water column changing reverberation levels that impact active sonar performance. Poor environmental conditions limit acoustic signal reception (due to downward refracting acoustic rays, steep grazing angles and numerous bottom and surface interactions between the source and receiver). Moreover, poor environmental conditions drive the need for (1) offboard deployable sensors and (2) cueing. Stated differently, environmental conditions may be so poor in littoral waters that the

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[13] Of course, they include other forcing functions, too, beyond the scope of this article. For example, U.S. sonars must take into account counterdetection range by a potential adversary. This, in turn, would include concern for our radiated signal levels and our target strength, including sail shape and reflectivity. Unlike cold-war, open-ocean operations, we will now also be concerned with the radar cross section of a sail exposed in littoral waters.

only way to sense objects of interest is to be cued by external controllers or offboard sensors closer to the objects of interest.[14] Of course, poor environmental conditions are a double edged sword in that such conditions provide added acoustic stealth for our submarines.

Thirdly, submarine operational posture will limit the submarine maneuverability normally required for optimal sonar and target motion analysis performance. Moreover, this posture requires NAUs during training and selected operations. Submarine operational posture requires low target strength under water and also requires low radar cross section in air. Further, this posture requires good open ocean sonars to get to littoral waters; this requires well behaved flow around submarine sensors so that spherical and wide aperture arrays, as well as other sensors, perform well. To be investigated are the impact of operating near the surface in the open ocean (enroute to the littoral) to receive HDR communications with mission planning updates, air tasking orders, and tactical pictures common to the JTF.

<u>Technical Requirements</u>

At the technical level, we envision at least the following submarine sonar requirements.

1. A mine avoidance sonar with a large (vertical or horizontal or both) aperture for accurate mine position estimation,[15]
2. Offboard sensors (e.g. UUVs, the deployable acoustic sensor system (DASS), or advanced deployable system (ADS)) with connectivity/linkage to the submarine and high gain aperture
3. A permanent NAU in the sail, to avoid continuous cross decking costs

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[14] It is noteworthy that offboard sensors is on the July 1994 COMSUBLANT/COMSUBPAC list of high priority Command Technology Issues.

[15] Vertical arrays are useful for vertical mine localization accuracy. One current assessment is that a vertical array on the sail is workable, inside the bow for mine avoidance appears to be unworkable or very high risk; while a vertical array affixed to the bow has some risk (due to a variety of factors including anticipated interference to the spherical array's reception).

4. Noise monitor sensors in several locations, including in and on the sail for acoustic stealth
5. AN/WQC-2 on the sail for acoustic communications call up
6. AN/WLR-9 or AN/WLY-1 on the sail for 360 degree intercept receive capability
7. A sphere and WAA for detection and rapid localization
8. A chin mounted AMDS, below and aft of the bow for underwater mine detection, (horizontal) bearing estimation, and bottomed mine detection, classification and localization
9. TAs and MLTAs for slow and high speed low frequency passive (bistatic active) operation.

<u>Submarine Sonar Advanced Concepts</u>

We have grouped advanced concepts for submarine sonars operating in the littoral into three areas: (1) sonars on, in or deployed for a new submarine sail, (2) sonars exploiting a new innovative sail with HDR communications, and (3) other sonars not on, in, or from a new sail. Several of these shipboard sonars are sketched in Figure 1. While Figure 1 depicts only a single vertical line array above the sail, this could be a vertical multiline system. Note also that while Figure 1 depicts both a vertical array deployed from the sail and a cylindrical sonar system (CYSS) below the submarine, for some operations only one of these array systems would be deployed at a time. If the submarine were submerged and hovering, near the bottom, the CYSS couldn't be deployed below the boat, rather a (single or multiline) vertical acoustic array would be deployed upward from the submarine sail. If the submarine had its sail exposed for communications or SOF operations and were traversing at low speed, it would lower (one or more) CYSS volumetric array(s) below the submarine; this would provide the needed vertical (and some horizontal) aperture and position some sensors below the layer. Notionally, this array could be lowered about 100 feet below the keel, or even deeper with spacers or affordable very thin optical arrays. In water shallower than 100 feet (plus hull diameter), the cylindrical array would only be partially deployed. For ranging, three CYSS arrays might be used.

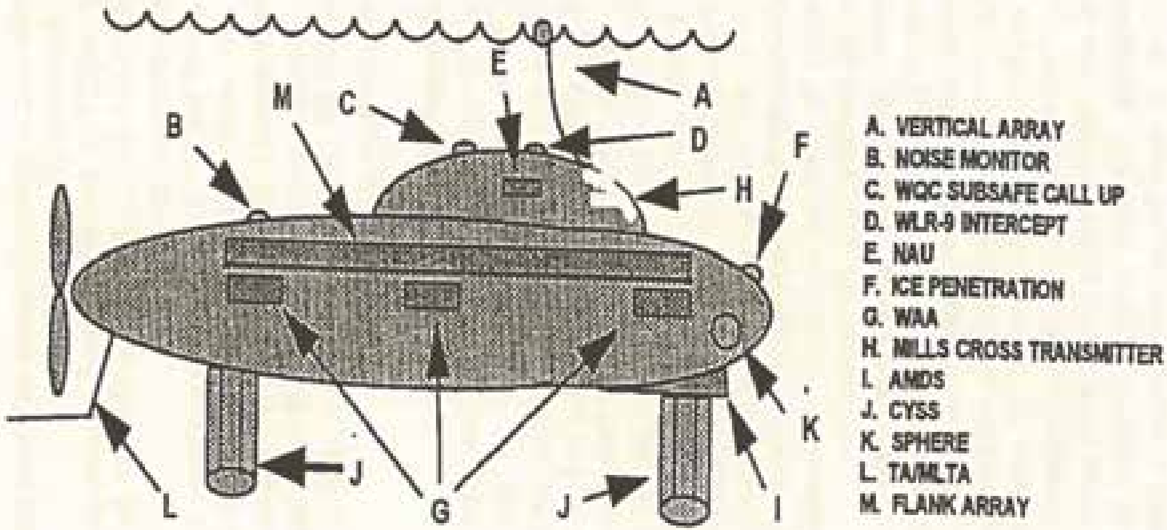


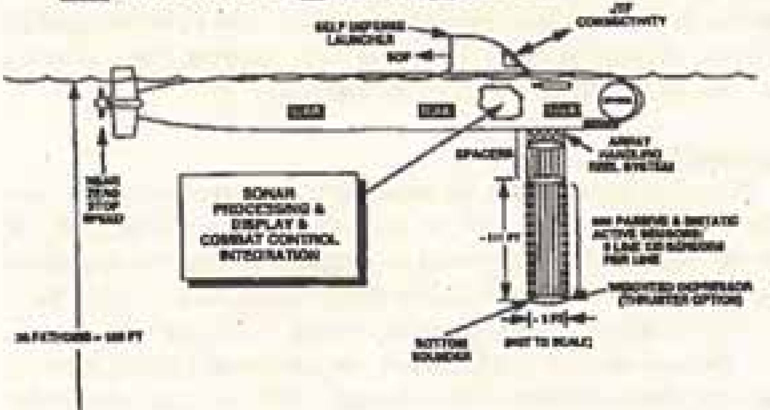
Figure 1. Sketch of advanced submarine sonar for littoral waters.

Sonars being considered in or from a new submarine sail include (1) a Mills cross or T array (with a full horizontal and vertical aperture) with an unimpeded vertical acoustic array in or on the sail (versus the riskier alternative of a high frequency array in or on the bow) and (2) acoustic sensors in a vertical line from a submerged submarine to a communications buoy. The T-shaped mine avoidance sensor with its vertical aperture would allow accurate depth determination when the submarine is submerged. Of course, when the sail is exposed in the air, the sail sonar would not be used to transmit or receive underwater signals, but it might receive in-air acoustic signals of air or patrol craft.

Sonars exploiting a new innovative sail with HDR communications include submarine sonar and combat systems linked by satellite, fiber optics, or RF communications to sonobuoys; DASS and ADS arrays; ocean surveillance assets; national (imaging) assets Tactical Exploitation of National Capabilities (TENCAP).

Finally, sonars for use during littoral operations include the CYSS, notionally this would consist of nine vertical arrays, each having 111 sensors deployed below the submarine.[16] However, the exact configuration requires additional detailed study. This sonar is illustrated below. A Navy patent is being prosecuted for the CYSS submersible sensor system invention.

CYLINDRICAL SONAR SYSTEM - CYSS



[16] This is a notional array of either 999 sensors or the thin optical equivalent. An independent performance assessment and demonstration of array gain would be conducted before settling on the final array configuration. The CYSS includes an active adjunct located on the depressor.

Submarine Sonar Advanced Demonstrations

We envision the need to demonstrate some of our advanced concepts (related to submarine sonar developments that are tied to a new innovative sail). For convenience, we group the submarine sensor research, development test and evaluation demonstrations into three areas: (1) sail specific sensors, (2) sensors that exploit new innovative sails, and (3) other littoral sensors.

First, sail specific acoustic demonstrations include the following: (1) Mills cross or T sail array beam patterns, (2) NAU transmission through new low radar cross section sail materials, and (3) a vertical acoustic line array from a submerged submarine sail to a floating radio frequency (RF) communications buoy. The demonstration treats both handling and acoustic performance.

Secondly, demonstrations to exploit new sail HDR communications include a submarine link from external sources to a prototype sail and then to land based sonar and combat system laboratories. In these demonstrations, we would link the sail by satellite and RF communications to ocean surveillance (e.g., ADS) assets, sonobuoys, and NCA, and then line the prototype sail to land based test sites.

Third, other littoral and sail alternative demonstrations include: (1) T or Mills cross array, but now on the bow (instead of the sail), (2) CYSS with perhaps, for example, nine arrays of 111 sensors each, and (3) as a possible alternative to a sail mounted or T array, consideration of a vertical mine hunting transmit array that telescopes out of a vertical stowage tube.

Summary

Four key points must be summarized in discussing the new submarine sonars that will be needed to operate effectively in littoral waters. First, we need to continue to improve sonars so that we retain our ability to move ships, troops, and supplies from U.S. ports across the open ocean enroute to littoral waters. We note that sail shape will affect both our underwater target strength and flow characteristics around the sail. This, in turn, will impact both ship handling and sonar self-noise. Second, we need mine detection, mapping, and avoidance sonars (some sail mounted) to penetrate littoral waters. Third, we need offboard acoustic sensors and assets. Fourth and last, we need connectivity to offboard sensors and national cueing and command assets.

Environmental conditions are such that several submarine sonar challenges exist to meet the Navy's new strategy focused on projecting power *from the sea*. Because of the profound shift in re-ordering the Navy's missions, we have prepared recommendations to assess and demonstrate sonar performance in littoral waters.

<u>Recommendations</u>

Submarines operating in the littoral may require improved sensors and connectivity. It is recommended that the following effort be performed:

- Subject notional concepts here to careful, detailed analysis.
- Develop and validate models of environmental conditions critical to submarine sonar operation in key littoral areas.
- Conduct studies and analyses that assess the cost and effectiveness (including performance and contribution) of various submarine sonar sensors in achieving joint and combined missions.
- Continue to develop submarine based mine avoidance sonars, some of which will be forward looking chin arrays and some will be mounted on the submarine sail, such as a T array (with full vertical and horizontal aperture).
- Develop and demonstrate offboard acoustic sensors that are linked to the submarine sonar and combat control system, such as sonobuoys, the cylindrical DASS the ADS arrays, and ocean surveillance assets. Some offboard sensors will be on or connected to UUVs.
- Develop and demonstrate HDR real-time connectivity to offboard sensors, national (imaging) assets, and TENCAP for improved cuing.
- Develop and demonstrate the performance of two CYSS-like sonars each consisting of, for example, nine vertical (thin optical) arrays, of 111 sensors or alternative design. Such a system would be deployed below the submarine for ownship defense when the submarine operates at low speed, near the surface, in littoral waters.
- Develop and demonstrate a vertical sonar[17] that reels into the sail or hull of the submarine. Such a nominally vertical

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[17] Such an array would serve a self-defense role in the littoral.

line array of acoustic sensors and would deploy from a submerged submarine to a floating communications buoy while the submarine loiters near the bottom.

- Continue to develop the deep water sonars necessary for (1) transiting to shallow water, (2) dominating deep water littoral undersea battlespace, and (3) (incidentally) retaining open ocean dominance. ■

APPENDIX A: LIST OF ACRONYMS

ADS	Advanced Deployed System
AMDS	Advanced Mine Detection System
ARPA	Advanced Research Project Agency
ASW	Anti-Submarine Warfare
ASUW	Anti-Surface Warfare
CYSS	Cylindrical Sonar System
DASS	Deployable Acoustic Sensor System
DoD	Department of Defense
FY	Fiscal Year
HDR	High Data Rate
I&W	Indication & Warning
JTF	Joint Task Force
LFA	Low Frequency Active
MLTA	Multi-Line Towed Array
NAU	Noise Augmentation Unit
NCA	National Command Authority
NSSN	New Attack Submarine
NUWC	Naval Undersea Warfare Center
RF	Radio Frequency
SBIR	Small Business Innovative Research
SEALs	Sea Air Land (SOF Commandos)
SOF	Special Operations Forces
TA	Towed Array
TENCAP	Tactical Exploitation of National Capabilities
UUV	Unmanned Underwater Vehicles
WAA	Wide Aperture Array

RADAR PICKETS AND THE MIGRAINE PROGRAM

by James L. Mandelblatt

Submarine radar pickets were born out of experiences encountered during the battle for Okinawa in 1945. A major part of the Japanese defense was directed against destroyer radar pickets and caused losses severe enough to make many destroyer skippers wish that they had a "hatch to close over their heads and submerge"[1]. When the concept of submarine-based radar pickets was developed, sometime during the middle of 1945 at the height of the fighting around Okinawa, the Navy proposed that 24 submarines be converted to assist in the invasion of the Japanese home islands, planned for November 1945. Although the dropping of the atomic bombs on Hiroshima and Nagasaki ended the war, eliminating the need for a costly invasion of Japan, the Navy decided to press ahead and continue the development of the submarine-based radar picket.

Two submarines, GROUPER (SS 214) and FINBACK (SS 230), were given hastily modified versions of radar equipment from surface ships near the end of the war, but the Navy decided to continue to develop the radar picket concept further. After the war, GROUPER and FINBACK reverted back to their normal attack submarine configuration and the Navy decided that two additional submarines would be more extensively modified to develop the radar picket submarine concept further. These two submarines, REQUIN (SS 481), just completing her first year of active service, and SPINAX (SS 489), still under construction, were modified to the early radar picket configuration in 1946. Again given radar equipment modified from surface ship versions, these two submarines retained their normal deck armament of two 5-inch wet-mount guns and 40 mm rapid-fire cannons on the fore and after cigarette decks. Below decks, the already crowded confines became even more crowded, with radar equipment and consoles being distributed throughout the boats. It became so crowded below decks that, according to Mr. Edward Ellsworth of Monongahela, Pennsylvania, who served on REQUIN from 1945

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[1] Lt. Cmdr. F.J. Ruder, Submarine Conference on 8 December 1948, Office of the Chief of Naval Operations, 17 December 1948, p. 31.

to 1948, that "you could hardly get past the maneuvering room"[2] into the after torpedo room.

This unsatisfactory arrangement, the cramming of the radar equipment into whatever space was available, along with the overcrowding of the crew spaces with the additional men needed to man the radar equipment and the unsatisfactory performance of the radar equipment, led the Navy to propose and initiate the Migraine Program, a three-phase program in which 10 submarines, including REQUIN and SPINAX would be given enough equipment similar to that in the CIC on an Edsall Class destroyer.

The first phase of the Migraine Program initially involved only one submarine, TIGRONE (SS 419), which was converted in 1949 and later on, BURRFISH (SS 312), converted in 1950. On these two submarines, the after torpedo tubes were removed, creating enough space for the extra personnel needed to man the radar equipment. The consoles for the radar equipment were located in the forward part of the crew's mess and galley, where the space was available for such equipment. In addition, TIGRONE and BURRFISH also received improved, higher capacity batteries. Topside, both TIGRONE and BURRFISH would retain their open fairwater, with the bridge being shifted to the forward cigarette deck and a 40 mm rapid-fire cannon being placed on the submarine's deck. The SR-2 air search radar, to be used for long range air search, was located on a mast mounted on the after cigarette deck, aft of the SV radar and snorkel. Located on deck was the SV-2 height finding radar on a mast at about the same level as the SR-2 radar, destined to be used to determine the altitude of aircraft and to assist in controlling guided missiles. The last radar placed on deck was the YE-3 fighter controller beacon, located above the forward engine room, and would be used to direct aircraft flying combat air patrols or to direct those going to and returning from strike missions. In addition, both boats were given a snorkel to allow underwater operation of their diesel engines.

The second phase of the Migraine Program, in 1948, involved the veteran radar pickets REQUIN and SPINAX and would entail an improved arrangement of the radar and the equipment to control them. Below decks, the after torpedo tubes were removed and the air control center relocated to the forward section of the

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[2] Interview with Mr. Edward Ellsworth in Pittsburgh, PA, 3 July 1993.

stern room (the after section being converted into crew berthing) from its position in the crew's mess on the Migraine I boats. In addition, two tubes were inactivated in the forward torpedo room and were left in place to be used as storage. Both REQUIN and SPINAX would also receive improved batteries to increase their underwater endurance. Keeping the conning tower profile common to wartime submarines, REQUIN and SPINAX would retain a 40 mm anti-aircraft cannon on the forward cigarette deck. The SR-2 radar was located on the after cigarette deck, in the same position as it was on the Migraine I boats, aft of the SV radar and the snorkel, and would be used for long range air search. The SV-2 radar was removed from its Migraine I mast and placed on deck above the air control center, further reducing its effectiveness. The YE-3 beacon, located on deck above the forward engine room on the Migraine I boats, was moved to a location above the after engine room.

The third and final phase of the Migraine Program commenced in 1953 and was more extensive and was a resolution of the overcrowded conditions on the Migraine I and II submarines. This phase was to involve six thin-skinned Gato Class submarines; POMPON (SS 267), RASHER (SS 269), RATON (SS 270), RAY (SS 271), REDFIN (SS 272), and ROCK (SS 274). These boats were subjected to some major surgery, which entailed being split apart between the control room and forward battery compartment, the space was filled by a 24 foot insert which would contain the air control center. As was the case with the earlier phases of the Migraine Program, the after torpedo tubes were removed and the space given over to crew berthing. Topside, the placement of the radars would be different, as would be the profile of the conning tower. An improved version of the air search radar would be enclosed in a streamlined sail, a possible precursor to the high *plastic* (fiberglass) sails featured on Guppy III submarines and later fleet snorkels. The improved height finding radar would be located on a mast which would have a thick base, allowing the radar to be accessed from within the submarine.

The tactics envisioned for the various radar picket submarines were to be three-fold and envisioned the radar pickets operating in pairs. The first tactic involved the direction of combat air patrols in their attacks against incoming enemy aircraft. Along this same line, the radar pickets would direct friendly aircraft in their missions against enemy aircraft and either to or from their attacks against enemy surface ships. Operating in pairs was deemed to be necessary so that if one radar picket had to submerge while controlling the CAP, the other radar picket, located within range of the first picket's radar, could immediately assume control of the CAP and provide constant coverage, never leaving the CAP without direction. This, however, became a problem at one time for REQUIN. While operating in the Aegean Sea during a deployment to the Mediterranean in the early 1950s, Captain Jack Magee (who served aboard REQUIN from 1951 to 1953), wrote in a letter to the author that "One CAP commander refused to be controlled by us in the Aegean Sea because he was afraid that we (REQUIN) would dive out from under him and he would not have direction for an enemy intercept. His boss in the carrier quickly set him straight and we were able to control him for the next couple of hours."[3] Another tactic envisioned for the radar pickets involved being used in association with an amphibious landing. Stationed some distance away from the amphibious force, the radar picket submarines would provide advanced warning of incoming enemy strike aircraft. A third use envisioned by the Navy for radar pickets involved being controlled by the commander of strike aircraft heading out to attack enemy targets.

Radar picket submarines were often at sea much longer than the normal diesel boats in service at the time. Whereas normal boats would be at sea for approximately two to three months, radar pickets were often out twice as long, due to their unique nature. Submarines such as REQUIN and SPINAX operated as radar pickets from 1946 until 1959 and provided early warning training to surface fleet units. The radar pickets were not without their own headaches (appropriate enough, considering the name of the program). One of the main problems was that all of the radar, especially the SV-2 height finding radar and the more advanced BPS-3 height finder (used on the Migraine III boats), were extremely susceptible to flooding and shorting out. The placement of, for example, the SV-2 radar on the deck of the two Migraine II radar pickets made it especially vulnerable to the spray caused by the submarines' movement through the water. Nevertheless, radar picket submarines continued to provide valuable service to

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[3] Captain Jack E. Magee, USN(Ret.), Letter to the Author dated 1 June 1993, p. 2.

the US Navy and other NATO navies up until 1959, when the Navy phased out the radar picket program, including destroyer-based radar pickets, and the Migraine Program entirely, in favor of airborne early warning aircraft.

Of the 10 submarines converted to the various Migraine configurations, most would become training ships and would be scrapped at the end of their service life. In the case of REQUIN, she was converted to a Fleet Snorkel at the end of the Migraine Program in 1959, receiving the high *plastic* (fiberglass) sail common to the Guppy III configuration, and would continue in active service until December 1968. After serving as a Naval Reserve Trainer until 1971, she languished as a tourist attraction in Tampa, Florida until 1990, when she received a new lease on life and was moved to Pittsburgh, Pennsylvania. There, REQUIN remains one of the most popular tourist attractions in the area. ■

"Submarine Warfare in World War II—USS POMPANO (SS 181)", an exhibit now in the Kentucky Military History Museum, Old State Arsenal, Frankfort, KY. The exhibit examines the role of submarines in the Allied victory with emphasis on the USS POMPANO, designated as the World War II Memorial Submarine of Kentucky. The exhibit runs through August 31, 1995.

INNOVATION AND THE SUBMARINE FORCE

by CAPT Ted Davis, USN(Ret.)

The July '94 issue of **THE SUBMARINE REVIEW**, and in particular the article by Rear Admiral Houley piqued my interest. Admiral Houley expressed a need for visionaries, reduced manning, and console projection of information needed to fight the ship.

The January '95 issue contained an article by Lieutenant D'Ambrosio prompted by his visit to the Naval Undersea Warfare Center (NUWC). His article, The Human-Computer Interface, showed his awe for the advances he saw at NUWC and lamented the lack of such equipment on his submarine.

A nuclear submarine is very complicated and my generation did not have to cope with the technology required of a submarine officer today. Lieutenant D'Ambrosio's article, though beautifully written, had a number of foreign phrases I was unable to comprehend. However, I did get his message and I think he is saying somewhat the same thing Admiral Houley said recently, and what Electric Boat said 30 years ago; and no one listened.

Both authors express somewhat the same desires for future submarines, i.e., console screen displays of computer-generated information so the CO can make faster and better decisions; provide computer solutions vice laborious plotting for bearings-only fire control (FC) problems; and single-stick course and depth control. The final result being reduced manning and increased efficiency.

It is safe to say these things will not be back-fitted and the big question in my mind is: *will they be included in SEAWOLF and NSSN*? I ask this question because these, and many other improvements were offered to the Submarine Force in the early 60s. Since the ideas are not new, one has to ask if the acceptance of visions has changed. If it has, and we can assume the next class of submarines will have state-of-the-art versions of equipment, displays, and procedures ignored in the past, you will walk aboard and say, "Wow, this doesn't look like a submarine."

Electric Boat conducted a study called SUBIC which advocated submarine integrated control. Exactly the same stuff Bill Houley and Karl D'Ambrosio suggest. They all recognize that there is a man-machine loop and there always has been. The CO needs information that he can see, NOT HEAR. He needs to see that which is pertinent to the situation at hand. The difference between seeing it 30 years ago and now is striking in presentation, but is the same information, refined a little.

Let me be the pilot and give me a picture window in which the FC system projects the target. I'll either lead, lag, or maintain a constant bearing as ordered. If the FC system fails, let sonar talk to me. I don't need Jonesey—I need bearings and a manual input of estimated range in my picture window—and the intuition from practice, practice, practice. That is the all-vital man portion of the man-machine loop. The next question is: *Where are you going to get the practice*?

How does the crew of a new class learn to fight their ship in its many missions? Who teaches them how to use all the new equipment and concepts? ALBACORE crews spent thousands of hours maneuvering at high speeds learning how to control the newly configured hull destined for future nuclear submarines. This was all done in single-stick control with rudimentary displays. Their job was to find out what this new hull could do and then tell the Submarine Force how best to use it in combat situations. They had the help of some wonderful people from the David Taylor Model Basin, and as a result, the Navy bought the hull concept for future submarines. This was a try-and-see evaluation. (Our booklet on how to fly a submarine never made the bookstands.)

We can use the ALBACORE try-and-see method to train crews, which is all we have; or the method used by aviators for many, many years. Are we going to hand over this new submarine to a crew and say, "You figure it out!"

Would you believe I am suggesting a simulator for training and evaluation? If we are to get serious about reducing crew size, the simulator is the best way to train in the new concepts. Take the pilot as an example. Normally, his duties are boring while transiting from A to B. However, in attack and evasion scenarios, he must be a highly trained master pilot viewing his underwater world on a computer-generated display.

The same goes for the approach parties, now reduced in numbers but enjoying computer-enhanced capabilities. The new console displays make decision-making easier. This new and different team can train in all aspects of submarining long before delivery of their ship; that is, if someone provides them the time!

The Trident Submarine Force trained its wardroom officers and navigation plotting parties in simulators. They learned a great deal about themselves and their new ships and solved many problems before they ever went to sea. Seeing people perform under real conditions prompted changes in shipboard assignments. They were allowed two days out of a very hectic building schedule to get this all-important training, away from home.

Every new class submarine should have a simulator as part of the price. A simulator will provide training in all aspects except propulsion. The crew can learn how to control, fight, handle casualties and still be home for dinner. This should be a genuine state-of-the-art simulator, programmed with all the ship's characteristics, fire control inputs and console displays. For about $10M, this type simulator will save thousands of hours of risky trial and error. They must be in the ship's backyard.

The wheel was invented a long time ago yet we are prone to ignore that and constantly try to reinvent it. If SEAWOLF incorporates the dream concepts long overdue and the planned simulator facility in Suffolk, Virginia materializes, hopefully someone who understands both sides will introduce them. Maybe then, evaluation and training time can be shortened and improved. Call him a visionary! Believe me, putting a radically new submarine through its paces is a risky business. The crews should have advanced training before trials and lots of follow-on experience in simulators.

The Trident people realized that the surface transit to and from sea trials could be fraught with dangers and they trained to make sure their first at-sea days were successful.

My advice to visionaries is be careful and don't try this at home. Wouldn't it be nice if we could say, "Don't try it at sea until you have tried it at home first!" ■

SHAPING THE FUTURE

by LT Robert E. Cosgriff, USN

[Editor's Note: This essay won first prize in the Naval Submarine League sponsored contest for the Submarine Officers Advanced Course at Submarine School.]

A basic fear pervades the submarine community and it has nothing to do with budget cuts or maintaining the industrial base. The fear is that some day women will infiltrate our ranks, operate our ships, and perhaps even one day command them. There is no other topic that yields a more emphatic and boisterous call to arms than the issue of women on submarines. Why is this? Is it because women really will degrade the morale of the crew or cause a loss of male privacy in a close quarters environment? Or is it really because we are scared? Scared of giving up our male ways, sexist innuendo and stories that can only be repeated when ship's depth is greater than 400 feet for fear of retribution.

We claim to be visionaries, knocking down barriers between the Submarine Force and the surface and aviation communities, and *shifting paradigms* regarding the role of the submarine in this post Cold War era. However, we have failed to adequately address the very basic question of who can serve in our selective group. We have repeatedly heard over the years that the Submarine Force is made up of the top performers—the cream of the crop, yet we are only drawing from half of our population. If we instantly double the pool of available applicants then it only makes sense that a step change in the positive direction will follow.

There are a number of reasons why women do not currently serve on submarines. Following are the major issues preventing women from serving on submarines with a short discussion with regard to current and future fleet makeup.

- Privacy and habitability
- Pregnancy and family planning
- The silent issues

Privacy and Habitability

The submarine fleet consists mainly of SSN 688 class submarines and SSBN 726 class submarines. Since the vast majority of the 637 class is scheduled for decommissioning in the next few years they are not addressed. The 688 class has a small head (bathroom), complete with shower, toilet and sinks in the forward compartment lower level, and at the top of the adjacent ladderway is the nine-man (people) berthing compartment. This setup would allow for a women's berthing area and head. No money is required to change the existing configuration or add any facilities. The 726 class similarly has nine-man berthing spaces and a head that can be converted to female use at no expense whatsoever.

Some people will be quick to point out that feasibility studies have already been done which have shown that significant redesign and costly reconfiguration would be required to satisfactorily place women on submarines. Like any military program there is a seller and a buyer in this issue. In this case the Submarine Force is the seller and the Congressional committees and the CNO are the buyers. However, the seller doesn't really want the program sold so we voice very loudly all of the negative aspects of the program which are then confirmed by an independent committee. If, on the other hand, we lobbied the positive gains with even a fraction of the vim and vigor with which we lobby for such things as the third SEAWOLF and the new attack submarine (NSSN), women would surely serve aboard submarines today. And, if after a positive campaign the committees still decide that submarines are not suitable for women, then what about the NSSN? Numerous lists of requirements and new features of the NSSN have been promulgated but there has been no mention of an ergonomic design suitable for both sexes. This is the stage where we should be working most fervently. It costs nothing to put up a bulkhead or move a berthing compartment on a computer screen, however if we wait until designs are approved and plans are made, then it will be too easy to shift back to the proven argument of costliness for redesign. It is imperative that the Submarine Force be proactive on this issue now, so at the very least we are not forced to accept some future alternative that is not tolerable for the men or women involved.

<u>Pregnancy and Family Planning</u>

The issues surrounding pregnancy and family planning have already been discussed and resolved regarding women serving aboard warships. However, the argument has been made that since a submarine crew is so small relative to our surface counterparts that the loss of a single crew member could result in unacceptable attrition and countless emergent personnel shifts. The answer to this problem lies in the recruiting of women submariners. Potential recruits should be counselled and educated with regard to the Navy's expectations of them in their upcoming sea tours. A logical family progression exists with the current sea to shore rotations. A certain amount of attrition will occur due to pregnancies but the key to minimizing it is to recruit highly motivated people who are provided with a clear and unequivocal picture of what lies ahead. Although these emergent losses will be painful for the executive officers involved, it certainly should not be the crux of the much larger picture. We only have to look to the surface and aviation communities to see that women have been deploying for years.

The Silent Issues

The silent issues are the issues which when examined carefully really don't amount to valid concerns, but are clearly seen as protests. They include the possibilities of fraternization, the concerns of spouses and others. It should be clear that all of these potential problems, when handled with the responsible leadership that is the hallmark of the Submarine Force, are moot points in considering the underlying question of whether women should serve aboard submarines. We need to throw away our old cloaks of masculinity and join our counterparts in the civilian communities who have long since integrated women into previously male only professions.

The Submarine Force has had an important role in the shaping of our Navy and our nation, and we are continuing to improve the fleet through myriad positive changes. To continue on the cutting edge and to maintain our role as leaders in the Navy we must make room now for the great women leaders of tomorrow. The issue of women serving on submarines is really a simple one that only requires a small alteration in our thinking to yield large results. As the plans are approved for the New Attack Submarine, which will shape the face of the Submarine Force of the 21st century, we need to prove now that we are the visionaries that we have claimed, and to gain the other half of our population as future wearers of the gold and silver dolphins. ■

POST COLD WAR BOOMER UTILIZATION

by CDR F.R. Haselton, USN(Ret.)

In light of the recent action of the Nuclear Posture Review confirming the continuing need for strategic submarines, the prospects of this magnificent fleet's demise appears remote for the present. This fleet will, however, likely diminish in size to the recommended 14 D-5 carrying submarines. This impending action will free four Tridents for either mothballing or, perhaps, other uses.

In the next few years, as some seem to see it, in the Russian threat may continue to decline from the Cold War era. Lurking in the not too distant future, however, is the likely rise of China as a major nuclear power. In the interim we are sure to be plagued by a multitude of relatively small *brush fire* encounters world wide.

What, then, are we to do as the vagaries of public opinion ebb and flow regarding our worldwide military responsibilities? I suggest that we consider converting the four *available* Tridents as they come off the line to alternative uses which will serve both the military and civilian needs of the U.S.

As the worrisome Third World nations recognize their ability to antagonize the *super powers* by nipping at their heels, an ever increasing need will materialize for dealing with them in a non-nuclear manner.

I suggest that there are many reasonable and justifiable missions for which these superb submarine platforms are suited, both now and into the future. The most covert systems in existence, they are capable of moving undetected and with impunity to any part of the ocean world. If one takes a look at all those soon-to-be-empty ballistic missile tubes a number of practical alternative uses suggest themselves. Among the most tantalizing are those employing mini submersibles capable of being launched and subsequently recovered. These may be either manned or autonomous and, themselves, capable of carrying a variety of payloads.

Of particular interest is the ability of the *mother* submarine to disburse its load of mini subs over a wide stretch of ocean or littoral areas wherein each performs its assigned task with little need for transit capability. The mother would simply use its unlimited mobility to disburse the minis and subsequently rendezvous with and recover them.

In this discussion I will address some of the possible missions, the economies and the technologies likely to be considered. Both national defense and alternative uses are discussed.

Missions

- SEAL deployment along extended coastlines
- Mine field clearance
- Intelligence gathering
- Littoral antisubmarine warfare
- Friendly force support
- Evacuation of nationals
- Barrier operations
- Show the flag
- Humanitarian supply of food and medical supplies
- Scientific

An almost endless list may be generated for national defense and for humanitarian, scientific and other needs. Consider, for instance, the potential uses that Woods Hole could generate were they not limited to the current small fleet of research submersibles. The potential of learning considerably more about the deep oceans with its undiscovered secrets is surely on a par with the space shuttle capabilities. We can surely utilize earth resources more economically than those likely to be discovered elsewhere.

Economies

- One nuclear power plant provides all the power needed for extended missions.
- Conventionally powered mini subs should be relatively inexpensive.
- Completely submerged operations avoid weather sensitive launch and recovery.
- The retiring C-4 Tridents will soon be available.

Technologies

- Modularity of the mini submarines to provide mission flexibility
- Powering alternatives to provide adequate mission duration
- Propulsion and control alternatives for transit and reentry
- Intelligent processing architectures for the unmanned missions

- Small submarine habitability
- Secure and reliable communication techniques
- Interfacing (access between Trident and tube loaded submarines)

As short term national defense priorities wind down and scientific and social programs accelerate, it would be a waste of existing resources, in this example the excess Trident fleet, not to plan meaningful alternative utilization. Space limitations prohibit the detailed exploration of each of the above suggested missions. Alternatively let us consider one military and one scientific mission for applicability:

One of the littoral nations has systematically acquired a substantial military force including some non-nuclear submarines and it is, in defiance of outside pressures, bent upon aggressive action against one of its neighbors. Assume, for practical purposes, that both oil and humanitarian issues are in the balance. Intelligence estimates reveal that a strike is imminent. The UN has called upon the U.S. to intervene in the interest of world order.

The President orders the rapid deployment of one ex-Trident with a full load of 24 tube-launched mini submarines modularly configured for various tasks. Some are configured for a crew of two while others are autonomous (UUVs). On arrival off the coastline after a four day transit from CONUS, the Trident covertly deploys its various minis along the coastline. Some are assigned the task of monitoring harbors for exiting vessels, particularly submarines, while others establish the necessary communication network(s) required to conduct a coordinated mission. Following the slow (1-5 knots) and short (5-10 miles) transit from their launch points along the Trident's track, they go about their various tasks. A minefield is detected! The mother submarine is alerted and a special mine hunter mini is deployed to locate and possibly neutralize the mines. Intelligence estimates were off and it is apparent that a longer mission will be required. After 1-3 weeks on station the manned minis are relieved along the track by fresh minis and crews. The UUVs have a 90 day mission time and are only replaced as necessary. More complex scenarios might include deployment of shallow-water surveillance arrays as well as SEAL insertion. Tube dimensions permit minis of the general size of current SEAL delivery vehicles. At the cessation of hostilities, or when directed, the mother submarine recovers the various minis and proceed to CONUS.

Turn your thinking to scientific endeavors. The potential of learning considerably more about the deep oceans with its yet undiscovered secrets is surely on a part with the space shuttle capabilities. For instance:

Woods Hole's budget is increased to enable them to make effective use of the availability of one converted Trident submarine. A two year period will allow them to acquire a full complement of 24 modularly configured tube launch submersibles, some of the modules capable of maximum ocean depth, while others are designed as shallower manned craft or UUVs. Their first priority is to adequately survey the mid-Atlantic Ridge along its entire length. Fully loaded and deployed, the scientific team launches the first mini at the northernmost portion of the ridge. Taking a southerly course it proceeds to deploy one mini every 10-20 miles until the full load is deployed. The mother submarine then reverses course and proceeds to the location of the launching location of the second mini where it recovers the first mini. Proceeding along the track it subsequently recovers each mini which, in turn, is recharged and readied for another deployment. At the recovery point of the 24th mini it repeats the cycle progressing along the ridge path. In this manner, depending upon the width of the desired sweep path, the mission proceeds at a rate of approximately 240 miles/day obtaining detailed topography and other oceanographic data. The scientific team analyzes each mini's data when it is recovered. A laboratory aboard the mother submarine would offer a convenient means of having the scientists at the scene and living in comfort. The benefit of on-scene analysis is difficult to exaggerate.

Other equally impressive tasks could occupy Woods Hole's team of flexibly configured minis for years to come in its quest to learn more about our past—and our future!

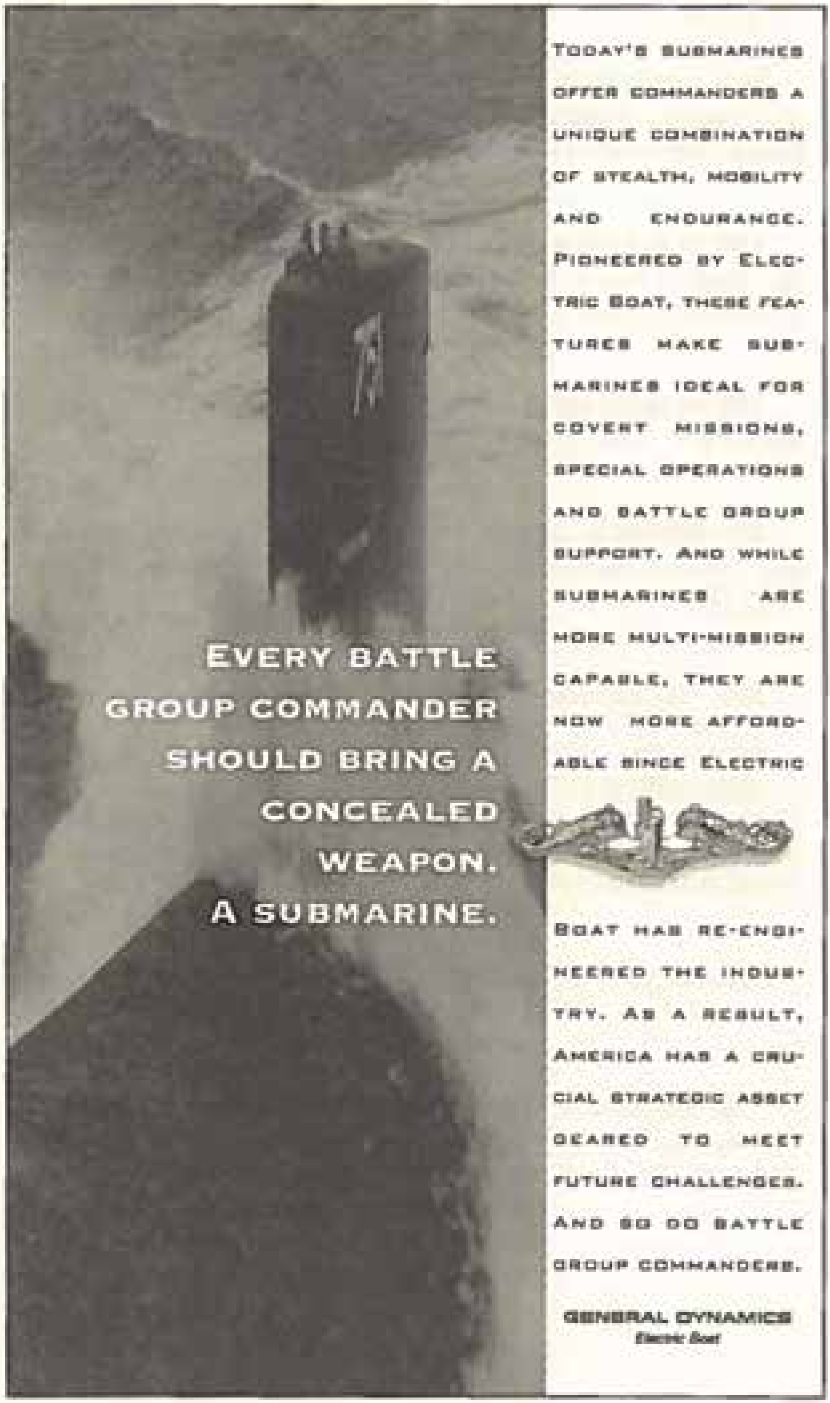
Although current planning envisions UUVs for deep ocean research having endurance approaching one year, it is likely that these will severely push the capability envelope of current technology. It would appear more cost effective to utilize a multitude of less costly UUVs supported by ex-Tridents and accept an occasional operational loss of a far less complicated and costly submersible.

Lastly is the fact that much of the technology required to develop and deploy such a fleet of Trident supported submersibles is in hand. Exotic new power storage techniques needed for the extended mission times of many of the UUVs under consideration are not required. Lead-acid will do just fine as will the Sterling cycle plants. Of all the systems for propulsion and control available, the one most capable of performing the intricate reentry maneuver AND providing silent and efficient mobility appears to be the Tandem Propeller System (TPS) currently under development for UUV tasks. Others requiring dual systems for mobility and maneuvering are either inefficient or incompatible with tube launch and recovery.

Economies of quantity production, particularly with the modular approach, could bring the cost of the typical tube launched mini submarine more in line with that of an upscale automobile. No longer, particularly in the case of the UUVs, is reliability as important an issue as in conventional military hardware. An occasional loss would be more than compensated for by the drastically reduced cost seldom associated with modern military systems. While we still need the Electric Boat and Newport News types with their infrastructures to maintain our military submarine edge, we could easily rely upon the smaller non-military submarine builders such as Perry Tritech, Benthos and others to mass produce the required UUV fleet. At, say, $1M/copy there should be ample competition to ensure a quality product. Those missions demanding a manned version will, of course, require the strict reliability—and higher cost—associated with all manned systems. Computer technology will eventually relegate almost all such missions to UUVs. Meanwhile manned versions will be required for complicated decision-making tasks such as ASW barrier missions.

Conclusion

Use it or lose it! As our Trident submarine force is downsized we should make every effort to imaginatively develop meaningful alternative uses for these most capable platforms. ■


EVERY BATTLE
GROUP COMMANDER
SHOULD BRING A
CONCEALED
WEAPON.
A SUBMARINE.
TODAY'S SUBMARINES OFFER COMMANDERS A UNIQUE COMBINATION OF STEALTH, MOBILITY AND ENDURANCE. PIONEERED BY ELECTRIC BOAT, THESE FEATURES MAKE SUBMARINES IDEAL FOR COVERT MISSIONS, SPECIAL OPERATIONS AND BATTLE GROUP SUPPORT. AND WHILE SUBMARINES ARE MORE MULTI-MISSION CAPABLE, THEY ARE NOW MORE AFFORDABLE SINCE ELECTRIC BOAT HAS RE-ENGINEERED THE INDUSTRY. AS A RESULT, AMERICA HAS A CRUCIAL STRATEGIC ASSET GEARED TO MEET FUTURE CHALLENGES. AND SO DO BATTLE GROUP COMMANDERS.
GENERAL DYNAMICS
Electric Boat

REUNIONS

USS CARBONERO (SS 337) - August 23-27, 1995 in Manitowoc, WI. Contact: Frank C. Sebesta, 541 W. Spring Valley Park, Dayton, OH 45458, (513) 433-8834.

USS CLAMAGORE (SS 343) - October 18-22, 1995 in Charleston, SC. Contact: Paul R. Brosi, 125 Stephen Drive, Stonington, CT 06378-1512, (203) 572-0699.

USS DIABLO (SS 479) - November 1, 1995. Contact: Ed Shields, 565 Kappler Road, Heath, OH 43056.

USS DOGFISH (SS 350) - September 26-29, 1995 in Portsmouth, NH. Contact: William W. Seaward, P.O. Box 386, Kittery, ME 03904 (207) 748-1137.

USS MACKEREL (SST 1)
USS MARLIN (SST 2)
USS BARRACUDA (SST 3)
SUBMARINE SQUADRON 12 STAFF
October 16, 1996 in Hagerstown, Maryland. Contact: LCDR Richard H. Coupe, USN(Ret.), 3004 Lord Bradford Court, Chesapeake, VA 23321, (804) 484-0113.

USS REQUIN (SS/SSR 481) - September 22-24, 1995. Contact: Robert Garlock, 207 S. 7th Street, McConnellsburg, PA 17233.

USS ROBERT E. LEE (SSBN 601) - October 27-28, 1995 in Virginia Beach, VA. Contact: Ronald C. Kimmel, 7019 Tracyton Boulevard NW, Bremerton, WA 98311, (360) 692-9487.

P.M.S. BLACKETT, PART 2
COLD WAR REVISIONIST: ANTI-AMERICAN ACTIVIST

by CDR Sam J. Tangredi, USN

[Editor's Note: Commander Tangredi holds a Ph.D. in International Relations and has written extensively on the impact of arms control on naval strategy.]

Brilliance in science does not always equate to brilliance in strategy.

I agree with John Merrill that the British physicist P.M.S. Blackett deserves considerable credit for helping to develop the science of anti-submarine warfare ["P.M.S. Blackett: Naval Officer, Nobel Prize Winner, Submarine Hunter," The Submarine Review, January 1995, pp. 86-89.] However, in deference to history and to those who fought the intellectual battles against the great Soviet diplomatic-arms control offensive, I must point out the other side of P.M.S. Blackett: originator of the theory that the United States bombed Hiroshima and Nagasaki primarily to threaten the Soviet Union; and supporter of the view that the U.S. and Soviet Union were *morally equivalent*.

Blackett's book Fear, War and the Bomb inspired the historical revisionism that has remained—despite much refutation—the academic *new-think* influencing the Smithsonian Institution's controversial exhibit of the Enola Gay. The book was published in 1948, several years after Blackett's involvement in ASW.

Blackett, like many of the British intellectuals of his era, held socialist leanings and a mild sympathy to the Soviet Union's *social experiment*. Following the war, this inclination—combined with his antipathy to nuclear weapons—caused him to adopt an anti-NATO, anti-American defense policy stance. He advocated a British policy of *armed neutrality* to prevent Britain from being a *pawn* of anti-communism.

But it is his argument that atomic bombing of Japan had "no compelling military reason" that was more significant. He laid the groundwork for the persistent conspiracy theory that American imperialism caused and maintained the Cold War through the immoral and unnecessary use of atomic weapons. "...We may conclude," wrote Blackett, "that the dropping of the atomic bombs was not so much the last military act of the second World War, as the first major operation of the cold diplomatic war with Russia now in progress."

Blackett remained passionately convinced that the Soviet Union's declaration of war against Japan on August 8, 1945 was the real reason Japan surrendered, and that the prospect of seeing a victorious Soviet offensive "engaging a major part of Japanese land forces in battle, overrunning Manchuria and taking half a million prisoners" prompted President Truman to drop the atomic bombs in order to prevent the Soviets from participating in the Pacific War. He made no reference in his writings to the necessity for an invasion of Japan or probable American and Allied casualties involved. When confronted with the fact that the Soviets declared war only after the atomic bombs were dropped, Blackett rationalized previous Soviet neutrality towards Japan as "military common sense" and part of an "agreed Allied plan."

Current revisionist historians have acknowledged their debt to Blackett as the first to articulate the theory that bombing Hiroshima and Nagasaki were cynical and unnecessary acts. Blackett's theory provided much of the intellectual foundation for the *Ban the Bomb* and *Better Red Than Dead* movements of the early Cold War period.

While his post-war writings do not take away from P.M.S. Blackett's critical participation in the Allied anti-submarine effort in the Atlantic, they do point to the fact that he was indeed a complex man...one whose positive contributions to operations research may have been balanced by his negative contributions to the policy of containment that won the Cold War. ■

NAVAL SUBMARINE LEAGUE

THE APRIL 95 REVIEW

A Personal View

by CAPT William G. Clautice, USN(Ret.)

About three years ago I felt honored when asked to become a member of the **SUBMARINE REVIEW** Editorial Board. In that role, I now feel privileged to read these articles before you see them—the sense of a researcher who suddenly knows something no one else in the world knows. As I sit at the kitchen table early Saturday morning reading these articles (before my bride of 35 years begins to stir), I suddenly realize how much I have shared with each of these authors—and how meaningful it is to be a Submariner.

Several articles for this April **REVIEW** are bringing back memories of *my* era. That compelling urge to put thoughts and feelings on paper is here, similar to the time I stayed up all night writing my first published paper in 1969. Fix Expansion and the 3rd Dimension in Submerged Navigation was printed in the SUBLANT QIB. The following year, at the urging of Bill Yates (CO SUBSCOL), it was presented at the Institute of Navigation (ION) 25th Annual Symposium and published in their Proceedings. That article, written during PCO School, was the result of reading investigations of the collisions, bottomings and groundings which plagued the rapidly expanding nuclear submarine Force. As commissioning navigator of the latest FBM. I questioned the wisdom of following the new CINCLANT *high speed post patrol* track taking us between two seamounts five miles apart. How good was our SINS DR after many hours without a fix?

This, and other questions facing a new *Gator*, led to that *all-nighter* tome which was written to stimulate some thinking on the subject. I learned last year from Bob Spear (now CO FLORIDA), that my paper had taken on near biblical force in SUBPAC and was now being questioned as too restrictive. (I would certainly hope so after 25 years!) (*The Submarine League has copies in case anyone is interested in that piece of history*.)

Meanwhile, as I dutifully review the articles before me, nostalgia and a sense of perspective take over. While reading Lieutenant Cosgriff's prize essay on Shaping the Future (with women aboard submarines), I start to chuckle. Having both a son and daughter as graduates of USNA on active duty, I should be thinking of EEO. However, my mind slips back to 1970 at the

Air Force Academy. I am standing before that audience of about 300 and delivering my submarine navigation paper to the ION. Realizing that I was the only naval officer in a sea of Air Force blue and speaking on a rather narrow topic—probably of little interest to this group of fighter jocks—I stated that I would be happy to answer any questions on this paper or submarining in general. The first question was from a uninformed AF general.

Q. "How long do you remain submerged on those FBM?"

A. "Two to three months, sir."

Q. "That's a long time. Any thoughts ever given to women on board, e.g., as cooks?"

A. "Yes sir. In the early FBM concept development, the subject came up, but cooler heads prevailed. And if you would like a little more insight on that, my wife is here in the first row." She told me later that was the correct answer.

My tour at ONR as Assistant Chief of Naval Research (under Rear Admiral Brad Mooney—see Mike DeHaemer's scholarly article on Research Submersibles) and later as CO of NRL gave me a certain kinship with Captain C.C. Brock. His tribute to those unsung heroes who brought the enabling technology of SINS to submarines was terribly meaningful to me. At that same ION meeting, I met wonderful people like Len Sugerman and General Bob Duffy. Later, as Deputy under Vince Argiro and acting Head of the Navigation Branch at SSPO in the late '70s, I worked with and greatly respected *Doc* Pickrell. But the next name, Dom Paolucci, really hit home. After four years of Latin and three years of Greek in high school, I was not terribly well prepared for Admiral Rickover's Self Study Program in 1962. Advanced Calculus for Engineers was worse than Greek. When no one aboard could help, my skipper (Howard Crosby), suggested calling Commander Paolucci (Ph.D. in Math) on the SUBPAC staff. An hour a week of his patient expertise in the application of calculus lifted me over that hurdle. When I was accepted by the KOG, I left a bottle of the best scotch available in Pearl on Dom's desk with a note "Thanks to you".

My tour in BASHAW (one of the earlier B girls and sister ship to BREAM—see Captain Rees' article this issue), with a deployment to WESTPAC and Special Op north of Adak, gave me a great appreciation for two other articles. George Fraser's <u>Get Me Down</u> was vivid, but Bill Ruhe's article is a classic about the toughness of the WWII sub vets. One of those was CS1 *Pappy* Ayers. Reporting to BASHAW in Yokosuka as the new Commissary Officer, I remember meeting my new LPO. *Pappy* was puffing on his pipe and engulfed in mountains of paper at the crew's mess table. I asked if they had that much paper in WWII? Answer: "No sir, we just fed the crew." I asked if I could help. "Yes sir. Just sign the menu." I did—without a change as I recall.

Then, after reading Dr. Lindell's article on restoring the TDC, I recalled the incident when a gear stripped our wardroom plotter in WESTPAC. After a week of searching for the spare part, Chief Engineer Bob Sarocco said, "Sorry Captain, it's permanently OOC". Skipper Bob Maxwell gently asked for a file and proceeded to make a gear! The red tag (if we had one) was removed and the plotter remained in commission for the rest of the deployment.

The stirring deactivation remarks of George Harper and Jim Patton brought back memories of my two *16 hour/day* new construction tours and the selfless dedication of each shipmate. Also, the devotion we each developed for our steel mistress and the world's political challenges of that period, which now seem so distant. However, Rear Admiral Barret's sage letter reminds us of the need to study (and recall) history, lest we repeat it.

That was quite an era and I firmly believe we made a difference—which gives life meaning. Now, reading the pages of the **SUBMARINE REVIEW** brings back that great feeling of accomplishment—and a thought. How many of our former shipmates are missing these precious moments of nostalgia? When I asked a submariner friend last evening if he got the **REVIEW**, the silence was deafening. (An application from the last page of the last **REVIEW** is in the mail.) Well, so much for reminiscing. It's time now to finish these articles for the April issue—and to thank each of you who took the time to share your piece of our proud heritage. ■

SUBMARINE SAILORS OF WORLD WAR II

by CAPT W.J. Ruhe, USN(Ret.)

At the Norfolk Sub Vets of WWII reunion there was a noticeable friendliness, great respect for each other, and close bonding between the men who had shared the same war patrol experiences. Having just written about my own submarine war, I reflected on what my crews had actually been like. As illustrated in my book, War in the Boats, they proved to be fine warriors and a unique breed of men with high *esprit de corps*.

These diesel-boat men were most importantly TOUGH—and a lot tougher than the Japanese expected them to be. (In fact, the Japanese had predicated their Grand Strategy for winning the Pacific War on the belief that U.S. men had gone soft and wouldn't put up a long, hard fight in a war at sea.) But as a result of the submariners' toughness and aggressive spirit, although they didn't single-handedly win the war, they certain were instrumental in eliminating any Japanese chance to win.

Almost all were volunteers—even while recognizing that the British had lost 44 of their Mediterranean boats in 1941. The men *in the boats* accepted the good possibility that their subs might be lost. But like fine warriors—in the Samurai sense—they were resolute in their acceptance of death as part of their job. It was an all or nothing affair—few Purple Hearts were awarded to them. And few wanted *off the boat* because they thought their time was up. (A *last letter to mother* before going on patrol was treated with derision.)

They fought their boats in a normally quiet, business-like way. There was no screaming at each other; no bawling-outs and no crying for anything. Afraid-talk was so rare that I carefully recorded each instance. (A stewardsmate's "Me all-time scared" was duly noted.) Moreover, crewmen under stress showed little emotion or fear. (Only one man during a depth charging went stone white and passed out.) They were a phlegmatic lot.

The men in submarines were unusually competent technically and so ingenious that they could repair almost anything while at sea—to either stay on patrol or make it back to port. (On a CREVALLE patrol, a special wrench was fabricated to tighten bolts which the building yard had not been able to get at with their wrenches. And later, the jury-rigging of flooded-out things was almost miraculous.)

The crews of *the boats* liked action. (There was no foot-dragging when the General Quarters "bong, bong, bong" sounded.) Inaction, even though it made for safe operations, was disdained. All were seemingly eager to go on each patrol. (A draft of 15 men for new construction in the U.S. got only 5 volunteers.) And submariners arrogantly believed that a sub with only a small crew was equal to or better than the largest of surface warships—having 10 to 20 times more men and fire power. This was so because submarines attacked with total surprise and evaded under a safety blanket of water. They used their power in a different way.

The Sub Vets, it can be concluded, were unquestionably an elite corps of the WWII U.S. Navy! ■

DOLPHIN STORE JOINS CYBERSPACE

If you attend our Annual Symposium this year, you will have the opportunity to purchase quality submarine related gifts from the Dolphin Store at their usual competitive prices. If your gift needs can't wait, you now may receive free information on their merchandise by using their **E-Mail** address:

73642.1724@compuserve.com.

A COLORFUL CHARACTER

by CAPT B.G. Rees, USN(Ret.)

Life tended to be more casual in the old diesel submarines, especially when deployed and in tropical waters. Not only were beards permitted, they were actually encouraged to decrease the use of hard-to-come-by fresh water. The uniform of the day often amounted to shorts, a short sleeve shirt and submarine sandals. While stationed in BREAM (AGSS 243), during a deployment in the South China Sea, I was dressed accordingly when notified that my surfaced OOD watch was approaching with the weather on the bridge being *warm with occasional showers*. My beard in those days, while not flaming red, was rather reddish. I donned a rain slicker and proceeded to the conning tower to talk to the quartermaster of the watch about our position and intentions for the next four hours. The sharp young quartermaster looked at me in sandals, red beard and rain slicker and remarked, "Gee, LT Rees, you look like Jesus Christ going duck hunting!" ■

THE MASS OF LIGHT

by CAPT Bruce S. Lemkin, USN

I have been telling this story for so long, I thought I'd finally write it down.

It was a very dark, very damp, very cold night—about typical for the Holy Loch in March. We were getting ready to breast out from the tender to allow another SSBN returning from patrol to berth alongside.

My ship was in her first pre-patrol refit since completing a lengthy refueling overhaul. We had a new CO and a new, young Officer-of-the-Deck. The CO asked me to be up on top of the sail with him to keep an eye on the inexperienced OOD.

This was my second submarine, the first having been a hot-running SSN, and I was detaching to report to another SSN after this one patrol. I had gone through the SSBN overhaul and had served as the duty OOD for virtually all the post-overhaul trials and testing—I thought I was pretty hot stuff!

Prior to the skipper's arrival on the bridge, I had donned an orange thermal *pumpkin suit* and had clambered up on top of the sail, inside the railing, affectionately known as the *playpen*, that offered the Captain something to which he could hang-on in his lofty vantage point.

About ten feet above me, perched atop a steel pole, was the ship's masthead light. On a 616 class boomer, this pole was retractable into the sail and was held up by a pin inserted through the aft bulkhead of the bridge cockpit.

Anyway, I recall shivering a bit from the damp cold and chatting with the young OOD, who was down below me in the cockpit, about the preparations for breasting out. The tug had not yet come alongside.

The next part of the story is based on a mix of personal recollection *and* the reports of my shipmates.

It seems as we were awaiting the Captain's arrival while continuing with the pre-underways, the OOD leaned against the pin that was *supposed* to be securing the masthead light pole in its raised position. Not being sufficiently engaged, apparently, the pressure of the OOD's back cause to pin to depart its hole in the pole and the masthead light, weight about 40 pounds or so, came crashing down toward its fully stowed position—with only my head to impede its progress

The light's point of impact was on the back of the head with sufficient force to push me forward, first catching my nose and teeth on the forward railing of the *playpen* and then following through so I essentially did a swan dive into the cockpit. (As I was momentarily unconscious at this point, I can only rely on the word of the somewhat surprised OOD).

The OOD, whose attention was directed aft by the feeling that perhaps the masthead light pin had loosened behind him (I guess!), saw the light hit me in the back of the head, and the blood coming out my nose and mouth as I dove forward. A goner, for sure, he figured.

Somewhat dazed, I came to hanging into the bridge cockpit. I took the OOD's matter-of-fact advice and went below. The dull ache in my face and the warm, salty taste of the liquid entering my mouth led me to believe, as a minimum, that I had a nose-bleed.

The control room, which I entered upon descending from the bridge access trunk, was filled with crewmembers busily engaged in the routine of the maneuvering watch. And, being nighttime, it was *rigged for red*, so they couldn't see the blood. The ship's hospital corpsman met me there and led me forward out of the control room into the lighted passageway. The way he yelled for a towel and told me that I had better get up to the tender got my attention—as did the expressions of the sailors on the tender as I was escorted up to sick bay.

Along the way, I spotted a mirror and decided to take a peak. It was pretty nasty. Apart from the dried blood plastered all over my face, was my nose, which was also plastered all over my face. That, and the ballooning of my upper lip, made me virtually unrecognizable, which, under other circumstances, might not necessarily be such a bad thing.

My corpsman left me in the tender's sick bay—naturally, he had to be aboard our ship during the breasting out. He left me with a very young third class hospital corpsman who he directed to contact a medical officer ashore in case a doctor might like to see me.

The young corpsman gave me a bag of ice and more clean towels to apply to my swollen and swelling face, and then proceeded to do the most important thing—make a medical record entry. He asked me to describe what happened. And he wrote intently as I attempted to explain, through my loose teeth and now gargantuan-sized lips in a most difficult to discern voice, what had happened.

Needless to say, eventually the medical officer showed up and I was x-rayed and taped up. And, for awhile, anyway, was the world's ugliest naval officer. We even fixed the masthead light.

But, nearly 20 years later—while the SSBN has been decommissioned and deactivated, the CO long since retired, the young OOD now a CO himself, and myself a lot older if not necessarily wiser—the somewhat supernatural legacy of that cold, wet night in Scotland endures in my medical record in the third class corpsman's scrawl: "Lieutenant Lemkin was struck by a *mass of light*!"

GET ME DOWN!

by CDR George K. Fraser, Jr., USN(Ret.)

Several months before reporting aboard my very first submarine, a GUPPY IIA in San Diego, it had been involved in an incident resulting from the old "Low power? I thought I was in high power!" syndrome. In the resulting micro-close encounter with a destroyer hull, #1 periscope and several other retractable masts had incurred extensive damage, all of which had been repaired by the time I joined the boat. Repairs to #1 scope, however, were far from ideal. When #1 was raised it was impossible to train, even with assistance, if the packing was tight enough to prevent heavy leakage. We tried to strike an imperfect balance between the ability to walk the scope around and the amount of water which inevitably cascaded onto the scope-jockey whenever it was in use at periscope depth. As a result of all this, most OODs and the commanding officer became habituated to donning one of those infamous rain parkas before raising #1 scope. You all remember those wonderful rain parkas—one size fits all, a high-thigh-length and loose fitting hooded garment guaranteed to raise such a sweat on even an immobile wearer that one will be just as wet with it on as without it.

One fine day during a type training week, we were scheduled to make a rehearsal torpedo approach against a single, zig-zagging target. The CO, a portly gentleman about six feet tall, had a good enough sense of humor but was otherwise extremely sensitive about his own sense of dignity and self-image. As was customary because of the leakage problems with #1 scope, he appeared in the conning tower decked out in his rain parka. (Remember the old conning tower, with the two periscopes positioned fore and aft, and with only about three feet between them?) The approach started normally, with the boat at periscope depth and with the target just slightly over the hill and positioned somewhere off the bow. The CO was the approach officer, making a number of observations using #1 scope. As was his custom, the CO would ride the scope up as the eyepiece and handles cleared the well, ordering the periscope assistant to stop the upward travel as soon as could see the target over the wave-tops. This practice usually resulted in a posture with flexed knees and with the posterior pushed out behind, because he was bent over from the hips.

As the approach progressed, the target zigged such that the CO decided to shift the firing torpedo tube to the after torpedo room, and he maneuvered the boat so as to take the target under fire from that extremity. At about this same time, he ordered a slightly increased depth and shifted from #1 to the longer #2 scope. We were now rapidly approaching the firing point, and target's position was tracking as almost dead aft. Ordering another observation, he rode #2 scope up out of the well, stopping the upward travel of the periscope when it was about midway between deck and overhead. Something about the target's appearance caused him to say breathlessly, "Hey, XO, take a look at this." As ordered, the XO started raising #1 scope so that he, too, could look at the dead-aft target.

As #1 scope cleared the periscope well, it was literally brushing against the CO's posterior, which was outhrust due to his *ride-the-scope-up* posture. Feeling the scope moving against his rear end, he tried to hunch his hips forward slightly in order to increase the clearance between his nether parts and the barrel of #1 scope. Too late, and not enough! As #1 continued its upward motion, its stop rod hooked under the tail of the CO's rain parka, which was pooched out behind him due to his doubled over posture. Inexorably continuing its upward travel, the stop rod hoisted the CO to the overhead, two-blocking him in a very embarrassing position. With both hands on the handles of #2 scope and his arms outstretched to maintain his hold on the handles, his hind quarters were about a foot higher than his head, and his feet dangled helplessly as he danced an unsuccessful jig trying to find terra firma.

The following exclamations and orders then ensured, all in very short order:

CO (excitedly), "GET ME DOWN! GET ME DOWN!"

XO (calmly), "Get me down, Aye, Cap'n. Lowering #1 scope."

Diving Officer (firmly), "Aye, Cap'n. FLOOD NEGATIVE! FULL DIVE, BOTH PLANES! MAKE YOUR DEPTH ONE FIVE ZERO FEET!"

Rehearsal torpedo run aborted. ■

REMARKS AT THE INACTIVATION CEREMONY
USS PARGO (SSN 650)
JULY 15, 1994

by CAPT James H. Patton, Jr., USN(Ret.)

Admiral Bell, Commmodore, distinguished guests, friends of PARGO, ladies and gentlemen. It's customary at this point to say how honored I am to have been asked to do what it is I am doing today. What goes without saying, however, should, and for the sake of brevity, shall.

Furthermore, the fact is that honor is not the primary emotion I'm experiencing at the moment. I'm not even sure just what it is that I am feeling, except that it is powerful and profound! Perhaps with your help as empathic listeners I'll be able to talk it out and gain a better understanding of it.

When Captain Wegner called me back in May to ask if I would speak at the deactivation ceremony of his ship, I accepted, then, with a sense of pride—the dangerous flip side of honor—I told my wife, Mary. She gave the look that any man married more than a week recognizes, and told me "Don't get maudlin!"

I, of course, was offended by that remark—the type of offense taken whenever one received unsolicited advice which is both desperately needed and painfully accurate.

It did make me reflect, however, that this whole affair isn't about me, or Steve White or Brian Wegner or any other person, but it is about PARGO. Furthermore, to borrow a line, we're here to bury PARGO, not to praise her.

Her—that pronoun reminds me that at this point there is something important of which to advise you. I, and most others of us that have lived so intimately with these kind of inorganic *hers* cannot refer to them in a genderless sense, and I'm afraid that some of the following comments might not be entirely politically correct. They could even be perceived by some to have, although certainly not offensive, some slightly sexual overtones.

In fact, when one thinks about it, Sigmund Freud would have had a great deal to say about why 120 otherwise healthy men freely chose to send themselves off for months at a time locked inside a device such as PARGO. There must be some level of bonding with these *hers*, then, that is different from that which we feel for our car or favorite TV program.

My good friend and mentor, Jerry Holland, as he left command of Sub School, said about those that shared this bonding to a vessel, that "Sailors were too embarrassed to use the word *love* when referring to one another, so they invented the word *shipmate*."

In any case, since I am neither in nor intend to run for public office, and since I have no more earthly selection boards to face, you, the audience will just have to deal with whatever it is that you think you hear me say.

When I first met PARGO she was a maiden—on the building ways at Electric Boat being coddled and protected by Steve White while I was building FLASHER. When some 12 years later I finally was told I could have her, she was fully mature and very experienced. Steve White, Dave Hinkle, and Jay Ransom had had their way with her, and she had developed a style and reputation that others on this waterfront whispered about with a degree of wonderment and envy.

A fast but discreet lady, she went in harm's way with a knowing flair and determination; and, eager to please, would try anything at all that was asked of her, even, I suspected, but never tested, to attempt violating laws of physics.

Some younger and even faster sisters were just beginning to show up, but were really rookies, and weren't even yet allowed to go downtown alone. She was truly a *working girl* of the highest rank, and, like others before me, I really believed her first allegiance was to me until she drove off with Harvey Cybul and began happily responding to his wishes and demands.

As I was forced to leave this deck, furious because of her demonstrated infidelity, I actually called her nothing more than several thousand tons of steel hull, thousands of pounds of copper-nickel piping, and a few grams or perhaps ounces of transistor grade silicon—it goes to show just what we are capable of saying to a significant other when anger gains the upper hand.

My words didn't phase her a bit, however, and she went on to know many other men as she evolved into the tough old broad she is today—now taken off the streets and out of a job, but still maintaining all the grace and poise of one on shakedown cruise.

She's not being *let go* because she's lost her stuff. The brains of these inorganic *hers* don't stagnate or atrophy with age as mine and yours are prone to do. They actually get completely replaced with better ones periodically. Ms. PARGO thinks a lot faster and better about many more things than she did when I was intimate with her, and I'd even be hesitant to presently consider myself an adequate intellectual companion. She's not faster, but neither is she any slower, and she's even more discreet.

What exactly did she do that justifies her having passed this way, really using us far more than we even thought we were using her? Nothing much more, along with a few dozen like her, than simply wining the Cold War. Any student of the Battle of Britain in 1940 knows that although *conventional wisdom* credits the faster **Spitfires** with much of the credit for the victory, it was the slower **Hurricanes** that did the bulk of the work.

These warrior amazons chased the Soviet bear out of the world's oceans back into the nooks and crannies of his own littoral—the *bastions* we used to read and hear so much about, and, as any naval strategist will tell you, when a Navy assumes a defensive stance, it is beaten.

Also, as befits a proud and gracious lady, some of the last services she provided were for the greater benefit of mankind when she brought civilian scientists to her beloved but previously private Arctic waters. In a sense, she gave it away for free.

I could continue on with the usual—how many miles steamed, how many dives and that sort of data, and everyone would be suitably impressed, but in a larger sense, those numbers are almost trivial. What we that slept in her bosom will remember of her is that she enticed and seduced us away from our homes and families for extended periods to do things we never thought ourselves capable of. Whatever other purpose the grand designer had in mind for testosterone, it also causes young men to drive cars too fast, and slightly older men to push other envelopes a little too far. It is not the least surprising that these families now somewhat sigh with relief that she is almost gone, for it was idiocy to ever have expected them to love such a competitor for our time and affection. The most we ever could have asked or expected was the relative absence of dislike, and we would have been well advised to accept hate.

But, she's gone—we come back to the hearth looking for the warmth and friendship we so often voluntarily left, and amazingly, it's still there.

Ceremonies like this are cathartic—the naval version of Four Weddings and a Funeral—maybe Four Commissionings and an Inactivation—I'll have to ask and see if Paramount is interested in that.

I think I speak for all that went before and after, both in the wardroom and on the mess decks, when I say I'm glad I knew her. She was a hard mistress, however, and I'm not sure I would have had the stamina to continue on much longer than I did. And certainly couldn't meet her expectations now. As dichotomous as it sounds, however, we who served her should strive to forget, while everyone else should not.

Thank you. ■

REMARKS AT THE INACTIVATION CEREMONY OF USS SEAHORSE (SSN 669) JANUARY 6, 1995

by CDR George G. Harper, USN(Ret.)

Twenty-five years, three months, and eighteen days ago at a ceremony at the U.S. Naval Submarine Base in New London, Connecticut, I had the honor of becoming the first Commanding Officer, USS SEAHORSE. With no small sense of pride, awe, and accomplishment we, the first crew of the 'HORSE, broke the commissioning pennant and the in port colors, set the in port watch, and opened the log to start the record of the life of this ship. We are assembled here today not only to mark the closing of that portion of the log that represents this ship's active service but also to celebrate more than a quarter century of distinguished service and significant contribution to the defense of the United States.

While the ship's log will never reveal it to a researcher or archivist in the future, she was not born on 19 September 1969. The most important period in the 'HORSE's life—truthfully in the life of any ship—began fully three years before that date, when her keel was set on the north building ways at Electric Boat and she began to take shape at the hands of the artisans and craftsmen, who had given us so many fine boats. It was not until early '68 before a glimmer of life could be perceived as the first members of the commissioning crew began to report.

I think a few words are in order to describe the American scene at that time, which, I suspect, occurred before some of you were born. The Cold War was at its height; social disorder and riots racked a number of major cities; the Vietnam War was escalating beyond anything imagined a few years before, draft cards fed the bonfires at countless demonstrations on the campuses of universities and colleges across the country; and the terms *counter-culture* and *anti-establishment* were the working buzz phrases of the news media. We were launching and commissioning a 637 boat every three to four months; the missile boats were moving from the Polaris to the Poseidon systems; and the 688 class was in final procurement and construction design. The pace of life in the Submarine Force was frenetic. We seemed to move from one boat to the next as we tried to accommodate building and operating schedules that strained personnel resources to their limits—and sometimes beyond.

In the midst of all this, 114 officers and enlisted men began to assemble on a living barge at Electric Boat. We came from all over the force—some from boomers and other attack boats, some from advanced schools, even a few from a rare shore duty assignment. A number came directly from Submarine School starting their first tour, while at the other extreme there were many more of us starting our fourth or fifth consecutive tour of sea duty. The ranks of those who had first qualified in diesel boats were thinning. As we pored over service records, I recall remarking to our XO, Lieutenant Commander Rich Enkeboll, that if we were successful in organizing and preparing this collection of strangers to produce the kind of synergism necessary to operate and maintain a ship like SEAHORSE, it would dwarf in significance anything we had done or would do in the remainder of our careers.

We first found the 'HORSE high and dry on a building way in the north yard. At first glance, she seemed to be a disorganized collection of steel shapes, platforms, pipes, cables, and insulation. Every equipment panel was unrecognizable behind protective coverings. She smelled of cutting torch, weld rod, of oil, grease, paint, and sweat. She seemed to exist in a cacophony of chipping hammers, metal grinders, and the clash of steel on steel. Through it all we could just make out the lines and arrangements of a submarine. The scenes of apparent chaos produced in all of us doubts, of one degree or another, that we would ever be able to get from that point to an operating boat in the time left to us.

Before we had even formed up and within a few days of launching the 'HORSE into the waters of the Thames, we were hammered with the knowledge that SCORPION would never return *to Norfolk. We paused. We did what pitiful little we could for those left behind. At services in Dealey Center we mourned our shipmates, our classmates, and our friends and we returned to our tasks with a sense of rededication that was almost palpable.*

Gradually we began to see her—and us—coming together. Strange faces were connected with names, the senior petty officers and department heads stepped up and took charge, recognizable divisions and departments were formed, and lines of communication and leadership were established. We climbed the boat from sail to keel, from bow to stern. To a man, we walked the pipes, touched the valves, and traced the circuits. We overcame the uncertainty we felt at seeing systems and equipment we had never seen before. We inspected everything and we watched everything. We complained, when necessary, and we applauded, when appropriate. It was a period of eight-day weeks and forty-hour days. It was a period that added stark meaning to the irreverent observation that the hull designation *SSN* meant *Saturdays, Sundays and Nights*. Small success and frustrating failure seemed to go hand in hand. Training was incessant. Plant manuals, equipment manuals, and our Mickey Mouse books were our constant companions. We shamelessly picked the brains of the crews and wardrooms of every 637 boat in New London. It was a time when every member of the crew was called on to give more than he ever thought he had to give and to give it freely and willingly.

Suddenly, we were there. We went *in service* and ran a test program the likes of which I had never seen before. We wrung out every single system in the ship and then we did it again. If anything escaped our attention, I cannot imagine what it was. The engineers walked through the Naval Reactors Readiness Exam with no open items—unheard of in those days. All of the training and exhausting hours bore fruit as sea trials went like clockwork and that crew looked like they had been working together for years.

With a clarity as if that event were yesterday, I recall my remarks at the commissioning ceremony. While I recognized the contributions of every organization in bringing SEAHORSE to that point, I reserved my special salute for that first crew, while I told the assembled guests, "The officers and men who stand here today have done an outstanding job. They have put a heart in this ship and in the months to come will complete the fashioning of a soul on which she will depend in no small measure for the rest of her life." When I hear the record of the 'HORSE recounted, I believe that that prediction came true. That first crew set a tone and left a legacy from which all who followed them have profited.

Now it is time to close the log. Perhaps the 'HORSES's time has passed—but I don't know. Perhaps the economics of advancing technology and budget restraints have made this ceremony necessary—but I don't know. Perhaps she simply deserves a rest—but I don't know. I do know that this ship and all like her and the hundreds of crews that took them to sea time and time again have contributed to producing a world order that was unimaginable in 1969. They have won a truly *Silent Victory* for which every citizen of the United States owes an incalculable debt.

To you, the last crew of the 'HORSE, I will close with this observation—offered from the perspective of 25 years. As you disband and each of you goes to wherever it is that fate will take you, you should go with the knowledge that you have just completed one of the most unique experiences of your life. You have been a valued member of a submarine crew. You have been a *shipmate*—a term that is little understood by those who have never shared or participated in any association founded on exclusive professionalism and mutual dependence. In all probability you will never again experience a culture so dedicated, so qualified, and so selflessly focused on the mission and well-being of the group as the one you are part of today. You will come to treasure this experience. As I do.

I wish you all the best of fortune in the future. You have done an outstanding job.

I thank you for that job and for these moments. ■

The MIT NROTC Unit has established the MIT NROTC Alumni Association. All former graduates and staff of MIT, Harvard and Tufts ROTC units are encouraged to contact:

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TORPEDO TECHNOLOGY BIBLIOGRAPHY

by Frederick J. Milford

[Editor's Note: Dr. Milford retired from Battelle Memorial Institute in 1989 as Vice President for Special Projects. He was on active duty in 1945-46 as an ET2 and held a commission in the Organized Reserve after the war. He is a life member of the Naval Submarine League.]

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ON PATROL FIFTY YEARS AGO

by Dr. Gary Weir

[Editor's Note: This first war patrol for TIRANTE provides a wide variety of insights into late American wartime submarine operations. For his daring, determination, and high degree of success, Lieutenant Commander George L. Street III won the Medal of Honor for this patrol and his Executive Officer Lieutenant Edward Beach took home the Navy Cross. The crew was awarded a Presidential Unit Citation.

Determination was important at this point in the war because of the vastly reduced number of available enemy targets in the East China and Yellow Seas thanks to consistent American submarine success in the region and the increasing number of boats available for deployment. On this patrol, TIRANTE frequently encountered other boats and conducted cooperative operations with TINOSA and SPADEFISH. Street's rendition of the Quelpart Island attack also provides good reading on daring solo operations and insight into imaginative attack techniques.]

USS TIRANTE - Report of First War Patrol

Period 3 March 1945 to 25 April 1945

PROLOGUE

Ship placed in commission at Navy Yard, Portsmouth, New Hampshire on November 6, 1944. Lieutenant Commander G.L. Street III, USN assumed command. Ship completed on November 23, 1944, and commenced training in fog, storms, and freezing weather off Portsmouth. TIRANTE's builders did a wonderful job.

Arrived New London, Connecticut on December 21, 1944. Departed January 8, 1945 for Balboa, arriving there in January 16. Departed January 26, arrived Pearl February 10, 1945.

NARRATIVE:

March 3, 1945

Departed Pearl Harbor in accordance with ComTask Force 17 Operation Order #65-45, enroute to west coast of Kyushu via Saipan to form coordinated attack group with TINOSA and SPADEFISH, with Commanding Officer TINOSA as group commander.

March 3-15, 1945
Enroute Saipan, conducting training enroute. Averaging three dives, one battle problem daily. Studying many patrol reports, and *Bushido* to get back in trim after a long layoff.

March 15, 1945
Arrived Saipan. Commenced investigation to remove shaft squeal. Underway on 16th to test preliminary work. Drydocked on March 17.

March 18, 1945
1000L Ensign W.N. Dietzen, USN reported for duty.
1306L Underway. Tested shafts, found no squeal. FULTON did a swell job. Proceeded on patrol under escort.
1420L Discovered stowaway, Delecta, J.J., 807 20 15, S1C, USNR, attached to USS FULTON.
1630L Put bow alongside escort (YMS 343) and transferred stowaway.

March 18-24, 1945
Enroute Area Nine, conducting routine training. Slowed SOA from 15 to 11 knots on account of heavy weather.

March 24, 1945
0855L Dived, commenced approach to Tokara Straits.
1608L Surfaced, intending to transmit weather as per instructions from ComSubPac and then transit strait.

March 25, 1945 1200 Posit 31-08 N 130-35 E. (All times item)
0504 Dived five miles off Kaimon Dake for first day's submerged patrol. Closed to 3000 yards off the beach.
First Attack Sunk 3080 Ton AK Kiyotada Class, Lat 31-08 N Long 130-30 E.
1320 Sighted ship. Commenced approach.
1325 Ship identified as torpedo target. Conducted normal submerged approach, used ST in early stages to obtain speed and masthead height. Completed attack using attack periscope and ping range just before firing to check setup.
1330 Identified target as Kiyotada class AK.
1341 Fired 3 Mk 18 torpedoes aft, ping range 1000 yards, gyro angle 180°, track 90S, depth set two feet, spread to get one hit, using spread setter designed by Commander H.J. Cassedy, USN..

1343 One hit, at MOT. Torpedo run $1^{m}10^{s}$. Target disintegrated. Took picture. Target sank bows first in about one minute.
1344 Two torpedoes hit beach and exploded.
1349- Received two depth charges and two aircraft bombs, all
1445 distant.
2123 Surfaced. All clear. Desire to remain undetected and dive up north off Oniki Saki in morning to allow this area to cool off a bit.

<u>March 26, 1945</u> 1200 Posit 32-08 N 129-55 E.
0505 Dived six miles off O Shima, just south of Oniki Saki. Not such a good place, as events proved. Were bothered all day by small craft. Although we closed to 2000 yards from a group of rocks offshore, two small tankers, a small AK, and a small hospital ship passed inshore of the rocks in the late afternoon disclosing the use of a heretofore unreported inland passage along the coast.

<u>March 27, 1945</u> 1200 Posit 32-15 N 129-57 E.
0450 Dived. Patrolled all day about 3000 yards off Oniki Saki. Bothered somewhat by fishermen working in pairs towing drag nets between them. A few bad moments as one persistent pair forced us to 150 feet to duck under their net. Glassy sea. Big ships stayed home.
1947 Surfaced.
2106 Dived for a plane. Lookouts getting better fast. Moon as bright as day.
2149 Surfaced. Commenced countermeasure of completely flooding down to 24 feet 1-1/4° down angle. Advantages (1) Diving time 30 seconds (average). (2) Smaller radar target and silhouette.

<u>March 28, 1945</u> 1200 Posit 32-15 N 129-56 E.
Intend to open from coast, transmit weather enroute to Fukae Shima, and them return to Oniki Saki.
0425 Dived off Oniki Saki. Sighted various patrol and small craft during morning. Patrolled 2000-4000 yards off Oniki Saki.
Second Attack Sunk 2700 Ton AK, 32-15 N 129-55 E.
1205 Sighted smoke, which developed into a small AK, MFM, composite superstructure, cruiser stern, plumb bow, heavily laden. About 2700 tons. Executed standard submerged approach from land side using ST in early stages for target speed and masthead

height determination and completed approach using attack periscope with ping range to check setup just before firing. Target speed solution slowed from 14 knots to 8 knots during the approach. The ST definitely gets the credit for this one.

1304- Fired three MK 18 torpedoes forward, ping range 900, gyro
30 angle 014, track 60 P, depth set six feet. Spread at MOT, bow and stern.

1305- One terrific hit at MOT by Mk 28-2 torpedo donated by
13 employees of the Westinghouse Mk 18 factory, Sharon, Pennsylvania. Torpedo run 43". Target sank instantly. Diving time 30 seconds. Took three pictures. Other two torpedoes were *robbed* as they ran out to sea *hot straight and normal* and sank. No end of run explosions, in water 50 fathoms deep.

1324- Evading. Received eight depth charges. Target was
1453 apparently not escorted, but the area was patrolled by Japanese Special Submarine Chaser #1 and he happened to be near by—also his partner, whom he promptly called in.

1826 Sighted *killer* group of three SC boats patrolling area, pinging sonically every 1-1/2 seconds.

2001 Surfaced.

2045 Dived for a plane, whose exhaust was sighed by lookout. Suspect this was the same star we dived for last night (sighted by same lookout.)

2123 Surfaced. Transmitted weather one day late, also giving results to date. Then changed course and headed south at high speed to let this area cool off.

<u>March 29, 1945</u> 1200 Posit 31-05 N 129-40 E.

Received message giving lifeguard station for air strike on Kyushu and Jap fleet if it comes out. Luckily we are near the designated position.

0100 Increased speed to full on four engines. Have time to make a sweep of coast of Kyushu from Mono Misaki to Kaimon Dake before sunrise.

0100- Ran down coast 13 miles off shore at 19 knots making careful radar search, hoping at least to be able to make a contact report on Jap fleet units, if any were there. Covered estimated speed of advance 18 to 12 knots. No luck.

0547 On lifeguard station. Made trim dive.

0615 Surfaced. Flooded down decks awash. Hoisted colors. Day uneventful. Saw eight planes during day, IFF response on many more. Stayed up and watched a Zeke go by at four miles. Dived

once, when two land based bomber-type planes came in zero angle on the bow, no IFF. Entertained ship's company by letting them hear and read our carrier plane pilots VHF remarks as they blasted Kyushu.
1845 Secured lifeguard. Dived twice for planes before 2400.

March 30, 1945 1200 Posit 31-07 N 130-36 E.
Enroute to submerged patrol spot of Bono Misaki.
0305 Radar contact 4300 yards, which developed into a small vessel on course about 020°T.
First Gun Attack Sunk 100 Ton Lugger, Lat 31-11 N Long 130-04 E.
0352 Decided this fellow was a gun target—so we went to Battle Stations Surface. Ended around to get target silhouetted against bright moon, then closed him keeping bows on, intending to open fire with the forward 40mm and 20mm while closing, then swing broadside to polish him off.
0410 Sighted target and identified him as standard Jap lugger.
0428 Commenced firing at 2000 yards. Target fired a burst of .30 cal. tracer which whizzed overhead. Forward 40mm silenced him. Swung left at 1800 yards range to unmask battery. First 5" shot hit the target, going completely through him, and that gun hitting consistently, demolished the target. The 40mm did not do as well because of poor pointing, until range decreased to 100 yards. The after 40mm partially blinded the 5" crew, and in return the blast from the 5 " trained well forward almost lifted the after 40mm crew out of the seats, but undaunted both crews methodically went to work and cut the lugger to ribbons.

April 2, 1945 1200 Posit 31-18 N 130-05 E.
Submerged patrol off Bono Misaki. Sighted various small craft.
1027 Surfaced in a fog—4000 yards off Bono Misaki light and air search radar station for a look around and a breath of fresh air. Combed the deck for several rattles JP had heard and found several. While several men were over the side sawing off a loose side plate, the fog commenced to thin.
1055 Dived with the lighthouse coming into view.
Third Attack Missed Standard Jap LST, Lat 31-15 N Long 130-05 E.
1558 Sighted ship coming out of haze. Battle Stations. First ST range 3200 yards, speed 16 knots by plot, angle on bow zero.
1600 The target was identified as a standard type, empty, Jap

LST, riding extraordinarily high out of the water with lookouts all over him. Bow out of water for one-tenth of his length. JP sound, which had picked up fishermen all day before they came into sight, had great difficulty in picking up this target even when close. The cause was soon apparent when his screw appeared to be up in a well.

1602 Intended to fire bow tubes with sharp track, but the setup was not good, range too short, dope still not definite. We had time for only three setups by time torpedo run was 500 yards. Changed mind and let target go by at 200 yards abeam, setup for a deliberate stern shot at large track.

1604 Fired three Mk 18-2 torpedoes aft, range 1000 yards, track port 160, gyro angles 210. Torpedo runs from 1300 to 1700 yards, depth set two feet.

1605 Target saw the usual plumes of spray thrown up by torpedoes *whale spouting* at this shallow depth setting, and made radical maneuvers to avoid; spinning on his tail like a trained seal. No hits.

<u>April 6, 1945</u> 1200 Posit 34-10 N 127-53 E.

Decided to investigate northern part of Area Nine for a change, now that we have been assigned it by SPADEFISH.

Dived off Shori To. Saw numerous fishing schooners dragging nets astern. Kept busy staying clear all during the day. Decided to try to capture one and take personnel back to base, since they ought to have information about the suspected anchorage at Reisue Kaiwan.

1918 Surfaced—going after one of the larger schooners.

1930 Having trouble coming alongside, and he isn't cooperating. Fired a 40mm shell through his mainsail. The shell exploded, making a big hole in the sail, .30 cal. machine gun cut his mainsail halyard so he lowered his sails in short order.

1940 Boat alongside. We look huge by comparison.

Lieutenant Endicott Peabody II (All American, Harvard 1942) and GM1C H.W. Spence jumped aboard, both armed to the teeth in terrifying fashion. The dignity of the boarding party was considerably shaken when LT Peabody landed in a pile of fish and skidded across the deck in a tremendous *prat* fall, but their efficiency was unimpaired. With many hoarse shouts and bursts of tommy gun fire, three thoroughly scared and whimpering fishermen were taken aboard. One Korean successfully hid by jumping over the side. Found out later he thought we were Japs.

thus putting his days as *draft dodger* to an end.
1958 Cast off schooner. Set course through the passages of the Korean Archipelago at full speed, navigating by PPI. Passed through fishing fleet of about 50 schooners. Hoped to route out some of the shipping our planes have reported hugging the coast here. Navigator now a qualified SJ operator.

April 7, 1945 1200 Post Lat 34-33 N 125-20 E.
0443 Entered Maikotsu Suido.
0546 Dived. Experienced currents up to five knots, luckily mostly northerly, which was to our advantage. Conducted submerged patrol in Daikokusan Gunto 2000 yards from the beach. Heard distant pinging. Closed it hoping for a convoy.
1652 Sighted two ships, later identified as a Chidori and a patrol frigate on an antisubmarine sweep. Avoided detection. Minimum range 7500 yards. Took several pictures of them with simultaneous ST ranges for intelligence purposes. Their usual loud pinging on 14.8 Kcs. was the first thing we picked up.
Fourth Attack Sunk 2800 Ton Freighter, Lat 34-35 N Long 125-20 E.
1755 Sighted ship proceeding up the island chain. Commenced approach. Because of increased confidence in the ST periscope, made ready only two tubes. Executed standard submerged approach.
1852 Fired two Mk 18-2 torpedoes; depth set four feet, range 600, gyro angle 352, track 120.
1853 Two terrific hits. Target sank instantly. Tried to get pictures, but target had sunk. Got one of the last three feet of his bow as it went under.
The target was brand new, 2800 tons, painted olive drab in color. He had a deck cargo of oil drums and a circular gun platform on bow.
1858 Surfaced 3800 yards from the beach, broad daylight.

April 8, 1945 1200 Posit 35-06 N 123-57 E.
0632 Surfaced after trim dive, intending to patrol on the surface in plotted traffic routes 60 miles west of Daikokusan To. Ran decks awash at slow speed, but wake could be seen several miles astern in glassy sea.
0732 Sighted plane, two engine bomber, directly in the sun, headed for us. Dived.
0735 Two bombs. One close explosion, one dud.

0825 Periscope depth for a look. Plane saw us with two feet of scope exposed, came in and strafed, dropping possibly another dud. Back to 200 feet, day's patrol ruined by getting spotted.
1025 Six distant bombs. He must have called in the wolves.
1506 Surfaced.
1535 Sighted plane, a two engine bomber, on horizon. Dived to periscope depth to keep an eye on him.
1545 Plane passed over the periscope. This lad is good! Went deep—all of 150 feet (200 feet depth of water).
1957 Surfaced. Cleared area. We now feel that staying on the surface and getting spotted by planes is a poor way to carry out our mission of inflicting the maximum possible damage on the enemy.

<u>April 9, 1945</u> 1200 Posit 36-50 N 123-57 E.

Fifth Attack Sunk 500 Ton Transport (Attack 5A), Missed 5000 Ton Freighter (Attack 5B), Lat 36-50 N Long 123-55 E.

0920 Heard distant pinging bearing 270°T. Went to 52 feet raised SD mast and at 0934 broadcast contact to SPADEFISH. No receipt.
0936 Sighted two large ships and three escorts. Commenced approach. The sea was glassy, sound conditions phenomenal, depth of water only 200 feet, no gradient. Poor conditions for a submerged attack, perfect for the opposition. In addition, our ST is operating at only 75 percent efficiency due to cracked mica window in wave guide, necessitating a high exposure at close range to get a radar range. However, we are convinced of its value, and will do whatever is necessary to get at least two ST ranges. with 8-10 feet of ST out failed to get radar ranges even as close as 8000 yards. Shifted to #2 periscope until range is 5000 when we will try again with ST. Mirage makes stadimeter ranging erratic.
The convoy is zigzagging radically, with one escort on the far flank, one on the near bow, one on the near quarter, with possibly more escorts. Ships identified as transport NIKKO MARU leading and freighter RAMB II in column astern. Speed dope poor, so—
1015 Forced to expose four feet of ST periscope to get 6200 yard radar range. Maybe we are foolish, but intend to get good dope. Looking down the escorts' throat with that much periscope out on this mirror smooth day made us feel like Lady Godiva in the market place. We will be most fortunate to get in undetected

today. The assured echo range is over 3000 yards.
1022 Near escort, a big new frigate passed close aboard, pinging horribly. We swung into him keeping our bow on him. Not detected. With our torpedoes set on six feet forward (dry aft) were ready to give him two if he showed any signs of acting up.
1025 Zig toward, giving NIKKO a starboard 50 angle on the bow, and RAMB about starboard 50. Had our bow right on them ready for a zig either way. Setup looks fine—now have time to wait a bit until track improves. Turn count on NIKKO of 88 rpm showed 15.5 knots.
1027 Up ST scope for firing bearings. This is necessary to double check our speed solution of 14 knots and to get a quick setup on second ship. Fired three Mk 18-2 torpedoes at NIKKO, range 1600 yards gyro angle 051°, track 110 S, spread 200 feet between torpedoes hoping to hit MOT, foremast, mainmast.
While firing saw a two flag hoist go up on the NIKKO. Shifted to RAMB, saw him to-blocking same signal, got a quick setup, and saw him start to swing right, decreasing the angle on the bow. Escort on his starboard quarter is headed our way due to zig so must shoot now or never, before hits in NIKKO alert the whole convoy.
1029 Fired three Mk 18-2 torpedoes at RAMB, depth set six feet, range 1700, gyro angle 013, track 55S-20P. Had to set in a different angle on the bow for each shot. Target surprised us by at least a 150° course change, with hard over rudder. In the process he nicely combed the spread.
While firing at RAMB, heard and saw three hits on NIKKO. The first, spread to hit MOT, hit in the after well, breaking her in two there and stopping her screws, never to be heard again. The second spread forward, hit amidships, rasing Cain generally, and she had already sunk to the water's edge when the third, spread aft, hit under the foremast blowing her bow of. The force of the first two hits was so terrific that they stopped her dead, causing the third Mk 18, which normally would have missed aft, to hit.
Complete swabo on RAMB. We were still using the ST scope, with exposures varying from 4 to 12 seconds and might have been sighted.
1030 Commenced evasion. The nearest escort, a patrol frigate of the Mikura class had turned during the second firing, and was bearing down fast. Headed deep (bottom 200 feet) and commenced receiving a deliberate depth charging by two echo ranging escorts. The third escort had apparently gone off with RAMB.

The most persistent escort was the frigate which had passed close aboard just before firing.
1236 We are now really boxed. One set of screws stays on the beam, running slowly and pinging and most probably listening. The other two are making alternate runs. Evaded lusty patterns by observing true bearing as run developed and speeding up slowly to cavitation threshold, so that listening escort would not hear us. If true bearing drew aft turned toward, if drew forward turned away.
1238 Fired one NAC beacon, with three minute delay on their low frequency band, plus two FTS. No luck—received good pattern just astern. NAC failed to function.
1259 Fired another NAC beacon plus three FTS. The NAC functioned seven minutes after being fired, although set for three minutes delay. Pulled away at 80-60 rpm. The anti-sub team, which had been getting setup for another run on us, shifted to the NAC and FTS, pinging like mad and never found TIRANTE again. Heard many more depth charges, more and more distant. Total for the day—83. Their retiring search curve, punctuated with depth charges, fortunately did not locate us.
1422 Struck bottom momentarily and heard a peculiar noise on the port shaft. Subsequently while making high surface speeds a pronounced vibration became evident. Ran a test for silence, which was satisfactory, but investigation for bent propeller blades will be necessary during refit.
2049 Surfaced. Transmitted results of attack to Group Commander in SPADEFISH.

<u>April 12, 1945</u> 1200 Posit 32-24 N 124-42 E.
Uneventful submerged patrol on Shanghai-Saisho To route. Sighted three horn-type floating mines during the day. Had all bridge watch standers take a good look at them through the scope. Took pictures of one in HP very close aboard.
1930 Surfaced, headed for Shanghai at high speed to scout Shanghai-Quelpart line.

<u>April 13, 1945</u> 1200 Posit 32-40 N 125-14 E.
0612 Returning from Shanghai sweep at high speed. Sighted dawn plane and dived for the day. Upon surfacing heard the melancholy news of the death of our Commander-in-Chief.
Intend to make investigation of a reported anchorage on the north shore of Quelpart during darkness. Our six Mk 14-3A torpedoes

left forward will be ideal for this work.

Sixth Attack Sunk Ammunition Ship 8000-10,000 Tons (est) Attack 6A, Sunk Frigate Mikura Class 1500 Tons, Attack 6B, Sunk Frigate Mikura Class 1500 Tons, Attack 6 C, Lat 33-25 N Long 125-50 E.

<u>April 14, 1945</u> 1200 Posit 32-35 N 125-50 E.

0000 Approaching Quelpart Island northwestern side.

0029 Radar contact. Patrol boat. Went to tracking stations and worked around him. Sighted him at 4500 yards—long and low. No evidence of radar until we were nearly around, when he turned on his (Jap 10 Cm). The patrol was evidently suspicious, probably because we came too close, but soon went back to sleep. Continued working up the anchorage.

0223 Radar contact. Another patrol craft, bigger than the other. Avoided by going close inshore. This vessel was patrolling back and forth in front of the anchorage, had 10 Cm radar, and was pining on 14,8 Kcs. He also became suspicious, apparently, and headed for our point of nearest approach to him. However our tactic of heading inshore confused him (as we no doubt merged with his land pips) and he continued routine patrolling.

During the whole of the ensuring action, except while actually firing torpedoes, this patrol boat was kept on the TDC and both plots. He was always a mental hazard, and potentially a real one. The only chart that was of any use was the Jap *Zoomie* chart labelled Japan Aviation Chart, Southern-Most Portion of Chosen (Korea) No. V3-36. No soundings inside the 10 fathom curve in the harbor and approaches were shown. Hoped the place wasn't mined and that none of the five shore-based radars reported on Quelpart were guarding the harbor.

0240 Battle Stations. Approached anchorage from the south along the 10 fathom curve within 1200 yards of the shore line. Took *single ping* fathometer sounding every three to five minutes. The smell of cattle from the beach was strong. Bridge could not see well enough to distinguish ships from shore line in the harbor, though a couple of darker spots in the early morning mist looked promising, as did indeed, the presence of two patrolling escort vessels where none had previously been seen several nights before during the night patrol in this area.

0310 Completed investigation this side of the anchorage form 1200 yards away. There may be ships there, but cannot see well enough to shoot. Started around the small island off the anchorage, staying as close as possible. The patrol vessel by this time was paralleling us 7000 yards off shore, still not overly suspicious, but annoying. Executive Officer on bridge could see him now and then.

0330 Having completed circuit of the small island, started in from northern side, cutting in across the 10 fathom curve. At about—

0340 Bridge made out the shapes of ships in the anchorage. Sound picked up a second *pinger*, this time in the harbor. Still too far, (4500 yards and not sure of what we saw). Patrol heading this way. Sounding 11 fathoms. Current setting us on beach. Decided to get in closer and have this over with. A/A 2/3. (Radar Officer confirmed sharp pips of ships in anchorage).

0350 Bridge definitely could see ships. For the first time put targets on TDC, with zero speed and TBT bearings. With assistance of TBT and PPI, SJ commenced ranging on largest ship—very difficult to distinguish from the mass of shore pips, and gave range of 2500 yards. Sounding nine fathoms. Still getting set on. Land loomed close aboard on both sides. Patrol still not overly alerted, passing about 6000 yards away, pinging loudly, outboard of us. Land background our Saving Grace. Seemed taking *single ping* fathometer readings; if those ships can get in here, so can we. Both 40mm guns are all loaded and ready with gun crews. Since it is too shallow to dive, we will have to shoot our way out if boxed in.

0355 Exec on TBT picked out three targets, and got on largest. Backed down and lay-to. Bow toed slightly out to combat the set.

0355- Fired one torpedo as a sighting-in shot to dope out current
30 using TBT bearings, range by SJ 2300 yards, gyro angle 344.30, track 90. Captain went to the bridge to get in on the fun up there. Missed to the right. Torpedo hit beach and exploded, proving there was no torpedo net.

0359 Fired one torpedo aimed at left edge of the largest target, to correct for current effect. Wake headed straight for the target.

0359- Fired another torpedo aimed same as the previous one—
22 straight as a die. Exec's keen shooting eye looked right on tonight.

0401- A tremendous beautiful explosion. A great mushroom of
05 white blinding flame shot 20-00 feet into the air. Not a sound was heard for a moment, but then a thunderous roar flattened our ears against our heads. The jackpot, and no mistake! In this shattering convulsion we had no idea how many hits we had made, but sincerely believe it was two. In the glare of the

fire, TIRANTE stood out, in her light camouflage, like a snowman in a coal pit. But, more important, silhouetted against the flame were two escort vessels, both instantly obvious as fine new frigates of the Mikura class. The Captain instinctively ordered "Right full rudder, all ahead flank", and as quickly belayed it. Steadied up to *pick off* the two frigates.

0402 Fired one torpedo at the left hand frigate, using TBT bearings and radar ranges.

0402- Fired another torpedo at the same target.
16 0403 Fired last torpedo at the right hand frigate.

0404 Not let's really get of here!

0404- One beautiful hit in the left hand frigate. The ship literally
20 exploded, her bow and stern rising out of water and the center disappearing in a sheet of fire. Must have hit her magazines. Very satisfying to watch, though not the equal of the previous explosion, of course. Possibly two hits in him.

0404- A hit on the other PF also—right amidships! No flame this
40 time, other than the explosion, but a great cloud of smoke immediately enveloped her and she disappeared. We jubilantly credit ourselves with three ships sunk with at least four, probably five, hits for six fish. Not the slightest doubt about any of the there ships. Now only one torpedo left aboard. Immediately reloaded it and reset TDC cams for our Mk 18.

The patrolling escort had now increased speed and turned toward the anchorage. Once more we pulled our trick of slipping undetected along the shore. As we left the gutted anchorage behind, a third PF could be seen standing out at slow speed. He did not, however, come out after us, but stayed, watching the fire. So we just ran down the coast of Quelpart headed for the open sea. Transmitted results of attack to submarines in area so they could avoid the certain A/S measures to come.

The large ship which exploded was, in the Commanding Officer's mind, unquestionably a heavily laden ammunition ship, or possibly a tanker loaded with aviation gas. Not much can be said about her type and size, but in the sudden glare of the explosion she appeared to be a large engines-aft vessel, of from 8000 to 10,000 tons. In the light of her own fire she was huge.

As we rounded Quelpart's southwestern tip, the glare from the anchorage could still be seen above the dark hills, and a heavy smoke cloud hung like a shroud over the entire western end of the island.

0513 Radar and sight contact with the other patrol, which we had

avoided initially. This time he was alert and we got definite SJ interference from him—10 Cm radar. Too light to evade surfaced, so dived and evaded submerged. He came over to the spot where we had dived and dropped a pattern. Many distant depth charges or bombs were heard and planes were sighted all day. This area will be hot tonight.
2043 Surfaced, following three aircraft bombs not too far away. Jap airborne radar fading.

<u>April 15, 1945</u> 1200 Posit 31-07 N 128-30 E
0228 Received orders to return to Midway for refit.
0655 Sighted Danjo Gunto, distance 20 miles.
0710 Sighted two periscopes on port bow about 2500 yards away. Avoided at full speed. Why did the Jap use two periscopes—no answer for that one. Maybe he was laying a minefield and had no torpedoes. Periscopes were raised and lowered several times.

<u>April 16, 1945</u>
0123 Passed through Nansei Shoto chain.
1027 IFF response all over the screen. Sighted 2 PBMs headed for us. Fired one mortar recognition signal followed by another. PBMs still coming in. Suddenly heard one plane say, "Look at that ship down there! Wonder if it's friendly?" Promptly opened up on VHF and set him straight. Situation eased.

<u>April 19, 1945</u>
0225L. Sighted lights on horizon. Investigated the contact, which developed into a correctly lighted hospital ship, on course 330°T at eight knots, evidently headed from Chichi Jima Retto to Honshu. Avoided.

<u>April 25, 1945</u> (plus 12 zone time)
Arrived Midway.

■

HIGH-LEVEL PERCEPTIONS AND GRASS-ROOTS EFFORTS

I have studied carefully the writings of Bud Kauderer and George Emery in the October 1994 and other **SUBMARINE REVIEWS.** I offer the following scribblings to you and to all others intensely interested in the future of submarines. I intend to *gunshot* these observations, comments and recommendations to various leaders of the Naval Submarine League for their consideration.

The submarine community is superb in analytical assessment and in strategic insight. The quality of our SLBM and attack SSN systems is accepted. Our weaknesses lie in defining the threat and in building an effective political consensus; you don't sell the steak, you must sell the sizzle.

With regard to the threat, we have limited our visions to the currently popular *forward presence* and *regional conflict*. There is no serious discussion of the current status of the Russian submarine force and its threat to *sea control* 10-20 years hence, given the current geo-political situation in Central and Eastern Europe and in the former Soviet Union. I find the CSIS study particularly deficient in this respect. Consider the following:

In 1919 Germany was defeated, disarmed and hungry. Russia was in ruin and convulsion and falling into the grip of the Communist Party. The victorious Allies had grave internal difficulties. "Peace in our time" was declared. Diplomacy, consensus and the ill-fated League of Nations were to be the tools of foreign policy rather than strong leadership, military, economic and moral strength, and common sense.

The German Fleet was sunk at Scapa Flow; her Army disbanded; her officer corps reduced to a tithe; submarines were forbidden and the German Navy reduced to a handful of ships under ten thousand tons. The British and French governments began acting ad hoc from crisis to crisis and from one election to another. The government of our United States and our people completely abdicated our leadership role in favor of the League of Nations.

Scarcely 20 years later Hitler moved into the Rhineland, Austria and Czechoslovakia. With the 1938 spectacle of Chamberlain and Munich came the greatest tragedy of our century—World

War II with its estimated fifty million deaths and inestimable destruction of national wealth and treasure. In matters naval, the Battle of the Atlantic and the Pacific campaigns are stark witness to the build-up of German and Japanese naval strength in that short interval and to their almost successful effort in wresting sea control from the Allies.

Much of the tragic-comic actions of diplomats and our political masters is being replayed in the Bosnian situation today. Incidentally, if you would like a sad, sarcastic chuckle of *here we go again*, research the Bosnia dispute of 1908 and the assassination of the Duke of Sarajevo as the triggering events of World War I—the seed corn for World War II.

The point of all this historical meandering is that the current and potential strength of the Russian submarine force and the principle of *sea control* in the early part of the on-rushing 21st century deserve far greater weight in any political-strategic risk assessment than currently being given, particularly in any long range discussion of the submarine and larger nuclear warship industrial base.

Shifting to the real world of our political masters, two recent statements need to be read and re-read, studied and re-studied, state and restated.

- "the understanding that most defense policy is made not on the basis of analytic assessments or strategic insight, but evolves from the process of building an effective political consensus" (top para., preface p. vi of CSIS study on attack SSN).
- Bud Kauderer's conclusion in his p.4 From the President in the October 1994 **SUBMARINE REVIEW**. His exhortation was "Take off the gloves, men. It's a jungle out there. The Marquis of Queensbury rules are N/A. Support your local submariner!"

Bud Kauderer is right on. But he needs help. On a short term basis people like each of us need to be contacting our federal senators and representatives to make our case. Immediate propriety should be given to those on the authorization and appropriation committees but none should be neglected in a longer range effort to build an effective political consensus for the years to come. In Southern California, for instance, Bob Dornan of the Orange County area will be a loud and influential voice on the rejuvenated House Armed Service Committee. The American Security Council's 1994 National Security Voting Index rates him at a 100 on their ten major issues. They rate eight other Southern

California representatives at 100, another at 90 (Kim), and another at 70 (Rohrabacher). With all the retired and civilian submarine community talent we have in the area, we should be able to find one leader to target each of these representatives and others for a plain old lobbying campaign. We could do the same for the Northwest. Three of us retired rear admirals made a small but significant contribution to the swing of Washington State from eight Democrats and one Republican to six Republicans and three Democrats, the largest swing in the country. My goal was to UNSEAT UNSOELD. We did. Skip Leuschner, a former carrier skipper, spent the last two years on the Internet organizing opposition to Tom Foley. The papers are giving him credit for being a major voice in Foley's defeat. Skip is not in Foley's Congressional District.

The harsh truth is that most of us dislike becoming involved in the messiness of the political process. But it is absolutely essential to build an effective political consensus for the submarine and larger nuclear warship industrial base argument. California representatives, in particular, should be sensitive to the industrial base argument.

Warm regards,
Jack Barrett
RADM, USN(Ret.)

REQUEST FOR INFORMATION RE: EARLY SUBMARINE ASW

I am a submarine officer and Submarine League member currently serving as a Federal Executive Fellow at the Hoover Institution and working on a research project on conceptual-/doctrinal innovation in the U.S. military. One of the case studies is the development of ASW capabilities by the U.S. Submarine Force during the period 1945-1969. I have reviewed records held by COMSUBDEVRON TWELVE (formerly COMSUBDEVGRU TWO) and interviewed a few submariner officers involved in the early days of submarine ASW. Please contact me if you have unclassified documents, know the whereabouts of unclassified documents, have a story to tell, can recommend people to interview, or can help in any way concerning the following:

- How the Submarine Force initially became involved in ASW
- Design and operation of SSKs (K1 class)
- Design and operation of fleet Guppy conversion to SSK role
- ASW operations by early SSNs
- Development of early submarine sonars through BQQ-2
- Early development of ASW tactics
- Early submarine quieting programs.

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