THE SUBMARINE REVIEW

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EDITOR'S COMMENTS

In this issue of The Submarine Review we are fortunate to have a broad sampling of policy views, mission assessments, determinants of design, footnotes to history, and personal submariner views of the war on drugs and the war in the Gulf.

Policy level perspectives on the future of American submarining are given from the current leadership of the Navy, the Submarine Force and the submarine staff in the Pentagon. The Secretary, COMSUBLANT, and the CNO's Director of Submarine Warfare each offer a special view of where we stand, where we are headed, and what we have to do to get there.

There are three other features included in what could be called a *high level* section of this issue of the Review. The first is the condensation of a report by one of the country's premiere national security think tanks, The Center for Strategic and International Studies, on the future of attack submarines. It is recommended for all. The second is a look at some design decision considerations as they appear to one eminent submarine builder. The third is a brief reminder of the importance of arctic operations, from the man whom most of us know as the intellectual force behind the Submarine Force efforts under the ice on a number of memorable occasions.

The mix of articles should be diverse enough for most tastes within the submarine community. It is recognized that there is no World War II piece among that rich assortment, but that omission is more than compensated for by the account of TANG's first patrol in January and February just 50 years ago. There is also the start of a brand new set of war stories, however, with one skipper's note from Desert Storm.

There seems to have grown up over the years a certain question about why the U. S. and the Soviet Union differed in the basic design of submarines. In America, there has been a concentration on single hulls and in Russia they have stayed with double hulls as a normal practice. Hopefully, the article reprinted from Morskoy Sbornik will provide some answers.

The Submarine Bibliography enters a new phase in this issue with the first of two listings of submarine-related articles that have appeared in the Naval Institute Proceedings in almost one hundred years of American submarining. The listing is by date of appearance. The challenge is to go over the list of authors to see

how many one can recognize; and identify their association with submarines. (Hint #1—At least one British Admiral is included. Hint #2—The first Commanding Officer of SNAPPER (C-5), or SS-16, is also on the list.) This first installment of Proceedings articles goes up to the early 50s. The age introduced by NAUTILUS will be covered in the April issue.

Since it has already been admitted that there is no feature article in this issue about the *big war* sailors, the Review may be excused if it recommends to all the letter about the preservation of COD in Cleveland, Ohio. We all owe a debt to those individuals and groups who have worked so hard to preserve submarine history, in all its fascination, for everyone to see and enjoy and take pride in.

Jim Hay

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FROM THE PRESIDENT

As this volume goes to press, the New Attack Submarine will be presented to the Defense Acquisition Board for a Milestone One decision. It would be appropriate to describe this event as a *critical juncture* for the program. On the other hand, it seems that every milestone is *critical* for this program. Once again, roles, missions, operational effectiveness, costs, and other factors such as industrial base considerations will be reviewed with the intent, this time, to obtain a *blessing* to go forward into preliminary design. It is not unlike waiting for the faculty advisor to approve your hypothesis for a doctoral thesis so you can finally get on with the real work.

We are well into planning for the classified May 1994 Submarine Technology Symposium, jointly sponsored with The Johns Hopkins University Applied Physics Laboratory, our seventh such event. This symposium will focus on the technologies that would enhance the performance of submarines in the transition to littoral warfare. The five half-day technical sessions will be chaired by Dr. Ron Clark, Director of Technology Applications, Lockheed Missiles and Space Company; Dr. Tom Clare, Executive Director, Naval Surface Warfare Center; Mr. Dick Shearer, Technical Director, Naval Command, Control, and Ocean Surveillance Center; Ms. Irina Vainshtein, Supervisor of Advanced Programs,

Loral Librascope Corporation; and Dr. Dave Kalbaugh, Supervisor, Missiles and Air Systems Branch, The Johns Hopkins University Applied Physics Laboratory. The Program Chairman is Mr. Dave Restione, also of the Laboratory. We are hopeful of another success.

The League's annual June Symposium is also taking shape with many Navy and Submarine Force leaders already committed to the agenda. We are planning several new events for the program which we think you will find both informative and enjoyable. Come join us 15-16 June 1994 in Alexandria, VA for a very special opportunity to learn about the issues facing your Submarine Force, and to reunite with old friends and shipmates.

The staff is also busy with planning for the annual Corporate Benefactors meetings early in the new year. We bring in the CEOs for classified briefings on the status of the Force and submarine programs. To the industry leaders who are not yet Corporate Benefactors, we encourage your participation.

Total membership continues its *zero float* at about 4050. If we are to maintain our vitality and continue our work in support of submarines, now and future, our membership must increase in numbers and must spread across a wider spectrum of the populace. The most successful membership programs are those based on personal contact between current members and their families, friends, and business associates. Recruiting new members requires only a bit of time and some salesmanship. An *all hands* effort could easily double or triple our number within a year. It marketing fails, there is always the gift membership!

Hope to see you in June!

Bud Kauderer

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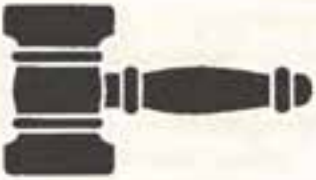

STRATEGIC PREREQUISITES AND THE BOTTOM-UP REVIEW

Remarks delivered by
The Honorable John H. Dalton
Secretary of the Navy
at the NSIA Submarine Seminar
New London, CT
22 September 1993

Thank you all for the warm welcome to New London. I am very glad to have the honor of being a part of your annual Submarine Seminar. This is my first New England clambake. However, as a Southerner I must point out that most New Englanders have never quite got the hang of catfish and hush puppies.

Now, the main reason I'm pleased I could escape Washington and be here with you today is that I recognize how crucial the products and skills of the members of the National Security Industrial Association are to the United States Navy. The submarine, the most revolutionary naval weapon developed and perfected in this century was not developed by the Navy. It was developed by private industry. It was perfected by a cooperative, productive partnership between the Navy and private industry.

As a former submariner and private businessman now in government, I really like the image of this partnership. And I know this partnership is vital for the health of the Navy. Without the ship construction, systems engineering, and other materials and services you provide, there would be no fleet. On the other hand, I know that the financial well-being of your companies are intimately linked to the Navy's plans for the future. As Secretary, and as a citizen who is very concerned about the economic well-being of our country and its businesses, this situation is not something I take lightly.

Because I take our partnership seriously, I would like to share with you my thoughts concerning future plans and priorities for the Navy. You have heard or will be hearing from the very architects of our submarine plans, such as Rear Admirals Tom Ryan, Bill Houley, Frank Lacroix, and Rear Admiral(sel) Rick Buchanan, and our type commanders and operators, such as Vice Admiral George Emery, and Rear Admiral Mike Barr. Rather than repeat their *thunder from below*, my remarks will be broader.

First, I'll discuss my view of naval power today, along with my priorities for the process of down-sizing—or rather, what I view as *right sizing*. And I will say this up front: I **am committed** to achieving the capabilities necessary for our ...From the Sea strategy. Submarines play a significant role in this strategy. I know that you recognize this. Indeed, it is the very theme of your seminar.

Second, I will touch briefly on some of the conclusions of the Department of Defense Bottom-Up Review. Again, I must tell you up front that I think the Bottom-Up Review is one of the early success stories of President Clinton's administration. The President directed Secretary Aspin to conduct a thorough, *nothing sacred*, start-from-scratch, zero based, bottom-up review of our defense plans—exactly what we needed to do after the collapse of the Soviet threat. As we develop a defense budget, sized for the post-Cold War threats that we face, the Bottom-up Review will be the reference from which we will be building our force structure.

Today, the United States Navy is not just the world's most powerful—it is, in a sense, the only **global** Navy. Yes, other nations possess respectable maritime capability and many are expanding and getting better everyday. But no other nation can deploy sizable task groups from home waters and project power ashore in a sustained, concentrated fashion. No other nation can fire a simultaneous salvo of land-attack missiles from three different seas—from both surface ships and submarines—and strike targets precise enough to avoid significant collateral damage. I know many of your members played a role in creating these capabilities.

With other navies pretty much obsolete as contenders for seapower—our focus has changed. The Soviet replacement, the Russian Navy, appears currently unable to deploy relatively few ships. And even if it is successful in re-acquiring all of the Black Seas fleet, the Russian Navy would be hard pressed to challenge Western command of the seas far into the future. They are still building submarines—and we will keep our eyes on that—but with the decline of communist ideology and collapse of its overseas influence, there would appear little reason for attempting such a challenge. There's just no threat in the open ocean anymore.

The absence of an ocean-going threat means two things: one, we can maintain mastery of the seas with a smaller fleet; and two, we can concentrate on the missions of forward presence and power

projection in the turbulent regions that concern us without tailoring our responses to the reaction of another military superpower. The result is a superiority at sea that allows us to use naval capabilities to their fullest extent to influence events on land. This is the premise behind our ...From the Sea strategy.

What sort of events are we talking about? Deterring Sadam Hussein from further misadventure is one. Defeating terrorists is another. Supporting United Nations efforts to bring peace and human relief in Somalia and the former Yugoslavia is a third. Helping to maintain the new peace in the Middle East is an important one.

I don't pretend to be a great strategist. I'm a businessman, although one whose education is strongly rooted in the naval tradition. I know the Navy from the deckplates as a division officer in charge of sailors. But, without having to reserve the bulk of our forces for preventing possible superpower confrontation, it seems to me that as a nation we need to make the best use of our precious resources—the tax dollars you and I contribute—yet without sacrificing the superiority we have at sea. And that is a challenge.

To accomplish this we need to do three things: maintain the quality of our people; reduce our infrastructure; and replace decommissioned ships with fewer, but much more capable vessels. Such is indeed our plan.

I am dedicated to maintaining the quality of sailors and Marines currently serving, even at reduced numbers. I recently visited the fleets on our three coasts and let me tell you, our sailors and Marines are the finest, most highly trained, most professional we have ever had. President Clinton told me when he offered me this job that we had the *finest Navy and Marine Corps in our country's history in quality of people*. I knew he was right then, but having gone and seen them in operation, I am more than convinced—I am proud as an American, and as a taxpayer, I know that what we invested in people has paid unbelievable dividends. I am proud to be their Secretary.

We will continue to invest in people. We will be shrinking the overall number of personnel to balance the reduced size of our fleet. But President Clinton and I are dedicated to ensuring that there will not be a *hollow force*. The personnel we retain—and these will be smart, dedicated, career personnel—will remain superbly trained and well supplied.

Our second objective of reducing infrastructure is necessary in order to streamline overhead and reduce overall costs. It makes no sense to operate a base and depot infrastructure designed for a 600 to 800 ship Navy when we have a much smaller fleet. We cannot afford it and maintain the current level of readiness of our operating force.

Our efforts in this regard are spearheaded by the Base Realignment and Closures Commission, otherwise known as the BRAC Commission. My perception of the BRAC is that it is fair—and it is the mechanism that Congress wanted. I know the BRAC can seem pretty fearsome to any community hosting a military installation. I will admit that, as a process, it may not be a thing of great beauty. But I do believe that it is a means by which everyone, both the Navy and the affected communities, can have their day in court. Like Winston Churchill said about democracy, BRAC is the worst system except for all others.

Our third commitment is to maintaining our technological advantage. By replacing older ships and aircraft with much more capable platforms—stealthier, more reliable and armed with precision weapons—we will retain our margin of superiority at sea into the future. This will be done through a continued investment in, and encouragement of, new technologies. Although the fleet will be smaller in size, it will be more capable overall. As Deputy Secretary of Defense Dr. Bill Perry said in a recent speech, we will be focussing on maintaining *an unfair competitive advantage* over all potentially hostile opponents.

To maintain this *unfair competitive advantage*, we are improving our land attack capabilities, such as the Tomahawk missile, by increasing our targeting precision. We are expanding our AEGIS weapons system so it can provide an area defense against attack by ballistic missiles, such as the SCUD. We will be upgrading our strike aircraft from the F/A-18C/D to the F/A-18E/F, and enhancing the attack capabilities of the F-14. Of particular note is that we are cost-consciously building new capabilities into existing weapons systems. Along with such quality enhancements, we are working jointly with the Air Force on the Joint Advanced Strike Technology Program for next generation aircraft. And we will pursue the New Attack Submarine Program. The fleet will be smaller, but stronger, and with greater reach.

The point is not to down-size for its own sake. What we are

doing is *right-sizing*. We are sizing our forces to the threat. We are shaping our forces to support the National Military Strategy and the Navy's ...From the Sea concept. We are also committed to jointness throughout our programming efforts. We are not simply operating our ships and aircraft in full integration with our sister Services; we are designing our weapons systems so that they have joint capabilities and provide unique advantages to our unified commands. Exercises like Tandem Thrust and Ocean Venture give us the training required to build the potential of Maritime Joint Task Forces.

The role of the submarine has long been closely linked to combatting the Soviet threat. But this role has changed and will continue to change in order to bring our new concepts into operation. It is important for us to articulate how submarines are critical to our new emphasis on power projection from the sea. We need to continue to refine our public message concerning the unique **joint** capabilities submarines bring to the unified commander even when there are no enemy fleets to fight. You and I know the reasons, but the big attention-getter is the overall cost of submarine construction. We need to educate the public on those joint capabilities and drive down the costs if we want a balanced sub force.

I view the role of submarines in our ...From the Sea vision as both **elements of**, and **prerequisites for**, the strategy. What I mean by prerequisite is that without a modern, capable Submarine Force we cannot even start the power projection mission as envisioned. The first prerequisite is, of course, **strategic deterrence**. SSBNs will have the prime role in this **joint** mission. The second prerequisite is **command of the sea**; our attack subs play the major role.

The *element of* portion consists of new roles and operations, such as described in the brief this morning by Commander Gove and Commander Lenci. When I was first briefed on the Battle Group operations conducted by HOUSTON and LOUISVILLE, I was amazed by the changes that have happened since my days in the Submarine Force—changes much for the better. When I served in submarines I think the only conversations I ever had with surface warfare officers were conducted in the O Club.

Now, I may be preaching to the choir on this. But I'm not always facing the submarine choir. My challenge—and one I'm hoping your association will help me with—is to articulate the

specific joint missions that submarines can **optimally** perform to accomplish the ...From the Sea presence and power projection missions. Such roles as intelligence and warning, strike, interdiction, local sea control, and dealing with the mine and diesel sub threats are what we are looking at for the New Attack Submarine Program that Rear Admiral Dugan Shipway will discuss. These are the roles I hope you will ponder throughout this seminar. I know these roles were recognized in developing the Bottom Up Review—but we're going to need the help of the NSIA and other experts in sustaining the argument outside the Department of Defense.

Many say that the Navy *made out well* in the Bottom-Up Review since Secretary Aspin came to the right conclusion on carriers, attack submarines, ships, and the size of the Marine Corps. The Bottom-Up Review concluded that the nation needs a modern, highly capable Submarine Force. Specifically, it was agreed that we would maintain a force level of 45-55 attack submarines and would preserve our submarine industrial base with slow, long term production. Meanwhile, strategic forces will be addressed in a follow-up review, with the exact number of Trident submarines to be determined—hopefully around 18.

Well, I don't agree that there are *winners* and *losers* in the Bottom-Up Review; I think our country was well served overall. But let me tell you—although the Department of the Navy's force structure proposals were accepted in this joint process, we still need bold ideas that clarify how the Submarine Force fits best in the changes in defense requirements and the new realities of the world. Also, how it delivers a payoff in joint operations and true value to the taxpayer. And that's what I intend to focus on during my tenure as Secretary—providing true value in a quality defense from the sea.

As to the prerequisites for our strategy, I know that the importance of the Submarine Force to our nation is at least as great today as it has ever been since the Second World War. I was reminded by Rear Admiral Larry Marsh before I came up here today that 1993 is the 50th anniversary of our first real successes in the submarine campaign against Japan—our legacy as submariners. The role of subs through the Cold War was recently recognized by Chairman Powell at a ceremony in Kings Bay, GA for the 3000th SSBN patrol. He said: No one—No one has done more to prevent conflict—no one made a greater sacrifice for the

cause of peace—than you, America's proud submarine family. You stand tall among all our heroes of the Cold War.

Well, we need to articulate why submarines stand tall among the forces necessary for the post-Cold War world. We need some revolutionary thinking. And we need to do it in partnership with those who invented the submarine—private industry. I know such thinking is the whole purpose of this seminar. I hope you generate many new thoughts. I'll be waiting to hear them.

Thank you for inviting me to your discussions and for the opportunity to give you a bit of a call to action. God bless you and our Submarine Force. And God bless America. ■

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A PLAN FOR THE NEAR FUTURE

Remarks delivered by
VADM George W. Emery, USN
Commander Submarine Force
U.S. Atlantic Fleet
at the NSIA Submarine Seminar
New London, CT
22 September 1993

I would like to start today's presentations with a few remarks, in my role as the submarine community sponsor and primary spokesman, on my view of what the Submarine Force needs to do, and organizations such as NSIA, need to do in this post-Cold War era. This will not be a running status report of the Atlantic Fleet Submarine Force. This will be a description of what I hope we all may accomplish over the next couple of years.

Secretary Aspin, at a 2 September press conference in which he reported the results of the Bottom-Up Review, described the dangers that the United States faces in the post-Soviet Union world. Our defense policy will focus on four main dangers to our security:

- The spread of nuclear, chemical and biological weapons of mass destruction
- Regional conflict—there are a number of regional *bad guys* that can threaten our interests
- The failure of democracy in the developing world, where reversals in the tenuous movement towards democracy in a number of countries could change our national security situation
- A weak economy—in the short term, our security is protected by a strong military, but in the long run, the country's national security is best protected by a strong economy.

Everything in the Bottom-Up Review had to relate to these four dangers, and they will continue to influence the size and shape of our military forces in the years to come.

The Bottom-up Review recommends a force size of 45-55 attack submarines and 18 Trident SSBNs, but these numbers are not cast in stone. They will continue to be reviewed in the future

and could go lower, especially under severe budget pressures. The question of how many submarines we need is a very complex one, dependent on many diverse factors, such as warfighting requirements, forward presence, and shipbuilding requirements to name a few. There are no simple answers. As taxpayers, we clearly don't want to buy any more defense than we really need. But what we must avoid are inappropriate reductions in our force structure due to a perception that submarines have no mission and are not needed in this post-Cold War environment. Too low a force level could leave us unable to meet our future national security requirements in a rapidly changing and unpredictable world.

Can we in the fleet actually influence the decisions on how many submarines are needed in the future? I believe the answer to this question is an emphatic yes! If we're going to remain an effective force in terms of resources and size, we must continue to be **indispensable** to the Navy leadership. And in addition to the Navy leadership, our leaders in the administration, the Joint Staff, and the Congress, must understand how the Submarine Force contributes to our security. They must understand that submarines are an **essential** part of our maritime forces, and that it's worth the expense to own, operate and maintain them. And, of course, we must have the support of the American people. So, how can we get this message across?

I believe that a key part of keeping strong support for submarines lies in how we operate with the various joint and Navy task groups, now and in the future. The requirements for the size and the employment of our forces are specified by the Joint Staff, which received inputs from the services and the unified CINCs, who in turn receive inputs from the fleet CINCs and so on down the chain of command. At the most elemental level, it is the task group commanders—carrier groups, amphibious ready groups, maritime action groups, counter-drug operations groups, joint action groups, etc.—who will define the number of submarines in the future Navy. Because of their ability to influence the requirements process, it is these *officers in tactical command* whose support is critical to our long term future. And to get their support, we need to be **indispensable** to them as integral parts of their task groups and be key players in their ability to execute the Navy's ...*From the Sea* concept.

How can the Submarine Force contribute **more** to the Navy's

...*From the Sea* strategy? We must **expand** our contributions in the joint arena, and with naval task groups. And we must continue to **expand** our roles and missions in yet to be imagined areas where the **unique** qualities of submarines can help ensure the effectiveness of the Navy's contribution to the nation's security. When I relieved Hank Chiles I said I was committed to a Submarine Force whose watch word is **versatility**, and whose contribution to the nation's defense is second to none. I still am. These are the key precepts for how I want the Submarine Force to run.

- Our strategic submarines must be the **indispensable** cornerstone of our deterrent forces. The historical reliability, effectiveness, and survivability of the SSBN system must not be degraded. Any changes in that system that could impact on proven SSBN capability must be brought to the appropriate level of authority for review and approval. Our nation is proceeding on a path which leads to **increased reliance** on our invulnerable seabased leg of the triad. Our SSBNs will carry more of the day-to-day deterrence responsibility as we reduce our land based missiles and strategic bomber forces. All this while the original *41 for Freedom* rapidly becomes an 18 Trident force. We're putting more of our eggs in fewer baskets, so we must ensure that these baskets remain secure and reliable. Although I agree that the world situation now is much different than during the Cold War, in the area of strategic deterrence there has been **no major change** in the nature of our mission—we still need to keep our SSBNs at sea, survivable, undetected, and ready to respond on a moment's notice, just as we have done so well for over three decades.

- As I indicated a moment ago, our attack submarines must be **integral** elements of Navy and joint task groups; **full members** of the team. We must continue to evolve in our operations with the battle group until we are **completely and seamlessly integrated, indispensable** and **inseparable**. We want the entire chain of command from the President down to the battle group commanders to ask "Where are the submarines?" when a crisis emerges. To make this happen, we need to make it easier for task groups to operate with submarines by eliminating the feeling among some task

group commanders and staffs that working with submarines is *too hard* and *not worth the effort*.

- We must be proficient and flawless at strike warfare. I know it's complex with all the variants of missiles on our submarines today, each with its own limitations. But each commanding officer and strike-capable SSN crew must be ready to launch a strike whenever tasked, and completely understand the capabilities of each missile and its applicability to potential missions and targets. Submarines must be interchangeable with surface ships for missions in which the launch platform type is not critical, and we must have lots of striking punch when a covert launch platform is necessary.

- We want to be known as the Force that cooperates with the rest of the Navy and helps guide the way to get the job done. In general, we will say *yes!* to each opportunity to contribute to joint operations and operations with other Navy organizations. If there is a need for a submarine somewhere, we'll do our darndest to fill that need.

- The missions that our submarines perform today are much more complex and diverse than in the past. In order to be at maximum readiness for deployments with the battle groups and our most demanding surveillance missions, it takes a **dedicated, tailored** pre-deployment training period. While every submarine must be proficient in the core capabilities of basic submarining and firing torpedoes and missiles, there is room for **selective** employment such as surveillance, CVBG operations, mining, and special warfare.

- And of course, all the fancy hardware and advanced technology are nothing without the right people manning our ships, shore stations, and supporting organizations. We must take care of our people. The fastest way to become a *hollow* force is to neglect our sailors. Our task is to ensure we have the motivated and superbly trained personnel we need to man our ships and shore facilities. This could be our biggest challenge as the Navy is downsized consistent

with perceived national defense needs.

So, what are we doing to move in the direction I've just described?

- We're looking at our operating schedules for opportunities to increase our operations with task groups. In some cases we don't have to look far because task group commanders are asking us for increased submarine involvement. If there is a choice between conducting underway operations that are strictly submarine related or operating with a joint or surface task group, we're trying very hard to make sure that we give precedence to operations with the most benefit to the Navy as a whole.

- We're changing the *Support Submarine Manual* to streamline the process of operating submarines with the rest of the task groups. We want the task group commander to feel a sense of *ownership* of his submarines, and we want to give him more tactical freedom and control. We want to make it easier for the task group commanders to operate with submarines. And we want to keep the submarines with the task groups as much as possible rather than splitting off for other independent operations.

- We want to increase the flexibility of the fleet commanders by increasing the amount of firepower we bring to the theater and by improving our strike warfare capability. We're working on a plan to accelerate the deployment of the Tomahawk block III GPS missile on submarines by early next year. We're also working to simplify the Tomahawk mission planning process so that submarine missions and surface missions are interchangeable. The biggest step in this process is to replace all partially fueled Tomahawks missiles with fully fueled missiles. This process is currently in progress but will take a couple of years to complete.

- We've written a new pre-overseas movement (POM) instruction specifically tailored for our most demanding surveillance missions with more specialized training and

workup guidance to help the squadron and the commanding officer better prepare for deployment. We're also revising the old POM instruction to include updated specific information for each type of deployment such as with the battle groups, counter-drug operations, arctic operations, and open ocean ASW operations. This revision should be on the street by next month.

- We are tailoring our tactical readiness evaluations, as well as POM workups and certifications, to the ship's intended deployment schedule and anticipated operations. By focusing our efforts to maximize the ship's proficiency for operations expected in the relatively near term, we should improve their overall deployed readiness.

What I've just described is what forces afloat are doing to get closer to our task group commanders and focus our efforts to get the best possible results with our deployed ships. There are also ways in which our supporting organizations can help. Clearly the area in which you in the NSIA, and your parent companies and organizations, can contribute most effectively is in figuring how to meet our needs through new technology. There are a few areas that I want to cover specifically today because I feel that they are among our most pressing needs in the Submarine Force.

- Leading the list is communications. We won't be able to accomplish our missions and operate with other forces unless we can talk with them—effortlessly and frequently—not only with the Navy task groups but also with joint organizations like the Army and Air Force, and with our Allies. The way we communicate now is perhaps the biggest paradigm shift for us since the days when our focus was on independent operations under radio silence. Today we deploy each submarine with all the communications gear we think they'll need—an alphabet soup of acronyms like BGIXS, OCTIXS, DAMA, JOTS II, TADIX-A, and ELF. We've made big progress in the area of communications over the last two years, but the future is clearly going to be a challenge as the rest of the Navy and joint forces move to SHF and higher data rates. **We need to be compatible!** I know that many of you in the NSIA have been working on

the submarine communications study to help develop a blueprint for where we need to go in the future. I cannot over emphasize how important this work is. We really appreciate your hard work and innovative ideas.

- We need a torpedo that performs reliably and predictably in shallow water. Operating in the littoral regions, in shallow water and with a growing number of Third World nations with modern diesel submarines, is clearly a big challenge to our capabilities. We're working hard to improve the software for the Mk 48 advanced capability torpedo for improved performance in this environment. And we're working to develop a shallow water fleet training range where we can train our Air, Surface, and Submarine Forces, and test our systems in that environment.

- Better mine detection and avoidance systems are clearly areas where we need new hardware and software to enhance the submarines' capability in littoral warfare. I've said this before and I'll say it again. There is no current system I know of capable of mapping a minefield and providing that information to the amphibious task force commander. **We need one!**

- Strike warfare is one of the theater CINC's biggest concerns for contingency planning and regional conflicts. We need simpler and faster methods to retarget our Tomahawk cruise missile strikes, and we need the ability to make more missiles available to the theater CINC on fewer platforms. Last week I listened to a presentation by one of our submarine shipbuilding companies on a concept to put up to 100 cruise missiles on a first flight Los Angeles Class attack submarine. We need this kind of innovation and I commend their efforts.

- The demand for tactical imagery is escalating daily—everything from exchanging photos of arms smugglers, to providing near-real time intelligence for special operations missions and strike mission planning, to teleconferencing between key members of forces afloat and shore command centers. The Submarine Force needs to progress

in step with the rest of the Navy and other joint forces in its ability to share imagery.

- The question is not "Do we need these innovations?"; the question is "Can we afford them?" There is a limited amount of money available to solve our problems, and it's getting smaller all the time. We've got to make submarines affordable to build, operate and maintain or they will not be resourced.

I'd like to close with the following points:

- Submarine roles and missions are expanding at the same time that the force is becoming smaller. That means in the future we'll be spread more thinly around the globe, and each submarine we have will need to be more versatile and more capable. The challenge is to do more with less. We must continue to be proactive and explore every area where submarines have a substantial capability to contribute to the Navy's missions. Our future will be determined by our value in meeting the defense needs of the country, not simply to preserve submarines or the industrial base for their own sake.

- The United States must maintain technological superiority over all potential adversaries. Organizations such as the NSIA play a key role in keeping us in that position. Your challenge is to find innovative ways to exploit technology to help us, while keeping a sharp eye on costs to keep them affordable. I look forward to your ideas and suggestions on how to make a better Submarine Force and a better Navy.

Thank you. ■

VIEW FROM THE PENTAGON

Remarks by RADM Thomas D. Ryan, USN
at the Capital Chapter, NSL Luncheon
Arlington, VA
30 November 1993

Ladies and gentlemen, good afternoon. It is a pleasure and an honor for me to have this opportunity to address you today. I congratulate the youngest chapter of the Naval Submarine League on making it through their second successful year.

Today, I want to touch on a number of issues that we in the Submarine Force are facing. As I am sure most of you are aware, the Secretary of Defense released the long awaited Bottom-Up Review in October. The most significant impact for the Submarine Force was the Department of Defense official acknowledgement of the critical need for maintaining the submarine industrial base. Recognizing the fact that the 688I line has been shut down and that significant sunk costs from SSN 21 and 22 have already been incurred, the Bottom-Up Review acknowledged that building SSN 23 in fiscal year 1996 is the least costly alternative to maintain the industrial base in the near term. Additionally, it recognized the need to begin construction on the new attack submarine in fiscal year 1998 and maintain a building rate thereafter in order to preserve a long term goal of 45-55 attack submarines.

The Navy and Marine Corps white paper ...*From the Sea* together with the Bottom-Up Review results describes a fundamental change in naval warfighting strategy. It signals a shift from open ocean warfighting **on** the sea to joint operations projecting power ashore **from** the sea. Naval forces will focus on responding to regional crises and will provide the *enabling* capability for joint operations, as well as participation in sustained efforts ashore.

Submarines have an important role in this new strategy and the new attack submarine will be specifically designed to incorporate the flexibility required for a world where the unknown is the rule and not the exception. The inherent characteristics of the nuclear attack submarine—stealth, mobility, and endurance—play as well, perhaps better, in the ...*From the Sea* strategy and in the new scenarios in the littoral as they did in the past.

There have been several wargames, seminars, and innumerable discussions centered around this new strategy over the past year. Through the course of those, several missions have been carved out for submarines. It is important to note that these are not necessarily submarine unique missions. There are other platforms and systems which can do all or part of each. But they are missions which the Submarine Force can do all or part of better and more effectively than any other system. They are missions for which the design of the new attack submarine will be optimized.

These four missions are: covert intelligence collection, covert mine detection, covert insertion of special forces and their support, and anti-submarine warfare focussed on diesels operating in the littoral. There are, of course, other missions for submarines, which they will continue to do very well. But these four missions which our force of the future, and in particular the new attack submarine, will be focussed. I'd like to spend the next few minutes describing each mission and how the Submarine Force intends to focus on them with the new attack submarine.

Consider covert intelligence collection and surveillance. In the opening stages of a regional conflict, the Submarine Force will be one of, and most likely, the first U.S force on the scene. The submarine will covertly surveil coastal defense systems, air defense systems, and determine command and control circuits and procedures. It can observe and locate minelaying operations, and shadow submarines to identify enemy patrol areas. The submarine can also surveil the coast to identify potential landing sites.

All of this covertly, avoiding adding fuel to a political confrontation and, perhaps more importantly, providing the opportunity to observe the activity of enemies when they are most unguarded and acting most like they would during actual conflict. All of this provides the joint commander with the knowledge necessary to define the battlefield as he prepares other forces to enter the littoral. This is particularly important as we consider potential conflict with Third World nations on whom intelligence collection may not have been focussed in the past and on whom there is only limited information available as a crisis arise.

Much of the surveillance mission fits well with systems we have had in the force for years. However, we are working for improvement where appropriate, particularly in optimizing the new attack submarine's capabilities for this mission including improvement in the new attack submarine's ability to communicate with

the battle group. One innovative concept is to equip the new attack submarine with a stealthy sail which would house a large SHF antenna. By designing a sail with a very low radar cross section, the submarine could broach and have a vastly improved high volume two way data flow, including imagery.

A second mission for the future is covert mine detection. Covertly is key because it precludes an enemy from acknowledge of planned amphibious landing sites or the need to reseed an already planted minefield. Additionally, it precludes the need to place vulnerable mine forces at risk within the range of coastal defense systems. Mines will be one of our biggest problems as we attempt to conduct naval warfare in the littoral. The joint task force commander will be reluctant to commit either an aircraft carrier preparing to conduct strikes inland or an amphibious force preparing to land as long as there is the threat of unknown or uncharted minefields. The submarine can make a significant contribution to safe operations in the littoral, arriving early to observe mining operations and equipped with an UUV to covertly map a minefield which then can be avoided or, if necessary, neutralized—without warning an enemy of your knowledge of his minefields.

The most significant new system for mine detection is the Submarine Offboard Mine Search System, an unmanned underwater vehicle. It will be able to be deployed from the torpedo tube of any submarine and to operate several miles from the ship on a fiber optic cable, surveying for mines both on the bottom and in the water column. Thus a minefield could be surveyed completely without the submarine having to enter the field and allowing the optimum use of mine counter measure forces to establish a route through a chokepoint, or sweep a minefield just prior to an amphibious operation with a greater certainty that all mine threats are cleared. Development of this system is proceeding, and it will arrive in the fleet at about the same time as the new attack submarine.

The BSY-1 sonar system installed on our newest SSNs includes a good mine detection sonar and we are continuing to push forward with the improvements for hull mounted mine detection sonars. These include the Advanced Mine Detection System for the new attack submarine and a backfit system, EXUS, for non-BSY-1 688s. These improved systems will provide a mine detection capability in the event ships find themselves in a

minefield and need to work their way out.

A third mission is covert support for special operations forces. Submarines have a long history of working with special forces, including World War II, Korea, and Vietnam. This mission is increasingly important as we look to regional conflicts in the future. The submarine can receive special forces at sea and deliver them to the coast covertly. And it can remain in the area undetected providing logistics and communication support, and potentially, fire support.

Special forces are not limited to Navy Seals. It includes Army Rangers, Marine Recon teams, or Delta Force. It can mean small groups or up to a few hundred. Launch can be underwater remaining totally covert or for large groups, the ship can broach and deliver them in a short time—another requirement for a stealthy sail.

You are all aware of our current dry deck shelter capability for Seals. We are working to ensure that we retain that capability into the 21st century after the presently converted SSBNs and 637s are retired. We are also working to develop other delivery methods. The Seals are developing a minisub, the Advanced Swimmer Deliver System, whose home will be a specially equipped submarine and whose pilot will be a submarine officer. The third Seawolf will be built with an enhanced SOF capability, including an internal lockin-lockout chamber and a reconfigurable torpedo room to support SOF forces, a capability we will likely backfit to the two initial Seawolfs. The new attack submarine will be designed from the start to maximize SOF capabilities. It will be DDS capable and have a lockin-lockout capability and a reconfigurable torpedo room. Some number of new attack submarines may be built to provide for the accommodation of large numbers of SOF forces, perhaps as many as 200. The new attack submarine will be built for shallow water operations, with the ability to bottom in many littoral areas. As I previously mentioned, its profile will be designed to minimize detection during broached operations when launching SOF forces or receiving large band width communications. The communications capability will allow it to serve as a command center for SOF forces while lying off shore, undetected and immune to coastal defense forces.

The last mission of the four, ASW, is perhaps the most familiar. But, in this case, ASW against diesels in coastal waters. More and more Third World nations are acquiring diesel subma-

rines since they are a high threat-to-cost platform against surface forces. The joint commander must know where those submarines are or, ideally, that they are destroyed. The Submarine Force can accomplish this mission, and at least for the near term, with much less risk than anti-submarine warfare against high tech nuclear submarines.

Most Third World submarines train almost exclusively in ASUW. Many don't have an ASW weapon and have little or no training against other diesel submarines, much less modern nuclear attack submarines. For these reasons and their inherent stealth, our nuclear submarines are the ideal platforms to locate, shadow, and, if necessary, destroy diesel submarines in their home waters. The submarine's relative immunity allows for patient search, localization and attack, without the expenditure of large quantities of ASW weapons on non-targets.

We have several programs designed to improve our ability against diesels in shallow water. The first is, of course, optimizing the new submarine for the littoral with the necessary quieting, speed and shiphandling characteristics. We are working on modifications to the ADCAP torpedo to improve its capability in shallow water. Several new sonar systems will come on line in the next few years which I believe will significantly improve our ability to detect and quickly target diesels in coastal waters. These included the QE2, TB-29 towed array, and the wide aperture array and the best of these will be in the new attack submarine.

I have described four key mission areas for the Submarine Force and the systems which support those areas. Let me briefly also mention one other area which is still evolving but which I believe will take on increasing importance. That is strike warfare and, in particular, the enabling strike. The requirements for anti-ballistic missile defense and ship self defense are taking an increasingly large number of the launcher holes on our surface ships. This means that the share of strike weapons carried by submarines will increase in the future providing a larger share in strike warfare. Additionally, one of the critical parts of any strike is the initial disabling of air and coastal defenses to improve the survivability of strike missiles and aircraft launches from further out to sea. This can best be accomplished by a missile launch from submarines lying close to shore, which significantly reduces a defender's reaction time.

We continue to improve our strike capability. TLAM Block III

is in the fleet and more VLS platforms are coming. TLAM Block IV, with a penetrating warhead and a man in the loop feature to improve strike efficiency and accuracy, will reduce collateral damage. This increased emphasis on strike has led me to the decision to include 12 VLS launchers in the new attack submarine while investigating the feasibility of expanding to 20. Also, we are looking at the need to build a *strike* enhanced version of the new attack submarine.

What conclusions should be drawn from this? I believe there are several important messages for the Navy and for the Submarine Force. ...*From the Sea* truly does reflect a new vision for the Navy and frames our goal and objectives for the future. Contrary to what some would claim, this change provides great opportunity for the Submarine Force. There are missions in this new regional focus which submarines can do well, some that submarines can do better than anyone else, and some that only submarines can realistically accomplish. The inherent characteristics of the submarine stand it in equally good stead in blue water or in the littoral. The talent of the people involved in the Submarine Force is equally as valuable in this new world as it was during the Cold War.

The new attack submarine program is alive and well and continuing forward into the 21st century. The cost and operational effectiveness analysis study clearly validated the need for the ship and bounded the characteristics. Our most recent budget submission fully funded the program through fiscal year 1999. The defense acquisition board is scheduled for the Milestone I review on the 10th of December. I am confident that we will gain approval to move forward and begin the design effort needed to make this ship the backbone of the force for the next century.

The Navy and Submarine Force of today are forging ahead with new ideas, technology and new skills to meet the challenges of the future. Our capabilities are extraordinary today and will continue to improve. The future will, no doubt, hold many surprises, but, with your help, we will be ready to meet the challenge.

Thank you. ■

THE ORIGINAL STEALTH FIGHTER.

Long before stealth technology was developed for military aircraft, submarines were perfecting the art of concealment. Today, the most advanced state of that art can be found on the new SEAWOLF attack submarine.

Using this technology to silence pumps, valves, bearings and other components, Electric Boat engineers have redesigned operating and propulsion systems to make today's attack submarine ten times quieter than improved Los Angeles class submarines. SEAWOLF is also twice as operationally effective as other existing attack submarines. And it will accommodate next-generation combat systems as they come on line.

Electric Boat Division, Groton, CT.

Like its airborne counterparts, our latest submarine will handle the toughest missions. It can get in and out unseen and strike with deadly force, even at targets several hundred miles inland.

Building America's "other stealth fighter" is a team effort. Electric Boat and hundreds of suppliers form an industrial base that is both unique and, for all practical purposes, irreplaceable. Because the need remains for a strong submarine force, maintaining this industrial base is a matter of national security.

The Navy's nuclear submarines are stealthy. But their contribution to our nation's defense should be clear for all to see.

GENERAL DYNAMICS
Electric Boat Division

ATTACK SUBMARINES IN THE POST-COLD WAR ERA

The Issues Facing Policymakers

Condensed by Ken Cox and Tom Maloney

[Published by The Center for Strategic & International Studies, Seminar Director, Don M. Snider, Ph.D., ISBN 0-89296-236-3]

In June 1993, the Washington-based Center for Strategic & International Studies (CSIS) published a timely new SSN study that provides valuable information to defense decision makers at the Pentagon and Capital Hill. This condensed version is provided for the readers of The Submarine Review. Due to space limitations this condensation is limited to those portions of the report that deal with the operational aspects of the attack submarines in the post-Cold War era. For full coverage of this timely important topic, the reader is referred to the complete document which is available through CSIS ((202) 775-3119).

Preface

Why debate the future of attack submarines? One reason is that it has been argued that the number of nuclear attack submarines (SSNs) should be drastically reduced, perhaps to as few as 20 ships. With the vast reduction in threat posed by what remains of the former Soviet Union's large submarine fleet, the argument goes, there is little reason to maintain a weapon system whose primary function was to counter that very specific threat and whose role in a world characterized by regional conflicts would be marginal at best. As the United States labors to define its role in the post-Cold War world and politicians decide investment priorities, there must be a careful and reasoned look at a major weapons platform that appears threatened with marginalization.

Our approach in addressing these issues has been to focus on the climate of opinion that runs through the various offices and corridors of U.S. government and the larger policy-making community, with 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. Such a consensus usually emerges from what is known as the *conventional wisdom*—a set of statements that may or may not be true but have the potential to develop into a political

consensus.

This report thus examines the *conventional wisdom*, reinforcing those elements of the wisdom that the study group believes to be true and seeking to disabuse the policy community of those elements it believes to be false. In a manner that is informative, balanced, and concise, the report focuses on the 20 most important questions whose answers best inform the policy debate. (Nine of the twenty questions are included in this condensation.)

The Changing Security and Policy Environment

Questioning the relevance of the most expensive military assets is hardly a new dimension of U.S. defense policy. Today's defense policy decisions, however, are made in an environment radically different from that of even a few years ago. This new environment is characterized by the following factors:

- The United States has shifted its focus from a global military competition to regional threats within more narrowly defined U.S. interests. Defense planning is no longer dominated by a monolithic threat, but must consider military operations in diverse locales, with different missions than those considered the norm in recent decades.

- Historically, there have been two different modes of U.S. defense planning; one that is resource driven, and the other that is strategy driven. The current and foreseeable environment is resource driven. Rather than the 25 percent cut in military force levels presented in the Bush Administration's *base force*, the military is more likely to experience nearly a 40 percent cut from Cold War force levels.

- A broad shift is occurring from single service operations to joint operations. Although a degree of service competition will invariably persist and remains desirable, there is an unmistakable trend, as exemplified by recent regional operations such as Desert Storm and Somalia, towards more narrowly defined roles for the individual services and more broadly defined roles for joint military institutions.

- For maritime forces, a shift in focus from open ocean warfare to operations in littoral areas has occurred.

Previously measured by its ability to defeat other ships in the open ocean, a vessel's relevance will now more often be measured by its ability to influence operations and events inland.

- The proliferation of advanced weapons and weapon related technologies is rapidly altering the threat environment. In the case of naval warfare, regional states that previously possessed little capability are making significant gains in undersea warfare.

This new strategic and policy environment is clearly one of transition, and it is not certain what the result will be in terms of either the international security situation or the U.S. role in promoting and defending its interests within that environment. One thing is clear, however: the United States will have, either by choice or by default, a superpower role. That role will require a strategy and accompanying military force structure unlike that of any other nation. Decisions concerning maintenance of current weapons systems, force levels, and future investment must be made with this unique role in mind.

Attack Submarines, the New Strategic Environment, and U.S. Strategy

1. The new regional orientation of U.S. strategy implies that the roles previously performed by SSNs could be performed in the future by non nuclear powered submarines.

False. The shift in U.S. military strategy to a focus on regional conflicts and contingencies has changed the mission emphasis for U.S. attack submarines, but this new mission does not call for a return to non nuclear powered submarines. For the United States, with global interests ranging from the Persian Gulf to the Adriatic to the Southwest Pacific, nuclear powered submarines are essential to support those interests. The site of future engagements will not be off U.S. shores, but on the other side of the globe.

As U.S. forces are returned to the United States, overseas bases are closed, and future threats become more dispersed geographically, the SSN's ability to quickly deploy to any region becomes even more important. SSN operations before and during

future regional contingencies will often require rapid deployments from U.S. home ports for other operating areas to the crisis region. These operations will place a premium on sustained high speed transit and submerged endurance, qualities that are the distinguishing characteristics of the nuclear submarine. As U.S. attack submarine numbers decline from the 80s to 50s and deployed forces are spread more thinly, it will become even more important for each submarine to be capable of responding quickly to contingencies throughout the world and remaining on station for extended periods. Only nuclear submarines can provide that kind of capability, whether acting independently or in conjunction with other forces.

The main advantages of a non nuclear powered submarine are lower cost (about one-third to one-half that of a nuclear submarine), smaller size and hence reduced potential for detection in some circumstances, and quietness (although most nuclear submariners argue their submarines are as quiet). The non nuclear powered submarine is an effective system for coastal defense where it can act as a mobile minefield or disrupt local sea lanes. It is not a system designed for long open-ocean transit. Even with the new air independent propulsion (AIP) technologies now in development, non nuclear powered submarines will have limited submerged endurance at higher speeds. Thus, although modern non nuclear powered boats are very capable submarines, they are primarily suited for operations in a theater of limited dimensions. Such a capability does not suit the global role of U.S. maritime forces.

2. SSNs in the post-Cold War era should be viewed primarily as antisubmarine warfare (ASW) platforms.

False. A prevalent stereotype regarding SSNs, and one of which policymakers should be disabused, is that SSNs are an ASW system and beyond that have little real utility. The U.S. nuclear attack submarine has been cast in the ASW role since the late 1960s because of a unique circumstance—the rapid expansion of the Soviet ballistic missile and attack submarine force and the need to counter that potent capability. ASW is a relatively recent primary role for submarines, made possible by technological advances in the 1960s. Historically, the submarine has proved a flexible and adaptable platform, performing a wide variety of roles

as warfare and technology have changed. Submarines have evolved from their early limited role as coastal defense vessels into independent raiders, fleet scouts, and coordinate torpedo attack forces. The historical and inherent flexibility of submarine operations should return as SSNs are no longer slaved to their Cold War ASW role.

Post-Cold War ASW operations will likely present a very challenging but different problem than hunting very capable, deep diving Soviet submarines. Contrary to conventional wisdom, U.S. attack submarine operations during the Cold War were not carried out independent of other forces. SSN operations were in fact coordinated with other forces and relied on information sharing with various sources and national assets. The SSN will continue to be a full partner in coordinated ASW operations in both deep and shallow waters. There are those environments, however, such as sensitive peacetime operations, crisis management situations, and distant areas not fully controlled by friendly forces, where the SSN will likely remain the ASW platform of choice.

3. Any role SSNs might have in a possible regional conflict is not important or unique enough to warrant buying more submarines of the current or future design. Any future missions SSNs perform can be filled *well enough* by aircraft, surface ships, the residual submarine force, or some combination of those platforms.

Party true. There is little reason to continue procuring an extremely costly submarine optimized to fight a foe that to a substantial degree no longer exists. Limiting the Seawolf program to only two or three ships acknowledged that reality soon after the collapse of the Soviet Union. The Seawolf, like existing U.S. attack submarines, was not optimized for regional conflict; it was designed to penetrate Soviet submarine bastions and destroy the Soviet submarine force. A submarine designed specifically for regional conflicts would be more effective in those situations than the Seawolf design or existing U.S. attack submarines.

A strategic rationale—discounting industrial base and other concerns—for continued design and eventual construction of the Centurion submarine as a follow-on to Seawolf depends largely on an assessment of the second part of statement number three. *Well enough* is a difficult unit of measurement. If a comparison is

made between an SSN and other systems, it should strongly consider the SSN's primary characteristic: its stealthiness. Some missions performed by submarines—missions that require a combination of stealth and extended time on station—cannot be performed by other platforms, at least not in the same way and with the same efficiency. Such missions include covert intelligence and surveillance, mine laying, special forces insertion, and stealthy, passive ASW.

The unique role for the attack submarine in regional crises or conflicts lies in its ability to approach a nation's coastline undetected and position itself close-in for extended surveillance and monitoring or, if needed, precision cruise missile strikes. With the Tomahawk cruise missile, the submarine can attack land targets hundreds of miles inland without alerting the enemy until the missiles are detected in flight or upon impact. The submarine also can enter hostile waters undetected and launch other stealth platforms, such as unmanned undersea or air vehicles, expanding the submarine's capability in surveillance, mine clearing, and targeting.

With the benefit of stealth, a state or people's activities can be monitored without their being aware they are under observation. Otherwise they might modify their behavior, particularly if they are covertly developing a military capability, preparing a military action, or carrying out some other illicit activity. The communications that take place at sea and ashore can be an invaluable source of information, particularly if the subject is unaware of the surveillance. The submarine can also insert special forces into a country with less risk of detection than any other platform, expanding intelligence collection and other covert operations well inland. These covert operations can continue across the continuum of peacetime surveillance, crisis monitoring and management, deterrence, and, if necessary, into hostilities. Such operations can remain entirely covert, or can be made known privately to the hostile nation. Currently, no other military platform can provide these capabilities with the degree of stealth offered by the submarine.

4. If the principal attribute of the SSN is its stealthiness, then it follows that the SSN will be unable to contribute to the forward presence mission because of its covert, or *invisible*, presence.

False. SSNs can contribute to the forward presence mission precisely because of their ability to operate either covertly or overtly. The conventional wisdom of forward presence remains unduly influenced by its linkage to *gunboat diplomacy*. Historically, the battleship silhouetted against the skyline was ideally suited for *showing the flag*, the type of presence that has characterized great power diplomacy. Such gunboat diplomacy, however, has given way to more subtle and limited uses of military power in pursuit of specific political objectives.

Attack submarines are not as easily or consistently visible as surface ships, but this doesn't mean they cannot contribute to the presence mission. A major element of presence operations are port calls; each year U.S. attack submarines make approximately 200 visits to 50 foreign ports. The announced presence of a U.S. attack submarine in a region can generate much effect, as seen recently in the case of U.S. attack submarine deployments to the Persian Gulf. With a sudden appearance in an area, submarines can generate a stronger impact than the gradual approach of surface ships. Conversely, the presence of a submerged submarine in an area can be disclosed to selected military and political leaders in that region, thus providing an option for a low profile, less provocative presence.

The unique option of employing SSNs either covertly or overtly as a crisis unfolds provides U.S. policy makers with a needed range of response options that can be applied with or without public notice, depending on whether the object of the deterrence is the man in the street, the leader in the palace, a political or military faction, or some combination thereof.

5. Attack submarines have difficulty operating in conjunction with other sea, air, and land forces and thus have limited utility in future joint military operations.

Mostly false. Currently, many U.S. attack submarines have limited capabilities to communicate with the broad range of other U.S. forces, thus inhibiting their ability to work with these forces in some respects. But even with these limits, attack submarines operate effectively in conjunction with other naval forces. Moreover, the U.S. submarine community recognizes the imperative to improve communications and data sharing capabilities with other U.S. forces in the regional warfare environment and has

given high priority to such improvements.

Rather than operating independently, SSNs now routinely operate as an integral part of a larger task force conducting advance reconnaissance, screening fleet movements, and working in regional environments in close coordination and cooperation with other task force components.

6. Attack submarine have contributed little unique capability in past regional operations.

False. The sinking of the Argentine cruiser ARA BELGRANO by a British SSN during the early stages of the Falklands conflict and the subsequent withdrawal of the Argentine fleet for the duration of the conflict dramatically exemplifies the combat effect of SSNs in regional warfare. By virtue of their mobility and endurance, the British SSNs were the first forces on station, 8,000 miles from home, and the last to leave. The stealth and endurance of these SSNs made possible their invaluable—but largely unheralded—support to the British battlegroup, including early warning of inbound Argentine air strikes, surveillance, and insertion of special forces. The Royal Navy submarines were an indispensable element of the British victory.

SSNs were also an integral part of the joint U.S. Navy and Air Force strike in April 1986 against Colonel Muammar Qaddafi in retaliation for Libyan-sponsored terrorist activities. Libya had dispersed its six Soviet built diesel electric submarines in several ports along the North African coast. The fact that the Libyan submarines remained in port during the pre-strike positioning of the Sixth Fleet and the raid itself was in part due to the presence of SSNs in the area. In addition, SSN surveillance of the Libyan coast provided the Sixth Fleet commander with timely and important information on Libyan activities.

Including submarines operated by U.S. coalition allies, at least 15 SSNs participated in Desert Shield/Storm conducting surveillance, intelligence collection, embargo enforcement, and precision strikes. Although the SSN Tomahawk strike was limited in numbers, the capability of the submarine launched cruise missile (SLCM) was proven. Moreover, future regional conflicts and contingencies may differ from Operation Desert Shield/Storm in ways that lead to a broader role for sea based forces in general, or attack submarines in particular.

7. Threats from technology diffusion in the area of underwater operations will be limited and come primarily from the former Soviet Union.

Mostly false. Despite the much publicized Russian sale of newly built Kilo Class diesel electric submarines to Iran, the former Soviet Union is only one of many contributors, albeit an important one, to the worldwide diffusion of new undersea warfare technology. Germany leads the world in providing modern submarines and submarine weapons to developing nations. French SLCMs and Italian mines and torpedoes are available to cash customers. The mine that damaged the Aegis cruiser PRINCETON during Desert Storm was an advanced mine made in Italy. The AIP technology being developed by Germany, Sweden, Italy, the Netherlands, and others will soon be on the market. The diffusion of Western computers, electronics, sensors, and signal processing technology will pose a considerable challenge in the future. Sophisticated technology for modern undersea warfare is available around the world today for use by any nation that has the funds to acquire it and the will to apply it.

8. Submarines are too technologically sophisticated given the nature of the developing world threat—technological sophistication along the lines of Seawolf will be unnecessary.

Partly true. The United States is currently in the comfortable position of possessing military capabilities that exceed those of any single potential enemy. In light of this advantage and the constraints imposed by a limited defense budget, the follow-on to Seawolf must, if it is to have any realistic chance of being funded, be less expensive than Seawolf. Although technology advances will remain essential to maintaining tactical and operational advantage over potential adversaries, the mix of technologies embodied in a follow-on submarine must be different than those developed for Seawolf. In addition, in the changed security environment, technology should be equally focused on achieving maximum affordability as well as capability improvements.

The mission of submarine forces has shifted to operations in littoral areas. The design of the next generation submarine, Centurion, therefore, must reflect the new regional orientation of U.S. strategy and focus technology development on capabilities in

those environments. Modern diesel electric submarines operating in coastal waters pose a difficult challenge to today's ASW technology focused on open-ocean operations, and it is reasonable to assume that challenge will become more difficult as submarine technology and operational expertise become more widespread.

Even when designing a submarine that may be operating against an unknown opponent 20 or 30 years from now, the basic submarine characteristics that provide tactical advantage over an opponent will remain its stealth, sensors, and weapons. Technical advances in these qualities have been developed for Seawolf, and a new submarine design should take maximum advantage of these technologies. This does not imply that a new submarine should look like, be as large as, or carry as many weapons as Seawolf, but it should not represent a step backward in those fundamental combat qualities.

9. SSNs cannot operate in shallow water because they are too big and unmanueverable.

False. U.S. nuclear submarines have been operating routinely in shallow waters for decades and have accumulated years of operational experience in shallow seas around the world. One example has been in the Arctic, where SSNs have explored the unknown waters beneath the ice, often threading narrow channels only 30 or 40 feet under the ice and scarcely that distance between the keel and the ocean floor. In fact, the SSN's size and endurance provide it with two particular advantages in shallow or coastal waters. First, the SSN can remain on station almost indefinitely, often within sight of the coast, whereas the non nuclear powered submarine must periodically reveal its presence by snorkeling, either while on station or withdrawn offshore. Second, the SSN's size permits it to carry a swimmer delivery vehicle, or manned mini-sub, which can penetrate very shallow coastal waters and harbors on a variety of missions. ■

LIMITED COST DESIGN: AN APPROACH FOR SUBMARINES

by Marc Menez
Ingénier Général de 1ère Classe de l'Armement
French Navy (Ret.)

[Ed. Note: Général Menez's equivalent rank is Vice Admiral, Naval Constructors Corps.]

Introductory Remarks

In my previous paper (What Price Speed?, Submarine Review, October 1993), I recalled the simplified relationship that can be established between maximum speed and total displacement for a given payload:

$$V_t = \frac{k^3 \rho^2}{\eta^3} S_m^t$$

This relationship, derived from a volume equation which is the main tool in submarine preliminary design (rather than weight equation), is based upon an unlimited anaerobic energy (i.e. nuclear) propulsion plant design. In submarines, at a preliminary design stage, volume equation supported by a drawing is usually preferred to weight equation alone.

This formula is of value in a wide range of designs. However, it becomes less valid at the limits, when some parameters can no longer be considered as constant. For instance, specific power of the propulsion plant η becomes larger and cannot be considered as a constant when maximum power decreases.

There are also other limits to the validity of this relationship, coming from the other equations or inequations (weight, stability...) which must be satisfied in any design. A smaller propulsion plant of lesser maximum power which can be suitable in a low maximum speed design needs a better (i.e. heavier) radiation shielding, as maximum speed is of more common use than it is in a higher maximum speed design. This may lead to buoyancy and/or stability problems which react on the design.

These remarks, however, have no significant influence on the tendencies derived from our basic relationship which remain roughly true.

Cost and Displacement

When writing my previous paper, I made use of the term *price* in an ambiguous meaning. My aim was to show clearly that maximum speed had a *price* to be paid in volume, i.e. displacement, with no direct reference to money. In my mind, it went without saying that displacement was also related to *cost* in money.

Since I wrote that paper, I had the opportunity to read thoroughly Rockwell's Rickover Effect, in which the opinion of the Admiral in that matter is strongly expressed in the paragraph entitled Dinner with Edward Teller with an example derived from clockmaking.

> "...Teller greeted us at the door, and before we could get our coats off, he stated the purpose of the visit. "Rick, you've got to build smaller submarines."
>
> I bristled. This was a subject we had debated often, and I was ready for it. But Rickover's response was calm and relaxed. "Why, Edward? The oceans are very big."
>
> "We will need lots of them, Rick. Lots of them."
>
> "We can build lots of them, Edward."
>
> "No, they are too expensive."
>
> "Ah, you don't mean they should be smaller. You mean they should be cheaper."
>
> "Isn't it the same thing?"
>
> "Not at all. You used to be able to buy a big Ingersoll pocket watch for a dollar. I suppose it's a bit more now. But a tiny lady's wristwatch is very expensive. Even without diamonds on it. No, smaller doesn't mean cheaper. Not at all."

The example put forward by Rickover is based on valuable knowledge of clockmaking, but it does not seem so valid when compared with submarine manufacturing.

In the mechanical clockwatch era, continuous progress in clock design and clockmaking was achieved by mass production directed to an ever increasing market. This single function item became therefore, more and more compact, whereas its price was falling. This does not mean, however, that the evolution of price per unit weight or volume for clocks over long periods, in constant money, was a decrease. Let us nevertheless assume that this evolution was

such, although we have no publication to support this opinion. Equally, this does not mean that all watches were sold at the same price. Small ladies' watches included expensive precious metals and needed more labor for their elaboration, leading to higher prices and thus making the market smaller.

With the evolution to electronic watches, all the data became obsolete. More expensive multifunction watches became available, together with low cost single function watches (Swatch).

There is no reason why a complex system like a submarine should follow the same laws in a market which, by the way, remains quite small.

Submarine design is governed by volumes and no volume is unduly created unless it is a useful one, because the propulsion plant should be increased accordingly and, consequently, the overall displacement. For instance, growth margin in volume, if incorporated in the design, is limited to a fairly low value.

Displacement, resulting from volume, is therefore a good evaluation of the costs which are to be expected at the beginning of a new design, although every volume is not given the same cost.

Technological Evolution

Since the very beginning of their history, submarines have incorporated various technologies in their design which have been subject to large improvements, occurring step by step with a quantum variation and no true continuity or simultaneity.

Referring only to the nuclear submarine's era, this evolution has first been concentrated on energy production and propulsion, then on noise reduction techniques, then on sonar improvement, which relies largely on digitalization and data bussing. Large arrays have become feasible, leading to high capacity data processing. Other steps could be put forward, for instance in the domain of communications. In all these changes, mechanical parts which are essential in energy production and propulsion have been subject to less variations in techniques and costs than electronics, where digitalization, in particular in sonar systems, has allowed a large increase in capacities for a given volume, leading to a considerable evolution of costs. For instance, software may well reach tremendous costs by adding neither volume nor weight.

In constant money, cost per unit volume of nuclear submarines has grown quite evidently between successive generations of

submarines, but at a moderate rate, due to the leverage effect of mixed mechanical, electrical and electronic technologies. Evolutions of 10 to 20 percent may well be put forward. Volume or displacement, as a result, is a good approach to the cost of a given design, provided that there is a means to cope otherwise with the influence of technical evolution on cost per unit volume. This may well be difficult when a new project is initiated and may lead to additional uncertainties on cost evaluation. These uncertainties may, however, be maintained at 10 percent or below, provided that a rough assessment of the technological evolution factor is made at the beginning and checked along the design process.

Dimensions

As mentioned in my previous paper, assuming that the designs are all of the ALBACORE type, which is very common in the Western world, the diameter of the pressure hull cannot be chosen at random. To accommodate properly crew and ship's systems, the diameter of the pressure hull (hence of the hull in a single hull design) must be made close to preselected values leading to a good occupation of available space.

Preferential values are about 8 m (~26 ft), 10.5 m (~34 ft), 13 m (~43 ft).

As the ratio of length to diameter cannot be too small or too high, each diameter covers properly a range of overall volumes, with some problems occurring at the overlap.

The following figures can be given.

Diameter		Total Volume
m	(ft)	m^3 (cu.ft)
~8	(~26)	2,000 (70,500) to 4,000 (141,000)
~10.5	(~34)	4,500 (159,000) to 9,000 (318,000)
~13	(~43)	(over 10,000) (over 354,000)

Speed Capacity for Smaller Diameters

In the 8 m (26 ft) diameter range, it is known by practice that it is possible to design a submarine with:

V_t = 3,200 m³ (113,000 cu.ft) V_u = 1,100 m³ (39,000 cu.ft)
Sm = 25 kn

Coming back to the full form of our relationship, we can write that:

$$\frac{V_t - V_u}{V_t^{\frac{2}{3}} S_m^{\,3}} = \frac{k\rho^{\frac{2}{3}}}{\eta}$$

is unvariable in a wide range of designs.

It is then easy to plot against V_u the maximum achievable speed S_m for a given total volume V_t:

V_t = 3,200 m³ (113,00 cu.ft)				
V_u	(m³)	1,500	1,100	300
	(cu.ft)	53,000	39,000	10,500
S_m(kn)		23.3	25	27.8

V_u = 300 m³ (10,500 cu.ft) corresponds to a submarine design where military equipments are reduced to a minimum (no weapons, very simple acoustic detection). Its rôle should be limited to training of surface forces, as a fast target.

One can also plot V_t against S_m for a given V_u.

V_u = 1,100 m³ (39,000 cu.ft)				
S^m (kn)		23	25	26.5
V_t	(m³)	2,500	3,200	4,000
	(cu.ft)	88,300	113,000	141,000

Larger Diameters

A wide range of attack submarine designs can be covered when a single 10.5 m pressure hull is adopted.

This can be derived quite easily from SSBNs, whole characteristics can be assessed to be:

V_t – 11,000 m³ (388,700 cu.ft)
V_v – 7,000 m³ (247,300 cu.ft)
S_m – 25 kn

The maximum speed of 30 kn can be obtained for a set of V_t, V_v plotted as an example in the following table:

S_m + 30 kn		Diameter 10.5 m (34 ft)		
V_t	(m³)	5,000	5,500	6,000
	(cu.ft)	176,700	194,300	212,000
V_v	(m³)	1,000	1,150	1,500
	(cu.ft)	35,300	40,600	53,000

Needless to say, 13 m (43 ft) diameter designs are not to be considered for attack submarines at the present time.

Conclusions

It has been shown in the three previous paragraphs that a useful volume of 1,500 m³ (5,300 cu.ft) can be accommodated either in a 3,200 m³ (113,000 cu.ft) 8 m (26 ft) in diameter submarine propelled at about 23 kn+, or in a 6,000 m³ (212,000 cu.ft) 10.5m (34 ft) in diameter submarine propelled at about 30 kn.

Higher useful volumes probably require 10.5 m (34 ft) diameters, although a more accurate definition of this boundary should be useful, if one considers its impact on costs.

Smaller useful volumes of 1,100 m³ (39,000 cu.ft) can be accommodated in a wider range of designs tabulated here.

V_u – 1,100 m³ (39,000 cu.ft)				
V_t (m³)	2,500	3,200	4,000	5,500
V_t (cu.ft)	88,300	113,000	141,000	194,300
S_m (kn)	23	25	26.5	30
Diameter				
(m)	8	8	8	10.5
(ft)	26	26	26	34

Two questions should be addressed now which require more operational and thus more classified considerations.

Is a 30 kn maximum speed much better than a 23 kn maximum speed, if one considers its impact on total volume of a design for a given useful volume?

I am not going to answer this question. My personal feeling, subject to controversy, is that the maximum usable speed, which is the only important one, is a *quiet speed* at which good passive detection can be achieved (limited self-noise) and counter-detection avoided (limited radiated nose). In the various designs considered here, it is most unlikely that large differences in maximum speeds will lead to appreciable differences in maximum usable speeds.

The true question, which I cannot address at all, is the second one.

Is a useful volume of less than 2,000 m³ (70,600 cu.ft) acceptable for a capable enough attack submarine?

This question leads to difficult discussions on what is essential, what is not. It also leads to questioning the *general purpose* design, that is to say a design including all capacities deemed necessary, sticking once more to the *best capable*.

In my view, more specialized designs of the 8 m+ (26 ft+) diameter with a speed limited to 25 kn are to be considered in the future. These specialized designs should have as much commonality as possible, in order to achieve a low unit price.

This does not mean, however, that no developments are necessary to achieve the required compactness. I suspect the

contrary is probably true. For instance, BQQ5 or 6 forward antennae cannot easily be made compatible with torpedo tubes in an 8 m+ (26 ft+) diameter design.

Neither does this mean that the inventory of a submarine force based on several specialized designs should not be higher than the one based on a general purpose design. As a whole, the total expense in the long term might well be higher. But in these matters, only the annual amount of budgetary money is of real importance. If such a policy were adopted, it should probably be easier to adapt programs to annual budgetary resources, which is the main financial constraint.

■

[Ed. Note: We regret that the final two paragraphs from Vice Admiral Menez' article <u>What Price Speed (October 93 Issue)</u> were omitted. The missing paragraphs, which should have followed from page 36, are printed below. The formulae on page 36 for V_{prop} and for V_t were printed with the <u>incorrect</u> <u>power</u> for the variable S_m. The correct formulae are:

$$V_{prop} = \frac{P}{\eta} = \frac{k\rho^{\frac{2}{3}}}{\eta} V_t^{\frac{2}{3}} S_m^{\frac{3}{3}} \qquad V_t - V_w = \frac{k\rho^{\frac{2}{3}}}{\eta} V_t^{\frac{2}{3}} S_m^{\frac{2}{3}}$$

We are sorry for any inconvenience]

<u>WHAT PRICE SPEED (October 93) (Final Paragraphs)</u>

In wartime or pre-wartime situations, fast deployment to places where increasing tension is observed must be considered. But as a rule this cannot be done without caution. Covertness must be achieved and the maximum usable speed is a speed at which good passive detection can be obtained (limited self noise), and counter detection avoided (limited radiated noise), that is to say a speed of between 15 and 20 kn maximum.

In conclusion, a high maximum speed seems of very little use in wartime conditions, while its usefulness in peacetime may also be questionable. Since it represents a heavy burden in any design where high speeds are required, why not consider the possibility of lower values?

■

ARCTIC ADDENDUM TO SUBMARINE ROLES IN THE 1990s AND BEYOND

by Waldo Lyon
Arctic Submarine Laboratory

The Submarine Force has concisely defined the future roles and missions of the Submarine Force.[1] The nuclear submarine has the critical advantage of stealth, endurance and agility, and is the only platform combining these advantages in a single unit. The submarine should play a major role in future projections of military power, particularly necessary in a changing, unstable world.

Precision strike, the relatively new role for the submarine is emphasized. "The accuracy and effectiveness of Tomahawk missiles were graphically demonstrated in Operation Desert Storm". Furthermore, "using the capability to conduct direct precision strikes, the submarine provides the National Command Authorities the ability to exert influence and project power over a large portion of the globe. Over 75 percent of the land can be attacked". Areas susceptible to attack are shown in a diagram illustrating the global reach of submarine launched Tomahawk land attack missiles.

The arctic marginal sea ice zone (MIZ) should be added to the diagram, as an uniquely specialized zone for missile attack (Figure 1). The reach of missiles launched by submarine in the MIZ is illustrated in Figure 2. The proportion of the land that can be attacked is increased to over 87 percent. It also illustrates that a considerable area of North America is vulnerable to attack from the ice covered zone. As a result of operating in nearly all sectors of the MIZ during the past 45 years, we have the technology and submarine capability to deny use of this ice covered zone for missile attack by all known submarine forces today. We also know, from experiments during the 45 years, what special equipment, what modifications, what special information and tactics are required to **specially** deploy a submarine in the MIZ. Once **specially** deployed, the MIZ becomes a virtual sanctuary for this submarine—the ultimate manifestation of stealth. And, if we know, we must assume that the whole world knows.

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[1] The Submarine Review, April 1992, p.4.

We do **not** know how to attack and defeat this offensive submarine when specially deployed in the MIZ. Only another submarine can locate and conduct the attack, but we have no concept of the requirements for combat in the sea ice canopy in this situation. Likely, a decade of dedicated research is needed to discern the concept of this combat, hence, the requirements for the defensive submarine. A discussion of the history and problems of this combat is given in Submarine Combat in the Ice, U.S. Naval Institute Proceedings, February 1992, p. 33.

Today, the submarines of the successors of the Soviet Union are capable of mounting a missile attack in the MIZ—a potential *hazard* to our national security, but we have the capability and technology to contain this hazard. However, in a changing, unstable world, in 5, 10, or 15 years, where may the threat come from? What advancements may develop in the missile and its delivery? Even now, the knowledge is available to develop a *threat* by a special deployment which we cannot contain. We should, at least, do the R&D necessary for a defensive submarine to contain it. ■

Figure 1. Marginal Sea Ice Zone. Unique Submarine Warfare Area.

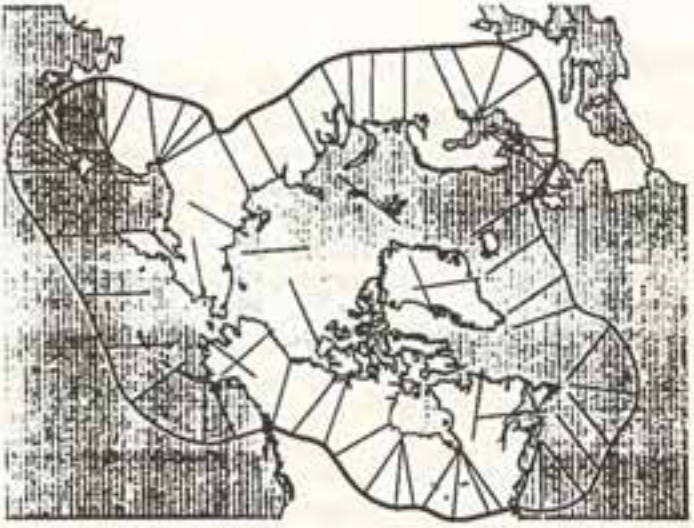


Figure 2. Reach of Submarine-Launched Missiles from Marginal Sea Ice Zone.

IN REMEMBRANCE

Captain Paul R. Schratz, USN(Ret.)

AN AFFORDABLE STRATEGY FOR INTRODUCING TECHNOLOGY INTO FUTURE SUBMARINES

by Roger N. Sexauer
Centurion Program Office
General Dynamics/EB

The Challenge

In the recently completed Bottom-Up Review, Secretary of Defense Aspin made the decision to build the third SEAWOLF at General Dynamics Electric Boat Division, to maintain two private nuclear capable shipyards, and to develop and build the new attack submarine (NAS). The construction of SSN 23 helps to solve the near term issue for the submarine industrial base; however, the long term issue of designing and building an affordable NAS needs to be addressed.

Barring a change in the world political situation, there is no mission requirement to build another submarine until early in the 21st century. Accordingly, low rate production will be the means to maintain submarine design and construction capability for at least the next decade. This situation presents two challenges to submarine designers and manufacturers. First and foremost: future submarines must be affordable. Second, the NAS design must facilitate the evaluation of emerging technologies in anticipation of resumed production due to changes in the threat environment and the eventual obsolescence of the current Submarine Force. The challenge therefore is: How to affordably introduce new technologies in a low rate submarine production environment.

A Winning Strategy

An answer to the challenge can be found by revisiting the historical development of today's nuclear submarine. The post-World War II approach to submarine acquisition included the building of *singular* or essentially one-of-a-kind submarines without commitment to long term follow on production. This philosophy produced ALBACORE, NAUTILUS and HALIBUT, to name a few.

- ALBACORE convincingly demonstrated the concept of the tear drop shaped hull to maximize submerged speed. A radically new streamlined hull and a number of innovative ship systems were introduced in this diesel electric subma-

rine that were later incorporated in the SKIPJACK class nuclear submarine.

- NAUTILUS proved the feasibility of a nuclear powered submarine and then served for 25 years as a fully operational attack submarine.
- HALIBUT introduced the concept of a dedicated nuclear powered missile submarine. Equipped with sophisticated navigational equipment and capable of extended deployments, it was a precursor to the Polaris program.

Each of these submarines tested new technologies at sea. Operators provided meaningful feedback for consideration in subsequent designs. This approach fostered conceptual innovation so that when the time came for series production, proven technologies could be affordable integrated into new designs with low technical risks.

To achieve an affordable NAS, the notion of singular submarines should be considered. It is suggested that the NAS be a baseline design that possesses the key attributes of a nuclear submarine: stealth, speed and endurance. This baseline submarine would emphasize modularity and reconfigurability and be receptive to being economically upgraded with new technology.

Modular/Reconfigurable Designs

The notion of modular **design** is different from the modular **construction** process used in the TRIDENT and SEAWOLF programs. Submarine modular construction implies that the vessel is constructed from a series of hull cylinder modules that are fabricated and outfitted in a more efficient environment than the traditional method of building submarines *on the ways*. These modules are then integrated in the shipyard, where system assembly and test are completed.

Modular **design** differs in that the ship comprises a series of independent system modules. The ship system module package concept allows for the cost effective upgrading of a design since the impact of changing one system does not significantly influence other modules of the submarine.

System upgrades are not new to submarines. However, the cost effectiveness of these upgrades can be improved by advanced planning. The 688 LOS ANGELES class is a classic example of a submarine that could have been most cost effective had modularity in design been incorporated in its initial design. The 688 combat system evolved from an analog Mark 113 Mod 10 to the

totally digitized AN/BSY-1 system. The upgrades to the combat system significantly altered the internal arrangements of the submarine and affected many other support systems such as ventilation and air conditioning. For current and foreseeable submarines, improvements such as state-of-the-art combat systems and evolving weapons like the Tomahawk vertical launch system (VLS) will continue to be a fact of life. However, we cannot afford a submarine design that requires extensive redesign to support new ideas. Designing future submarines with the provision to support affordable integration of new technologies and mission enhancements is mandatory.

Technologies that maximize the ability to upgrade a submarine cost effectively must be emphasized. Distributed systems that minimize air and hydraulic piping and rely on electrical interfaces will facilitate inexpensive upgrades. Systems should be designed that are self sufficient and do not require extensive modifications to other existing systems to function.

Submarine designers can learn some important lessons from successful programs that demonstrated the baseline design and economic upgrade concept such as the Lockheed C-130 Hercules aircraft. Although it is unlikely that the designers of the C-130 anticipated the current 54 configurations of this airframe, the basic modularity of the C-130 enables tremendous reconfigurability. The original concept of the C-130 was to provide a baseline heavy lift aircraft capable of transporting a variety of cargo. Over the years, operators and designers have found a host of uses for this plane—from U.S. Coast Guard Search and Rescue to U.S. Air Force gunship configurations. The C-130 has also gone through a series of upgrades over the years, incorporating advanced technologies that have increased its endurance, speed, payload and power. The success of this simple, spacious, affordable design is attested by the fact that over 2000 aircraft have been delivered to 63 countries around the world since 1954, and upgrades are still under way!

Breaking the Cycle

In order affordably to integrate advanced technologies into new submarines and test them at sea, the historic and lengthening *cycle time* to design and build submarines must be reduced. Currently, the cycle time to design and build a new submarine is approximately 12-14 years. The key to compressing this span is to reduce the activity level associated with changes to the design after construction has begun. Minimizing changes and their associated

activity—through the incorporation of concurrent engineering and integrated product development—will simplify material procurement, reduce support and retest requirements, and improve labor productivity. However, it is naive to assume that, as construction progresses, changes to the design will not be required. Minor corrections or changes to the design will be incorporated in the particular submarine; major design changes will be incorporated into the design cycle for the next submarine. These major changes will typically be included in a major technology upgrade to the baseline platform.

Strategy for Success

NAS will provide the opportunity to demonstrate new affordability and multi mission concepts where it really counts—at sea. Submarine operators will supply feedback to the designers to improve the baseline design. Modifications to baseline submarines will be incorporated in subsequent construction units. These essentially one-of-a-kind submarines will be built at a rate to maintain the critical mass of the submarine industrial base. When serial production is required, proven technologies will be available for incorporation into a new class design.

This strategy alone will not assure an affordable Submarine Force. Cultures must be changed. Government and industry must join together and challenge all aspects of the submarine acquisition system. For example:

- Contractual procedures must be revised to reflect the Administration's decision to build nuclear submarines in one nuclear shipyard, and aircraft carriers in the other.
- Traditional submarine performance criteria must be rigorously examined to reduce cost.
- The entire bureaucratic administrative process must be streamlined to eliminate unnecessary procedures and activities.
- The philosophies of concurrent engineering and integrated product development must be embraced and their principles reflected in the acquisition process.

These cultural changes, coupled with the philosophy of integrating new technologies into a baseline design, represent an affordable approach to maintaining the submarine industrial base into the next century.

■

IS THE MIDDLE GROUP OF MAIN BALLAST TANKS REALLY NECESSARY ON SUBMARINES?

by CAPT 1ST Rank L. Khudyakov
Doctor of Technical Sciences

[This article is reprinted from Morskoy Sbornik.]

In the course of the evolutionary development of our submarines, as well as foreign ones, three basic architectural types of hull construction have been developed:

- Dual hulls, in which the main ballast tanks (TSGB) are positioned in the light outer hull (LK) over the entire length of the pressure hull (PK) and encompass its entire perimeter, that is, in any place on the submarine the external plating of the light hull appears. An exception is the separate sections of the free flooding space between the inner and outer hulls where the rigid tanks of the auxiliary ballast can be positioned. Auxiliary ballast includes the fast diving or negative tanks, the regulating or variable tanks, and the like.

- One-and-a-half hulls, when they have the external tanks of the main ballast over the entire length of the pressure hull, but the outer hull, which forms these tanks, does not cover the entire perimeter of the pressure hull, that is, the external plating of the submarine in the lower part of its hull is the pressure hull (a variety of one-and-a-half hull types exist, like the type with *rolls*, where the outer hull and respectively, the tanks of the main ballast have been located in the middle part of the pressure hull according to its length and height).

- Single hull, there are no external ballast tanks.

Our domestic, underwater shipbuilding industry has found a use for all these architectural types. We have used the dual hull architecture to achieve the following: the best hydrodynamic contour for surface transit; simplified construction of the pressure hull, which can consist only of cylinders and truncated cones without molded or curved contours, though when necessary it's possible to use more complex patterns in the cross sections—for instance, a figure eight; an increase in the amount of free flooding

space between the inner and outer hulls which gives more reserve buoyancy to ensure surface flotation; the use of external ribs on the pressure hull, which has made more internal space available. Furthermore, in the free flooding space between the inner and outer hulls, it's easier to accommodate the rigid tanks of the auxiliary ballast and also part of the fuel or fuel reserves (in the fuel/ballast tanks of the main ballast tanks), and the like.

The hull-and-a-half and the single hull architectures are used (by us) for submarines with relatively small displacement, particularly when the calculated, allowable width of the free flooding space between the inner and outer hull of the double hulled boats was excessive and led to increased displacement and a subsequent decrease in the boat(s) speed and maneuver capabilities.

After the war, all our diesel submarines (including the projects 613 and 641 attack subs, and the project 651 SSGN) were double hulled, except the small projects 615 and A-1615, which were fitted out with the ED-KhPI powerplant.

It's well known that a submarine will submerge when it is on the surface and blows out all its main ballast tanks, which then fill with sea water. During this activity the elimination of negative buoyancy and the absence of pitch and roll are achieved by observing the following conditions:

- The total volume of the main ballast tanks should be equal to the water-tight volume of the submarine's hull above the water line (when surfaced), that is, it's reserve buoyancy in the surfaced position.

- The center of gravity of the above mentioned water tight volume should be located on the same vertical plane with the center of gravity of all the main ballast tanks.

The second of these conditions determines the basic requirement for the distribution of reserve buoyancy (from the main ballast tank) along the length of the submarine. To avoid significant pitch during diving and surfacing, it's also necessary to ensure balance during flooding while diving and when blowing out the main ballast tanks during surfacing. This is ensured by choosing the proper profile of Kingston valves, flooding ports (when Kingstons are not present), ventilation valves, and also the regulation of the high pressure air equipment, which supplies air for blowing out the individual main ballast tanks.

To effectively fight damage caused by the flooding of the pressure hull, some tanks of the main ballast should be positioned

at both ends of the submarine, which would compensate for the pitch (caused by the flooding) when the main ballast is blown out. Theoretically, putting the necessity of maintaining the surfaced submarine's buoyancy at the top of the list, it can be proven that it would be advisable to concentrate all buoyancy reserves (all tanks of main ballast) at the ends of the submarine. With that, the required buoyancy reserves would be minimal and the submarine's full underwater displacement would accordingly decrease. However, we traditionally continue to position the main ballast more or less evenly along the length of the submarine and divide them into three groups: bow group and stern group (end groups which include tanks positioned behind the pressure hull, as well as parts of tanks adjacent to them), and the so-called middle group positioned approximately in the middle of the submarine.

The middle group of ballast tanks is isolated so that when the ballast from these tanks is blown out while the submarine is surfacing, there is no severe pitch, and the submarine is in broached position with a definite lateral and longitudinal stability. A minimal part of the deck is above the water to allow the crew to come out and perform repairs on the superstructure. The volume of the middle group of main ballast tanks is usually up to 30 percent of the submarine's total buoyancy reserve, or 8 to 10 percent of its normal water displacement. Also, the middle group is used for:

- Surfacing and submerging the submarine in two steps. While surfacing, only the middle group is blown out; after surfacing the end groups are blown out by exhaust gases of the diesel engine, which saves high pressure air. While submerging, the end groups of tanks of the main ballast are flooded first, and then the middle group. That helps to decrease possible pitch and roll when the upper stringers enter the water and lateral stability becomes minimal—a normal occurrence for submarines of two hull and hull-and-a-half architectural types.

- Surfacing of the submarine with minimal pitch in instances when an accident is not connected with the flooding of the submarine's end sections with seawater. The normal procedure in this case is maximum acceleration with a simultaneous blowing out of the middle group of main ballast tanks. Then, depending on the rate of pitch increase, the high pressure air is supplied to the end group of main ballast tanks.

Also, in many cases diesel electric submarines charge their batteries and replenish pressurized air reserves while in a broached position, since in the event of a sudden attack by the enemy, diving from this position is much faster then from the surface.

Forming of a group of main ballast tanks in the middle section of the submarine and achieving the above mentioned goals on double hulled and hull-and-a-half types submarine is not complicated technologically. As far as single hull submarines are concerned, the main ballast tanks located in the middle part of the submarine must be strong, which significantly increases the weight and reduces usable volume of the submarine. That becomes very important with the increase of the submarine's maximum depth.

These reasons were the basis for making the presence of the middle group of main ballast tanks on domestically produced submarines not only a tradition, but the rule.

Comparing the advantages and disadvantages of double hulled submarines with single hulled submarines it is notable that an increase of the buoyancy reserve on the former (up to 25-30 percent as compared to the latter), and therefore increased full underwater displacement, practically does not inhibit their speed and maneuverability. For example, at the fixed power of the engine, the full speed (Vmax) is related to the full underwater displacement (D) by an equation (Vmax – D-2/9), and the radius of established circulation (when the vertical rudder area is fixed) is reversely proportional D1/3. That means that at the above mentioned conditions, the increase of water displacement in 1.2 times causes a 4 percent reduction in full speed and 6 percent increase in circulation radius. The rate of speed increase is proportional to D, which is not very important.

The influence of an underwater displacement increase on the required engine power (Ne) is more noticeable. Here, the equation Ne – D2/3 is taking place. Therefore, the decrease of D 1.2 times will cause the reduction of Ne by 13 percent. The area of outer hull is also changing proportionately to D – 2/3. This particular reason, as well as the low hydrodynamic noise of submarines of this architectural type (which is especially important at higher speeds), resulted in exclusive use of single hulled submarines with a small buoyancy reserve (around 12-15 percent) and placement of light tanks of main ballast in the end sections of the submarine (without the middle group) by the American Navy. The example of this type of submarine is the Los Angeles class. The quantity of sections on this class is reduced to three, which makes it impossible for her to stay on the surface when even an insignificant area of its section is flooded.

However, in this article the attention should be paid to the absence of the middle group of the main ballast tanks, which is probably a normal consequence of the transition to the classic single hull architectural type; there the *middle group* (as a geometric term) is losing its meaning. We can only talk about some unidentified group of main ballast tanks which includes separate ballast tanks positioned at the ends of the submarine, the purging of which brings the submarine to a mid position (between periscope depth and surfaced), which still can be called broached. Therefore, this group can be called not *middle group* but the *broached group*.

Such a *broached group* on single hull submarines with the main ballast tanks located at both ends of the submarine can be formed with the same purposes as the *middle group*. However, when the submarine is surfacing, its use may cause heavy pitching if for some reason the main ballast tank at one end would not blow out, or the main ballast would not blow out evenly.

There was a case in submarine history, when in the 1920s the main ballast tanks on the stern of an American single hulled submarine blew out, and the ballast on the bow did not. The submarine was practically in a vertical position, with only a small part of its stern above the water. She was able to float in this position because of a small amount of air in its rear main ballast tanks. Fortunately, the submarine did not have any negative buoyancy, otherwise it would have sunk. It was completely helpless, because the group of tanks on the bow could not be blown out; there was no middle group and residual air in the stern-positioned tanks could not be blown out because they were higher than the stern ventilation valves. Only after 40 hours and because of a series of lucky events was the crew of 28 rescued.

During emergency surfacing, heavy pitching is very dangerous for a submarine without Kingston valves on its ballast since it leads to a reduction of the ballast tanks' air pressure through the flooding ports, and it is also dangerous for submarines with Kingston valves on the main ballast tanks because the air pressure is lost through the valves when they're open.

During this heavy pitching, the amount blown out of the main ballast tanks is significantly reduced. As in the Black Sea in 1957, when during an emergency dive the hull-and-a-half submarine, number M-351 of the project A-615 class, sank and laid on the bottom at a depth of 84 meters with a pitch of about 60° at the stern. The cause was the intake of sea water into the diesel engines through the air feed shaft. The sixth compartment was two-thirds flooded and the water seeped through the transverse

bulkhead and penetrated to the end of the seventh compartment. The submarine could not independently surface because the severe angle of pitch had reduced the volume of main ballast tank blow out. Only after three days was the submarine rescued by the Navy's emergency rescue service.

For submarines with their main ballast tanks positioned only in the extreme bow or stern, controlling pitch while surfacing (with the help of blowing out the main ballast tanks) becomes complicated. To some degree this is possible to illustrate by holding a barbell in a horizontal position with both hands in the center, then disturbing the weights at the ends, Of course, more complications will arise during surfacing while not underway, or at a slow speed.

It becomes difficult to design single hull submarines with main ballast tanks positioned only in the extreme bow or stern. First, all the diving and surfacing calculations should be conducted with the utmost precision, in particular the flooding and purging the main ballast tanks. Secondly, additional measures should be taken to synchronize the supplying of air, the opening and closing of the Kingston valves and the ventilation vents of the main ballast tanks. Third, the design should provide a balanced, stable, surfaced position if one of the main ballast tanks in one of the ends of the submarine is damaged (this type of damage can occur at any time, for example, during a collision). And with this, the general reserve buoyancy decreases, the danger of heavy pitching recedes, and the difference between the trim and broached positions disappears.

In conclusion, and considering the foregoing, I would like to put forward three questions for working submariners to discuss:

1. Is it possible to do without the middle group of main ballast tanks, understanding that this group is centered along the length of the submarine?

2. Is it necessary to design single hull submarines with their main ballast tanks located in the extreme ends of the hull, and having only a relatively small buoyancy reserve (up to 20 percent)?

3. Finally, in connection with the creation and operation of the submarine with a relatively small buoyancy reserve (this is a characteristic of single hull submarines), it's worth considering increasing the effectiveness of the pressurized air system when combating incoming water in the pressure

hull when submerged.

At the current time, during emergency surfacing, supplying high pressure air into a damaged compartment, before the submarine has begun to surface is not recommended, and in fact is forbidden. During this, the pressurized air should only be used for blowing out the main ballast tanks, since only in this way (with the current buoyancy reserves) can the positive buoyancy needed for emergency surfacing be created. Feeding the high pressure air into the damaged compartment can only reduce the negative buoyancy. In this case, blowing the main ballast tanks is more effective than feeding high pressure air into the compartment. Thus the submarine will have the property of single compartment surface flotation, and consequently by effectively flowing out all of the main ballast tanks, it's theoretically possible to always have a positive buoyancy in a damaged submarine.

If the full buoyancy reserve is small and specific, and single compartment surface flotation has been effected only *during* the partial flooding of the damaged compartment, blowing out only the main ballast tanks can lead to loss of air (pressure) from the already purged main ballast and, accordingly, to the useless expenditure of pressurized air. After the complete purge of the main ballast tanks, it will be necessary to direct pressurized air into the damaged compartment (if, of course, the rupture is situated lower than the compartment's water line). If the submarine continues sinking and seawater again beings flowing into the main ballast tanks, then it's necessary to again turn on the pressurized air and feed it into the main ballast tanks, etc. However, this principle can only be realized with water level sensors in the main ballast tanks and compartments, with the sensors preferably automated. I won't stop here and detail the significance of accidents/casualties involving seawater penetrating the pressure hull of a submerged submarine, and the possibility of increasing the submarine's speed to utilize the hydrodynamic drying capabilities of the hull.

We will gratefully accept and consider opinions an suggestions on the topics discussed. Material can be sent to the following address: 197061, g. Saint Petersburg, P-61, TsNII MO RF, or to the Editor Morskoy Sbornik, 103175, Moskva, Chaplygina, 15. ■

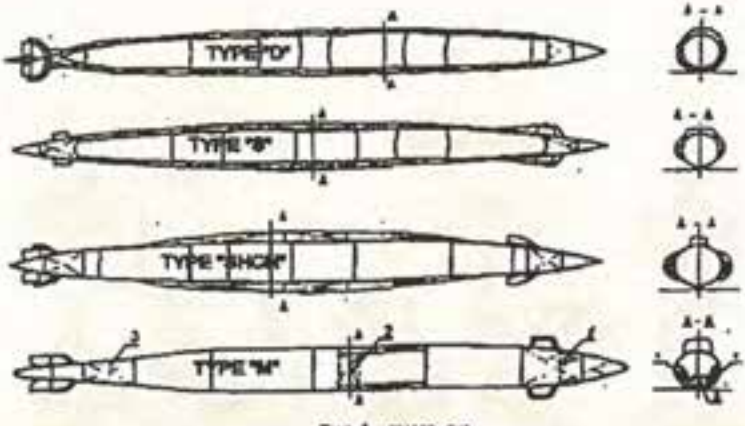


FIG. 1 (DWG #1)

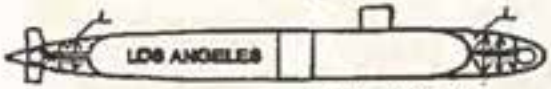
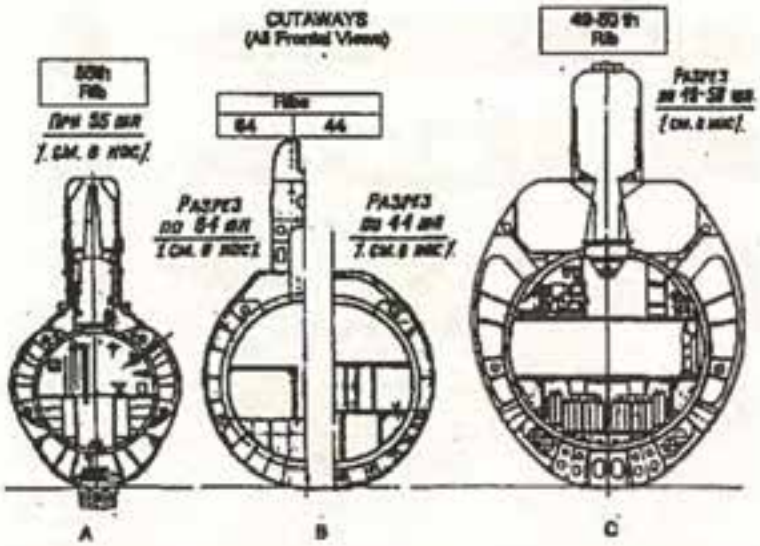


FIG. 2 (DWG #2)

Enclosure 1. Architectural types (plans and cross sections) of some Soviet submarines of pre-war design (from the top down): Type D (1st series), double hulled; Type S (9th series), hull-and-a-half; Type SHCH (5th series), with bilges; Type M (4th series), single hulled; #1-Main Ballast Tanks number 2; #2-Middle Tank; #3-Main Ballast Tanks number 3.

Drawing Two. Single hulled Los Angeles class submarine of the American Navy: #1-the bow group of Main Ballast Tanks; #2-the stern group of Main Ballast Tanks.



Enclosure 2. Cross sections of some Soviet diesel submarines of post-war design: A) attack, project 613; B) attack, project 641; C) tactical missile, project 651.

OPERATIONAL AND TECHNOLOGY IMPLICATIONS IN JOINT LITTORAL WARFARE

by John R. Benedict, Jr.
The Johns Hopkins University
Applied Physics Laboratory

[Ed. Note: This article is taken from Mr. Benedict's presentation at the Sixth Submarine Technology Symposium in May.]

Potential Drivers

Although a particular study, war game or exercise may focus on only one scenario, it is recognized that future planning and training must be based on uncertainty. The post-Cold War era is nothing if not unpredictable (and unstable) with a multitude of contingency possibilities. One can not simply concentrate on rewinning the last war or stress only 1-2 future scenarios, regardless of how convenient this may be to simplify planning and training activity.

Based on a review of U.S. Navy and Marine Corps historical involvements in regional contingencies, a diverse list of military missions is evident. These include: peacekeeping roles (presence, show of support, coastal surveillance); counter-terrorism/ narcotics operations; various peacetime/crisis contingency operations (show of force, disaster relief/humanitarian assistance, non-combatant evacuations, freedom of navigation exercises, and protection/control of air and sea lines of communication including selective embargoes/quarantines); forcible entry/recovery and seizing territory (i.e., various special force and amphibious operations); and strikes ranging from massive sustained operations to more limited strikes to achieve specific objectives (e.g., close air support, fire-support, or retaliatory/coercive strikes). Most of these missions would occur near land (in littoral settings) and would directly/indirectly contribute to achieving joint littoral warfare (JLW) battlespace dominance. Bottom line: mission flexibility is essential in JLW—highly specialized warships will be found wanting and *need not apply*. Future regional contingencies will prove challenging despite limited force levels because of various *drivers* that are likely to exist. In the **threat** area, no trend is more significant than the proliferation of high-tech weaponry into Third World regions—modern submarines, surface

platforms, and aircraft plus their advanced missiles, torpedoes, and mines. U.S. forces may also face unconventional methods of attack by small boats, craft of opportunity, or mini-subs. Limited technical and operational intelligence may exist on an adversary including the conditions under which he might employ weapons of mass destruction. In the **environment** area, littoral regions are likely to be either shallow, confined, or both, with resultant impact on usable battle space, combat maneuverability, and sensor performance. Littoral environments are also likely to be complex (e.g., propagation) and confusing (e.g., noise/ clutter). In the **operations** area, the overwhelming *driver* for most contingencies will be low tolerance for losses. Objectives must be achieved with damage and casualties commensurate with the importance of the operational objectives. Other operational *drivers* include unpredictable *come as you are* contingencies, ambiguous situations (collateral damage concerns, restrictive Rules of Engagement (ROEs) and uncertain basing or overflight rights.

Potential Technology Benefits and Current Capability

Priorities in JLW

A review of various lessons learned and planning documents for each of the services resulted in a list of eight potential benefit areas for technology—common to all services and certainly applicable to JLW. The eight technology benefit areas identified by the author are as follows:

1. *Win the information war* (achieve both situation awareness and tactical initiative, but deny the corresponding capabilities to an adversary).
2. Enhance joint operability for decisive combat.
3. Achieve economy of force.
4. Reduce force vulnerability and potential for high casualties.
5. Improve force deployability and agility.
6. Enhance force/system reliability and sustainability.
7. Improve doctrine, training, and planning.
8. Achieve greater affordability.

Actual warfighting examples of positive trends in each of these eight technology benefit areas can be shown, but only two will be highlighted at this point. The first example relates to *win the information war* and the change in Israeli air superiority operations

that occurred between the 1973 Arab-Israeli War and the 1982 Bekaa Valley Conflict. In 1973, Israel lost more than 100 aircraft, or more than one-third of its order of battle, in 19 days of combat. Conversely, in the 1982 Bekaa Valley air campaign against Syria, Israeli aircraft suffered no losses while shooting down 84 Soviet-built fighters (64 of which were destroyed in the first two days along with 19 Syrian SAM sites). Israel made superb use of electronic warfare (ELINT, deception, jamming), airborne early warning, unmanned remote piloted vehicles, and a new generation of smart munitions (AIM-9L, Exocet, anti-radar missiles) to win the information war. This was a clear forerunner to the Air Campaign in Desert Storm.

The second example relates to reduction in force vulnerability and casualties (in this case for the Marine Corps) and is synopsized in the following quote from the 1992 STAR 21 report issued by the U.S. Army:

> "In the Persian Gulf in 1991...an entire reinforced marine division suffered 24 killed in action. By contrast, the earlier [lesser] contingency operation in Lebanon...[involving] a single reinforced company had 239 killed in action."

Clearly, the Desert Storm case benefitted from much technology; whereas the 1983 lesser contingency in Lebanon proved more difficult due to the less than overwhelming forces, restrictive ROEs, and lower technology involved.

Advanced technology solutions can be expensive and will likely result in fewer weapons and platforms than in earlier eras; however, if sufficiently capable, these weapons and platforms can nevertheless achieve dramatic *force multiplier* effects. "The ultimate force multiplier", quoting future Director of Naval Intelligence Thomas A. Brooks in the July 1985 U.S. Naval Institute Proceedings, "is the ability to locate, observe and target an enemy force...while remaining undetected and denying that enemy the ability to bring his weapons to bear." Where can technology be best applied to alleviate potential warfighting deficiencies in JLW? Twenty preliminary critical capability priorities were examined this past year as part of the JLW mission area assessment and provide a useful construct for this paper; they were organized by the four key operational capability areas

described in the Department of the Navy "... From the Sea" document and, within a category, are listed in current priority order. In addition, I have provided a subjective indication (low, medium, high) of the extent that U.S. attack submarines appear to be potentially involved in these capability areas. The 20 priority capability areas are as follows:

A. Battlespace Dominance
   1. Self-defense against sea-skimmers (--)
   2. Mine warfare (M-H)
   3. Area-defense against sea-skimmers (L)
   4. Shallow water antisubmarine warfare (ASW) (H)
   5. Tactical ballistic missile (TBM) defense (L)
   6. Shallow water torpedo effectiveness (H)
   7. Torpedo defense (M)

B. Power Projection
   1. Integrated strike (M-H)
   2. Enabling components - Marine Corps (L-M)
   3. Mine warfare (M-H)
   4. Aircraft survivability (--)
   5. Naval fire support (L)
   6. Special operations forces (SOF) (H)

C. Command/Control and Surveillance
   1. Joint command and control (C^4I) (M-H)
   2. Combat assessment-battle damage assessment (BDA) (M)
   3. Surveillance (H)

D. Force Sustainment
   1. Sealift force (--)
   2. Combat logistics force (--)
   3. Protection (M)
   4. Logistics over the shore (--)

U.S. attack submarine involvement (areas of interest) appear to be highest in surveillance, C4I, mine warfare, shallow water ASW (including torpedo effectiveness), integrated strike, and the insertion, support, and extraction of SOF assets. The technology examples that follow for the three principal themes of the paper will focus on these areas.

Win the Information War in JLW

Theme #1 for this paper is *win the information war*, and it has four facets. First, it includes adequate command, control, and intelligence assets to direct and control the employment of forces as well as to manage and to disseminate information among these forces. Second, it involves electronic combat to perform effective force-wide surveillance, reconnaissance, tracking, targeting, engagement, BDA and reengagement functions. Third, it includes countermeasures to deny these same and electronic combat capabilities to an adversary, e.g., by jamming or destroying key nodes. Finally, it involves the supporting areas of operational security and signals management.

What capabilities are then needed to enhance SSN contributions to winning the information war? These capabilities should include the following: improved SSN communications to assure being an integral part of force-wide battle management and surveillance systems; maintenance and development of unique SSN intelligence collection capabilities; enhanced SSN reconnaissance, surveillance, targeting and BDA capabilities (across the electromagnetic and acoustic spectrums) including employment of unmanned underwater/air vehicles (UUVs, UAVs); enhanced SSN precision strike and SOF insertion capabilities advanced deception technology (acoustic, electromagnetic) for employment by SSNs. Two areas of related technologies (to Theme #1) will now be addressed.

To improve SSN communications/connectivity to allow full participation in joint task force operations, a number of technology areas are being (or could be) pursued. These include advanced towed buoys to allow tactical communications at speed and depth, additional data links to allow real time tactical data exchange (e.g., with aircraft), *bell ringer* technologies (ELF, acoustic, laser), robust SATCOM capability (e.g., advanced antennas, data compression, multiplexing techniques) to allow greater access to surveillance and targeting data, required interfaces with "Copernicus", special communications links for off-board systems or forces ashore, and various communication technologies related to ensuring countermeasure resistance and LPI (low probability of intercept) signal transmissions.

To improve SSN surveillance, spotting and BDA capability in support of strike and SOF missions, SSNs need the capability to control unmanned air vehicles (UAVs) and to exploit UAV data in

the near-term. In the far-term, SSNs should also be designed to deploy and recover UAVs. Technologies related to UAVs that should be of interest to the attack submarine community would include VTOL technology (to allow SSN employment), light-weight high efficiency propulsion, signature control technology, multi-domain sensor systems, and integrated multi-spectral processing techniques. The exact mix of sensors on the UAV would depend on the application (probably including day-night use) and could include a special TV, forward looking infrared, electronic support measures (ESM), or various types of radars (e.g., mini-synthetic aperture radar, millimeter wave radar or laser radar).

Reduce Potential for High Casualties in JLW

Theme #2 for this paper is to reduce joint force vulnerability and potential for casualties when employed in littoral regions. The following eight operational needs are apparent to this author for JLW: the need to counter-aircraft, counter-warships/fast-attack craft (FAC)/small boats, counter-submarines, counter-coastal cruise missiles, counter-tactical ballistic missiles (TBM), counter surface-to-air missiles (SAM), counter-mines, and counter-terrorism (e.g, rescue hostages). U.S. SSNs could be expected to make either primary or secondary contributions in most of these *counter* roles; however, only the two needs involving undersea warfare (counter-mines, counter-submarines) will be highlighted later in terms of related technologies of interest to SSNs.

But first, actual operational examples (both poor and good) will be identified for these eight vulnerability categories. Poor and good examples of counter-aircraft performance exist in the British Falklands and U.S./Coalition Gulf War experiences, respectively. To date most counter-warship/FAC/small boat examples have been good including the British in the Falklands, the U.S. during Libyan operations (1981, 1986), and the U.S./coalition forces in the Gulf (1987-1991). U.S. counter-submarine activity has been confined to various exercises and, if recent SHAREMs are any indication, the results have been less than stellar against diesel submarines (even those operated by developing or Third World countries). The ASW experiences of the British in the Falklands and of India in the 1971 War with Pakistan have also not been very encouraging. The U.S./coalition counter-TBM (*Scud Hunt*)

and counter-coastal cruise missile performance were poor and good, respectively, although coastal cruise missiles would be a greater concern in other scenarios, e.g., involving Iran and the Strait of Hormuz. Recent counter-SAM examples (1986 Libya, 1991 Gulf War) have been markedly better than earlier experiences (1972 Vietnam Linebacker I Operation, 1983 Lebanon Strike). Counter-mine examples from 1950 in Korea to 1987-1991 Gulf operations have been generally poor with the only exceptions being various clean-up operations (e.g., after conflicts are over). Poor and good counter-terrorism examples exist in the 1980 Desert One and 1985 Achille Lauro incidents, respectively. In summary, the overall warfighting trends are good, but significant deficiencies appear to exist in countering mines, countering certain missile delivery mechanisms, and countering submarines.

What capabilities are then needed to enhance SSN contributions to reducing force vulnerability and potential casualties? These capabilities should include the following: enhanced capabilities against diesel submarines, mini-subs and large ships, and smaller craft in adverse littoral environments; maintenance of effective offensive mining capability and development of covert minefield reconnaissance capability; enhanced force alertment capability against aircraft and missile attacks from ashore; improved capabilities to support SSN (and other force) strikes on fixed or mobile sites; enhanced special warfare force capabilities; and reduced ability of adversary forces to detect (and engage) SSNs in shallow and confined littoral environments. This last capability related to self-defense would also include adequate mine detection and avoidance capabilities.

To improve SSN shallow water ASW (or near land ASW) sensor capabilities, a number of technology areas are being (or could be) pursued. These include advanced sonar (active, passive) technologies, advanced information processing techniques (i.e., data fusion for effective classification and tracking), and torpedo guidance and control improvements for shallow water and low doppler target conditions. Advanced active sonar related technologies of interest are reverberation suppression techniques, LPI, advanced classification algorithms, and bistatic receivers. Advanced passive sonar related technologies of interest are full spectrum processing, machine-aided detection techniques, adaptive beamforming, and enhanced acoustic intercept receivers.

To improve SSN minefield reconnaissance (or mine detection

and avoidance) capabilities, a number of technology areas related to unmanned underwater vehicles (UUVs) are being (or could be) pursued. These include the following: high-energy density power systems; technologies to support ruggedness, reliability, stealth, and minimum maintenance requirements for UUVs; advanced mission controllers; advanced microprocessors for untethered control, auto detect and classify, image processing, and fault-tolerant computing; ultra-thin low-loss fiber optic cables; precision navigation systems; advanced sensor suites (swath echo-sounding/side-scan sonars, cameras); small onboard (SSN) support systems for planning, control, and display; and advanced launch and recovery techniques.

To improve SSN stealth in shallow and/or confined littoral environments, a number of technology areas are being (or could be) pursued. These include signature management and control systems, enhanced structural acoustics design concepts, sail and periscope signature reduction techniques, submarine hull treatments (coatings, paints for camouflage), advanced propulsors, magnetic (electric) field reduction techniques, and signature control technology for expendables and off-board systems, i.e., UUV, swimmer delivery vehicle (SDV), communications buoy, weapon launch. Stealth is the quintessential attribute for U.S. attack submarines but, in a cautionary note, it should not be over-designed for future regional contingencies, i.e., a clear vision of potential vulnerabilities (e.g., to modern mines) must be traded off against affordability in future submarine designs. It should also be remembered that designs for new submarines that will enter the fleet early in the next century must be robust enough to pace (or allow pacing) of threat developments through the year 2030 or beyond. **Regional threats to SSNs may be relatively low today but that will not always be so, particularly if ill-advised (short-sighted) cost reduction measures related to stealth are adopted today.**

Achieve Greater Affordability

Theme #3 for this paper is to achieve greater affordability in future submarine design. To improve SSN affordability, five technology categories have been identified. First, automation techniques can be used to reduce crew requirements for both operations and maintenance. In the operations area advanced

decision support systems, tactical decision aids (TDAs), and improved and automated signal analysis techniques could result in crew reductions. More importantly perhaps, automation techniques could reduce crew requirements for ship maintenance. These potential techniques could include high reliability component design, plug-compatible components, fault-tolerant designs, and advanced monitoring/fault-correction systems.

The second and third related technology categories would reduce space and weight requirements for HME (hull, machinery and electrical) and combat systems, respectively. On the HME side smaller nuclear reactor plants,alternative pump/motor/ cooling system concepts, and simplified piping and valving arrangements could be investigated. On the combat systems side non-hull penetrating periscopes, reduction or elimination of separate radio rooms, innovative combat system architectures, and reduced size acoustic arrays (e.g., in the bow) should be considered for impact on ship weight and space (and whether associated cost savings would be evident).

The fourth technology category involves computer architectures and interfaces to ease future upgrades to SSNs. Among the concepts under consideration are *open architectures*, software standards and protocols, reusable software code, and reliance on non-developmental items (NDI)/commercial off the shelf (COTS) systems, e.g., militarization of commercial work stations. The last related technology area involves advanced manufacturing processes such as design simulation and visualization tools and efficient low volume production techniques.

SSN affordability versus capability trade-offs will determine eventual SSN force levels and mission utilization. Technology potentially has as much of a role in controlling/ reducing costs as it does in maintaining/increasing warfighting capabilities.

Summary/Conclusions

It is essential that the correct balance between near-term *requirements pull* and far-term *technology push* be achieved in JLW planning, based on a clear strategic vision. This research, development, and acquisition strategy should not over-react to the Gulf War or focus exclusively on Persian Gulf scenarios; instead planning should be based on a variety of potential contingencies in order to design for flexible mission execution by U.S. attack

submarines in an uncertain future.

In addition, the vulnerability of surface forces (and aircraft) in regional contingencies will likely increase as Third World countries gain access to and learn to effectively employ high-tech weaponry. This should result in expanded mission opportunities for submarines if they have the needed technical wherewithal to perform those missions. SSN conduct of both new and traditional roles should significantly contribute to minimizing force casualties (including the indirect benefit of not putting more vulnerable platforms at risk).

The Gulf of Oman/Strait of Hormuz/Persian Gulf littoral region is not only a high interest scenario locale but in many ways it represents the essence of joint littoral warfare, i.e., featuring shallow and/or confined seas and a variety of potential threats. These threats include mines, coastal cruise missiles, missile-equipped FAC, small boats, submarines, mini-submarines, missile-equipped aircraft, coastal SAMs, etc..

If during a future contingency the Strait of Hormuz (SOH) is closed to most surface forces for several weeks due to mines or coastal defenses, could future SSNs *pick up the slack* by operating aggressively in the same region denied to other forces. If not, why not? Because of lack of warfighting capabilities or due to concern for SSN vulnerability while performing certain missions in shallow, confined, heavily defended and minable coastal seas? We can control the answer to this hypothetical question by a prudent investment in submarine related technologies in the coming years.

Technology advances related to SSNs that should be of most benefit in JLW will likely occur in the following areas:

1. Communications/connectivity
2. Recce/surveillance/intel/targeting/BDA
3. Precision strike
4. Special force insertion/support/extraction
5. Shallow water ASW
6. Mine warfare
7. Platform survivability
8. Platform affordability

It should be noted that the "cueing, connectivity and offboard systems" theme of the late 1980's still appears valid for circa

2000-2010. Thus, future attack submarine designs should allow for flexible employment of a variety of offboard systems including SDVs, UUVs and UAVs (Note: with employment unconstrained by the particular dimensions of torpedo tubes).

In conclusion, **stealth can be the ultimate force multiplier in JLW**, but only if the platform involved has the requisite warfighting capability enhancements (via technology upgrades) to allow optimal exploitation of this stealth. Quoting Admiral Jeremiah from a recent speech, "we're moving away from systems that are so inflexible that they cannot be upgraded to exploit new technologies...we're moving away from systems that are so specialized that they can only be used against a narrow threat or in a very unique environment". Flexibility is clearly the key in JLW, and technology is the enabler—thus, future SSNs must be carefully designed to incorporate (or allow incorporation of) high *value-added* technologies for JLW. So let's get on with it; the future remains bright for judicious and innovative application of advanced technology to the U.S. attack submarine force. ■

[Mr. Benedict is a member of the Principal Professional Staff of The Johns Hopkins University Applied Physics Laboratory in the Naval Warfare Analysis Department, specializing in anti-submarine warfare (ASW). He is Study Director for the Submarine Offboard Mine Search System (SOMSS) COEA and is a principal investigator for the update to the Congressionally mandated MIW plan. He has a B.S. in Mathematics from the University of Maryland and a M.S. in Numerical Science from The Johns Hopkins University].

WHY SUBMARINES FOR PRECISION STRIKE?

by Dr. James R. Brooke
General Dynamics
Electric Boat Division

[Ed. Note: This article is taken from Dr. Brooke's presentation at the Sixth Submarine Technology Symposium in May.]

The Need for a Covert Strike Capability

The question has been asked: Why should this nation continue to invest in technology for undersea precision strike? One answer, in the opinion of this author, lies in the ever increasing proliferation of advanced conventional and special weapon technology into the hands of so-called *rogue* nations. This *threat*, according to the new Director of Central Intelligence (DCI), R. James Woolsey, has the alarming potential of placing future naval forces deployed forward at risk. During testimony at a recent Senate Government Affairs Committee hearing, the DCI made the following points to back up that assertion:

- Advanced surface-to-air missiles that can detect U.S. stealth aircraft and cruise missiles are part of a growing list of technologies seeping into the Third World.
- The Allied victory over Iraq triggered Third World demand for advanced conventional weapons.
- Some precision guided weapons (PGM) now on the market are more capable than certain U.S. systems.
- Already Iran, Syria and Libya are fielding cruise missiles with precision guidance and countermeasures effective enough to threaten U.S. naval forces.
- Advanced conventional weapons may have a "more pronounced impact on the military outcome of future regional conflicts than weapons of mass destruction".[1] The DCI concluded his remarks by outlining future threats as single-stage, Scud-type missiles mated with chemical weapons, two-stage missiles with the range to threaten Europe and American forces overseas, and in as little as 10 years, an ICBM threat to the Continental U.S.

Likewise, then-Congressman Les Aspin in his January 1992 paper, From Deterrence to Denuking: A New Nuclear Policy for the 1990s, warned:

> "Nuclear weapons would likely be the only way a nation with inferior conventional forces could hope to counter our superiority. It is in our supreme national interest to stem the spread of nuclear weapons, nuclear weapons technologies, and their associated delivery systems."

Now-Secretary of Defense Aspin lists the proliferation of nuclear weapons as the first of four "dangers" confronting the United States. Speaking at his welcoming ceremony on February 1, 1993, Aspin said, "the new nuclear danger stems from a handful of warheads in the hands of terrorists or terrorist states."

These new threats—advanced conventional weapons, *weapons of mass terror* and nuclear weapons—threats that could put U.S. ground and naval forces at risk, will undoubtedly motivate new risk-minimizing ways to deploy our forces overseas. The concept of preemption—in light of this new class of weapons—is now spoken of more frequently. Again, in the same paper of January 1992, Congressman Aspin wrote:

> "We must confront and work through together the prospect that force may be the only way in some instances to stop proliferation of nuclear weapons."

The element of *surprise*—to shutdown or preempt an adversary's ability to deliver advanced conventional or nuclear weapons either within a theater of conflict against allies, or in placing U.S. forces at risk—has now re-emerged in the lexicon of necessary crisis response actions within the new strategic environment.

The element of surprise is, and always has been, just one of a myriad of enduring characteristics of the attack submarine. An ability to be pre-positioned in-close to a shoreline, undetected, for indefinite periods of time, loaded with stand-off precision weapons to be fired on authorization after all diplomatic activity has proved fruitless, at little or no risk to the platform or lives on it, is now a compelling option of choice when deterrence of advanced conventional or nuclear weapons is the declaratory policy.

Precision Strike

The goal of the precision strike mission, one of the seven announced science and technology thrusts, was articulated by the Department of Defense in a July 1992 briefing document as follows:

> "The desire for **reduced casualties, economy of force**, and **fewer weapons platforms** demands that we locate high-value, **time-sensitive fixed and mobile targets** and destroy them with a **high degree of confidence** within **tactically useful timelines.**"

Descriptive terms such as reduced casualties, economy of force, time-sensitive fixed and mobile targets, high degree of confidence, and tactically useful timelines, fit exceptionally well with the enduring complementary characteristics of attack submarines and advanced technology cruise missiles. The ultimate goal of undersea strike should be the denial of refuge for any adversary.

The attack submarine force exists to provide the theater commander with a range of warfighting options, including precision strike. One may begin to sense the utility of such an option if the problem happens to be one of weapons of mass terror, regional intimidation, and the capability to deliver such weapons. As the U.S. declaratory policy is deterrence, the option to pre-position strike forces in a covert manner, inserted or withdrawn without fanfare while diplomatic activity continues, with the capability to attack **with surprise** against "time-sensitive fixed and mobile targets" with "tactically useful timelines", the utility and complementary nature of cruise missile and submarine technology is readily apparent. However, **describing** the utility of the attack submarine in the precision strike role and **measuring** that utility are, of course, two different issues. Quantifying the usefulness of cruise missiles launched from under the sea is a challenge but one worthy of exploration and study. The following section describes one attempt to quantifiably measure the utility of attack submarine precision strike.

Measuring SSN Precision Strike Utility: A Three-Step Process

This section describes the methodology used in attempting to quantifiably define the value-added of attack submarine precision strike operations.

Step One. The first step in building a model that will illustrate a measure of effectiveness is to make some basic assumptions regarding the target. These assumptions include:

- For every target set (such as an airbase, for example) there is a percentage of specific targets that are dispersible (aircraft, missiles, etc.) and some that are fixed (plants, command posts).
- The dispersible targets will commence relocating after a time period (t_s) representing preparation following alert of an impending attack.
- Moveable targets are dispersed rapidly at first, then slower until all that are moveable are relocated; i.e., relative dispersal rate decreases with time.

Step Two. The second step adds to the dispersal rate a normalized scale of range and time. The scale is normalized at .65M representing the average speed of a Tomahawk cruise missile. Through this methodology one can begin to link range, time and percentage of targets dispersed. If the alert time is 20 minutes and all 20 percent of the targets that are moveable are dispersed by approximately 75 minutes, then any surprise or pre-emptive strike occurring at less than 200 nm will strike the target set during the movement preparation phase when 100 percent of the target set is at the mission planned location.

Step Three. In step three, after computing some basic weaponeering figures based on a known probability of kill (P_k) for a derived target set, we can compute the number of TLAM sorties required. Additionally, if we assume that each aircraft is loaded with two JDAM, the equivalent of two cruise missiles, we can also compute the number of aircraft sorties required for the same target. Aircraft success rate is assumed to be 80 percent (20 percent factor for maintenance, in-flight abort, etc.).

Completed Model. After all three steps are completed, we can now link the three elements of the model to illustrate the advantages of surprise, or in-close land attack, covert precision strike.

A less than 200 nm strike could be accomplished by a submerged, prepositioned strike asset with minimal risk from an increasing threat of conventional weapon delivery. Greater than 500 nm delivery could be accomplished by any naval force asset (TLAM or aircraft or combination) without risk to the platform

due to being outside an advanced conventional weapon delivery threat. By assuming two aircraft sorties required for each dispersed threat (one for the preplanned position, the other to find the dispersed target), we can see the nominal increase in strike sorties required as a function of range and dispersed targets.

Model Results. To have a capability that can penetrate increasingly lethal advanced conventional weapon delivery threat envelopes, to be prepositioned off the coast for a preemptive strike prior to any target being dispersed, to be covertly present in close striking distance during on-going diplomatic activity, would seem to be a deployment option offering unique utility to any theater commander. Minimizing life or POW risk, minimizing target dispersal potential, maximizing cruise missile lethality and survivability by penetrating unalerted or misaligned defenses, enabling maximum CVBG TACAIR launch options through elimination (or delaying) of conventional weapon delivery and minimizing the potential for retaliation either against allies in the region or naval forces in the littoral are the inherent significant advantages of in-close covert strike. Another potential advantage is the possibility for operational synergy with other stealth assets (B-2, F-117, AF/X) in combining for an effective stealth attack.

The following scenario, using unclassified references to describe the future advanced conventional weapon delivery threat serves a useful purpose in applying this model to a hypothetical crisis.

Scenario

This scenario involves all the potential threat warning signs that were described at the beginning of this paper: a Third World nation that has accumulated advanced conventional weaponry as well as a nascent nuclear capability, delivery systems that put the region as well as naval forces at risk, and a belligerent government that does not hesitate to use these assets to intimidate and influence regional behavior for personal gain.

Of concern is the increasing trend in advanced conventional and nuclear technology accumulation for a representative Third World nation. SU-24 possession is of keen interest due to its long-range delivery capability that affects not only the region but forward deployed naval forces as well.

Our hypothetical scenario emphasizes deterrence and covert strike planning. The operative threat in this case is the SU-24

aircraft loaded with an air-launched cruise missile that can be either nuclear, chemical, or biological warhead-capable, potentially placing naval forces deployed in the area at increased risk. Joint forces such as the B-2 squadron at Whiteman AFB and the Air Combat Command's Intervention Wing are also brought into play.

The primary operational objective is to employ a 6-SSN strike force to pre-emptively attack (after diplomatic activity has proved fruitless) the potential aggressor's conventional weapon delivery capability—both air and ground launched—in order to enable a CVBG task force multiple launch points to attack infrastructure. A pre-emptory attack also minimizes the risk of retaliation by them against pro-Western allies in the region.

The threat is of both air and ground. SU-24 with an air-launched cruise missile gives it an approximate 700 nm combat radius. The surface-to-surface missile threat (estimated by Janes to be exportable by North Korea in 1994) has a reach of 620 nm. The areas of influence with just these two delivery systems alone is considerable. The U.S. decides to dispatch a 6-SSN strike force and various joint forces for response. The decision is made to retain the CVBG outside the SU-24 threat radius, minimizing the risk of an air-launched *leaker*.

The actual SSN/B-2 pre-emptive strike is made against delivery bases and critical weapons staging areas. Utilizing our aforementioned elementary weaponeering calculations against a generic airbase and missile sites, we can determine that 144 TLAM are required leaving 24 TLAM remaining for possible air defense suppression strikes.

To reiterate, the primary objective of U.S. forces in this scenario is to strike the delivery capability **before** there is potential for target dispersal, launch or retaliation. Surprise is crucial to this operational concept and suggests a compelling role for the attack submarine in a covert land attack.

Payoff

The results of scenario development can be analyzed in terms of the measure of effectiveness model. The assumption is made that for the basic target set we have chosen (1 airbase, 2 surface-to-surface bases) 10 percent of the individual target elements are dispersible after an alert time of 20 minutes. Using the .65M normalized range/time scale, we can determine that 20 minutes (t_c) equates to approximately 130 nm. Therefore, to ensure ordnance

arrives at the target prior to dispersement initiation, an attack — maximized by the element of surprise offered by an SSN — must be launched at a target range of less than 130 nm.

As is current naval warfighting policy, most strike plans would include a combination of cruise missiles and aircraft. Cruise missiles would normally hit highly defended targets or air defense nodes to enable a more effective tactical aircraft strike. That operational concept can be taken one step further: with a potential advanced conventional or nuclear weapon threat radius (in this case, 700nm), there may arise a necessity for a surprise or pre-emption strike against delivery systems prior to dispersement which, if successful, would free up the carrier to launch follow-on strikes from a number of locations. Any increase in strike range greater than 130 nm would force the theater commander to contend with dispersed targets—increasing sorties required, increasing risk of life, and possibly decreasing mission effectiveness. Medium- to long-range naval force strikes—inherently foregoing the element of surprise—would also allow the adversary opportunity to retaliate either against naval forces or against other allies in the region in addition to increasing the likelihood of targets not being at planned locations.

Summary

This paper has attempted to describe one possible MOE model that quantifies the utility of surprise in SSN precision strike operations. Acknowledging that this is a somewhat rough attempt —and that more refinement is required—this author would nonetheless conclude that in an age of increasing proliferation of advanced conventional weapon technology as well as nuclear components, it will be imperative for the theater commander to have on-scene, covert strike options. Preemptive attack, prior to threat launch or relocation, will assume a higher strike option priority as the risk from advanced conventional and nuclear weaponry becomes greater. ■

NOTES

1. "Aviation Week and Space Technology", 1 March 1993, p. 25.

[The opinions expressed in this paper are those solely of the author, and do not necessarily reflect the views of General Dynamics, Electric Boat Division.]

[Dr. Brooke retired from the Navy in 1990 after 20 years as a naval aviator. He accumulated over 4000 hours in seven aircraft and was Commanding Officer, VS-38, an S-3A Viking squadron. In addition to his naval aviation experience Dr. Brooke had tours of duty on the staffs of Commander Carrier Group One, Command ASW Wing Pacific and the Director, Navy Program Planning in the Pentagon.

His doctorate is from the Fletcher School of Law and Diplomacy, Tufts University.

During his career with General Dynamics, Dr. Brooks has made numerous presentations on military strategy and advanced systems to audiences within the Defense planning community.]

PAT LEWIS
MEMORIAL SCHOLARSHIP

Contributions are being received at NSL Headquarters for a Dolphin Scholarship in memory of Pat Lewis.

- If contributions of at least a total of $1,000 have been received by early March of 1994, a one year **Pat Lewis Memorial Dolphin Scholarship** will be established.
- Once the memorial scholarship awardee is named, NSL will strive to honor her or him during the Symposium Banquet on June 16, 1994
- Contributions should be sent to NSL Headquarters, payable to Naval Submarine League, and marked Pat Lewis Memorial Scholarship. Contributions are deductible; receipts will be provided.

SUBMARINERS AS BATTLE GROUP COMMANDERS
An Idea Whose Time Has Come

by RADM David M. Goebel, USN

Recent changes within the OPNAV organization have had as one of its goals the removal of warfare branch parochialism. Then Secretary of the Navy O'Keefe commented to this effect at the initial press conference when the reorganization was announced. One result of the reorganization has been that the three star barons have been replaced by two star mini-barons and budgetary dollars, which used to be distributed to the warfare specialists for individualized spending, are now only done so after all warfare priorities are integrated. In support of this, the fleet has been encouraged to take a much stronger role in determining future warfighting requirements which should also lead to a more integrated approach to determining acquisition priorities. Additionally, it is rumored that there is support in some camps to follow the Admiral Ike Kidd model and require flag officers to remove their warfare specialty pins when they attain flag rank. The mood is clearly one of barrier reduction in the best Deming manner (Point 9), putting the goals of the organization, (in this case, Navy) above the goals of the individual (in this case, individual warfare specialty). In this environment of increased professional integration, is it not time to consider assigning a submarine flag officer as a Battle Group Commander? A second but related question is, can this flag officer also be a Submarine Group Commander just as today's Battle Group Commanders are Carrier Group and Cruiser-Destroyer Group Commanders?

In today's world the Battle Group commands are restricted to surface warrior and aviator flags. It is evidently felt that the ships which comprise the Battle Group and/or the taskings assigned the Battle Group are sufficiently unique that officers reared outside the Battle Group main stream will not be capable of commanding such a force. It is clear that this kind of thought is *old think* and there are numerous examples to indicate this point. Additionally, assignment of a submariner would not result in a *Battle Group neophyte* as some might think. In the first place, submarines are now assigned as members of Battle Groups and whole wardrooms are thereby gaining first hand experience in Battle Group operations. Their bosses must keep pace in order to properly train and equip them for this mission. The submarine community also fills

supporting roles on the Battle Group staff with junior officers as Submarine Liaison Officers. We do likewise on numbered fleet staffs where Commanders/junior Captains serve as ASW officers and C^{4}I officers. Additionally, for several years now submarine qualified Captains have served successfully as CARGRU or numbered fleet Chief Staff officers, working Battle Group issues day in and day out. Several of these officers have gone on to become flag officers, including Vice Admiral Emery and Rear Admirals Oliver and Clemins. Submariners have also served with distinction as Fleet Commanders. Looking only at those who have so served in the recent past, the list includes Admirals McKee, Kelso and Larson, and Vice Admirals Williams and Owens. In each case these officers directed fundamental Battle Group actions without the benefit of a prior Battle Group command. And who would argue that any of the other submarine three and four star officers over the years could also have performed well in the fleet commander role had the opportunity presented itself. It is therefore a natural follow on question: Why not assign a submarine flag officer (possibly also a Submarine Group Commander) as a Battle Group Commander?

In fact, such an assignment would be a natural extension of the current assignment policies for it would plug a hole between the major command and fleet command positions if a submariner were to move into the Battle Group Commander slot. The submarine community is already integrally involved in Battle Group and numbered fleet supporting roles. Therefore, possibly a more germane issue would be whether the Submarine Group staff is structured as well as the Carrier Group staff or the Cruiser-Destroyer Group staff for running a Battle Group. And if not staffed as well, are they *adequately* staffed to perform this tasking?

Before this issue is undertaken though, it is instructive to first look at the differences in the missions and responsibilities between the Submarine Groups and the Carrier Groups and Cruiser-Destroyer Groups today. The Submarine Group is an administrative commander to one or more submarine squadrons as well as ships in related shipyards, responsible for conducting various operational and administrative certifications (e.g., supply management inspection, tactical readiness, communications readiness, post shipyard readiness for reactor operation, as well as at sea operations, etc.) for the assigned submarines. In the case of Submarine Group TWO this has included 56 submarines in four submarine

squadrons and four shipyards, with the operational examinations being conducted at an approximate 15 month interval. Submarine Group staffs do not deploy routinely (RADM Oliver deployed once to Alaska when he was SUBGRU FIVE) and are not in the operational chain of command for deploying submarines, but clearly stay current on operational matters by virtue of their certification responsibilities, as well as the frequent times they go to sea on assigned submarines to observe underway operations.

On the other hand, Carrier Group staffs and Cruiser-Destroyer Group staffs do deploy (as part of their assigned Battle Group) and serve as the operational commander for the units assigned during that deployment. However, when not deployed, they do not routinely have ships assigned and devote the time between deployments to preparing the staff for the next deployment. Neither ship training, training certification nor maintenance responsibilities are vested in the Carrier Group staffs or Cruiser-Destroyer Group staffs during the periods not actually assigned to a Battle Group. In many respects then the Submarine Group, who spends time at sea year round, is as operationally prepared as its Carrier Group or Cruiser-Destroyer Group counterparts, and perhaps more so, when the Battle Group pre-deployment workup begins.

Recognizing the natural extension of the assignment process, COMSUBLANT (Vice Admiral Chiles) started to work with CINCLANTFLT (Admiral Mauz) in October 1992 to factor the Submarine Group Commander into rotation as Commander Task Group 4.1 (CTG 4.1), leading the Navy's drug interdiction efforts in the Caribbean for Commander Joint Task Force FOUR (CJTF FOUR) (Rear Admiral Gee) in Key West. Although shifting priorities have recently deleted that underway flag assignment and directed CJTF FOUR to control the operation from ashore, it is instructive to review the span of control of CTG 4.1, to examine how it might compare to a Battle Group.

CTG 4.1 was a joint command, routinely consisting of 8-10 Navy ships in the Caribbean and along the Pacific coast, possibly a U.S. and a Dutch ship, at least two Coast Guard cutters and about 40 Navy, Air Force and Coast Guard aircraft, including E2s, E3s, P3s, F15/F16s and EC130s. And, although not directly controlled by CTG 4.1, the TG interfaced daily with the U.S. Customs Agency and their fleet of aircraft (P3s, Citations) in the AOR, the Drug Enforcement Agency, and various civil law

enforcement agencies. It also interfaced frequently with foreign governments via the State Department (using a middle man), not unlike the Battle Groups and the numbered fleets, for that matter.

But is CTG 4.1 a Battle Group? It doesn't have a carrier some might say, and therefore can't be a Battle Group. However, these nay sayers must remember that the Sixth Fleet frequently doesn't have a carrier, and the remaining Mediterranean assets are often diluted to numbers equal to or less than those assigned to CTG 4.1. It follows then that, although CTG 4.1 did not have the same structure as a Battle Group, it could certainly pass as a reasonable facsimile of a Battle Group, but with joint responsibilities. In fact, some of our assigned Battle Group Commanders have never had the opportunity to deploy with their Battle Group over the past few years for one reason or another, and assignment as CTG 4.1 was the only *Battle Group* deployment they or their staffs received.

Although COMSUBLANT had started to work the process to have a submariner assigned as CTG 4.1, success was not anticipated until Spring-Fall 1993. Other staffs had already been scheduled to fulfill this commitment. However, in November 1992 an unexpected gap in coverage occurred. A replacement was needed. COMSUBLANT was tasked to fill in behind this loss and he assigned Commander Submarine Group TWO the responsibilities to prepare for and conduct this mission.

Earlier mentioned was the need to look at whether the Submarine Group staff was *adequately* prepared to perform as a Battle Group staff. Without going into excruciating detail about each and every staff billet, let's look instead at where holes might be on the Submarine Group staff. Intelligence, legal, messing, and administrative support are comparable. Submarine Groups can even provide SEWC trained individuals. What is missing is coverage in the air operations area and the expertise to step in and immediately assume the duties as the Staff Tactical Action Officer (STAO). These deficiencies are manageable with advanced planning. For example, the air operations job can be covered by assigning an aviation experienced officer(s) to the Submarine Group staff similar to those assigned to a Cruiser-Destroyer Group staff. Concerning the STAO job, it can really only be learned *in situ*, but a concentrated training regime at TACTRAGRULANT (or PAC) with a professional TAO team on the flagship can make this transition imminently doable. This is not intended to belittle the extensive TAO qualification, which ultimately vests in this

experienced individual weapons release authority. The STAO can be lesser qualified and certainly would not need to be a super TAO, although it would be nice. The six month Battle Group workup would upgrade the Submarine Group watchstanders significantly in this arena and thereby help mitigate the obvious lack of experience.

Some might think that the duties of surface operations would also confound the Submarine Group, but naval officers with experience in submarine routing can perform this function once the concern for fuel burn rates—not normally a consideration in the nuclear Navy—is integrated with the overall operational needs of the Task Group/Battle Group Commander. Clearly some learning would be required here. Unique characteristics/capabilities of various ship types needed to effectively fight the ships can be gleaned from an experienced Surface Liaison officer, similar to the Submarine Liaison officer. Again, the six month Battle Group workup would upgrade the Submarine Group staff significantly.

From a *CTG 4.1 after action report* type approach, the Submarine Group TWO staff met the basic mold and was therefore *adequately* prepared to assume the duties aboard the flagship for drug ops. To make up for the lack of unique Battle Group type experience and the fact that there was no workup per se (1-1/2 days at TACTRAGRULANT) members of the Carrier Group SIX staff were integrated with members of the Submarine Group TWO staff for the deployment, with Commander Submarine Group TWO as CTG 4.1. Heavy reliance was placed on the prior drug ops experience of the Carrier Group SIX officers for the first half of the deployment, with the Submarine Group TWO officers assuming the primary responsibilities on the second half. The Carrier Group SIX staff continued to provide the air operations expertise. There appeared to be no lapse in professionalism when the shift occurred. A POA&M had been prepared prior to the deployment to maximize the efficiency of preparation by the Submarine Group staff, as well as the implementation of a shortened STAO qualification card and syllabus intended to bring the submarine qualified officer up to speed on air contact tracking and coordination as rapidly as possible. As a result of superb cooperation between the two staffs and the flagship, USS DALE (CG 19), the deployment was successful. And because of a well qualified staff left behind, the Submarine Group TWO normal functions did not suffer during the deployment.

So, although CTG 4.1 was not exactly a Carrier Battle Group in the purest sense, since there was no carrier associated with the other forces, the span of control of CTG 4.1 was sufficiently broad that there was a very close resemblance to a Carrier Battle Group. The Submarine Group TWO staff clearly required augmentation for the deployment to be successful and this augmentation served the dual purpose of enabling additional officers to be left behind to carry out the normal routine. Such augmentation on a permanent basis is an achievable event and would go a long way toward enhancing submariner cross training as well as preparing the Submarine Group staff for eventual Battle Group deployment. When this occurs, possibly we could do away with the terms Carrier, Cruiser-Destroyer and Submarine Group Commander and retitle the job as, for example, Commander Naval Expeditionary Task Group. Submariners have demonstrated the ability to perform well on both sides of the Battle Group spectrum, that is as members of a Battle Group and as junior officers on Battle Group staffs, as well as serving as numbered fleet staff officers and as numbered fleet commanders. The next natural extension is to assign a submarine qualified flag officer and his staff (augmented) to the Battle Group (Naval Expeditionary Task Group) role. It is an idea whose time has come. ■

MEMBERSHIP STATUS

	Current	Last Review	Year Ago
Active Duty	925	954	975
Others	2728	2716	2717
Life	254	256	242
Student	25	28	28
Foreign	69	72	76
Honorary	19	19	20
Total	4020	4045	4058

DEFENSIVE ANTI-AIR WARFARE FOR SSNs

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

Background

In the broader concept of general war with the Warsaw Pact and the execution of the Maritime Strategy in the Soviet littoral, some U.S. nuclear attack submarine (SSN) losses to air ASW were operationally accepted as a minor portion of total losses. This rationale will no longer survive a prudent examination of post-Cold War submarine employment.

If a major conflict had occurred between NATO and the Warsaw Pact, U.S. SSNs would have deployed en masse to the littoral waters of the Soviet Union (Barents Sea, Sea of Okhotsk, Sea of Japan, etc.) where an extremely *target rich* environment of Soviet submarine and surface units would have existed. The high rate of engagement with these units most likely would have resulted in a very rapid virtual destruction of the Soviet Navy. In spite of the large technological advantage held by U.S. SSNs, it was to be expected that this engagement would have involved significant U.S. losses, considered acceptable at the time, principally due to reactive counterfire from attacked Soviet submarines and defensive anti-submarine warfare (ASW) mining. The percentage of these total losses caused by air ASW was rightfully considered too small to warrant the development of air defense capabilities for SSNs, particularly since any such devices would likely impact the number of offensive weapons carried and/or the employment of limited weapon launchers—capabilities badly needed in the expected target and engagement-rich environment.

U.S. Submarine Employment Within The New World Order

With the need now to deter regional war on a global basis rather than deterring global war on a regional basis, and to do so with fewer military assets, an evolving theory of *The Great Black Fleet* defines a key role for U.S. SSNs. As the only naval platform that by itself represents a survivable military capability across a broad spectrum (including reconnaissance, surveillance, strike, mining, injection of special warfare forces, ASW, anti-surface ship, etc.), and also unique in being invulnerable to threats of attack by highly proliferated chemical or biological weapons, the SSN is particularly appropriate for being the *first warship on*

the scene as the far more powerful but less plentiful Carrier Battle Groups (CVBGs) transit to the crisis. It is not at all beyond the scope of imagination, particularly given the emphasis on *jointness*, that a scenario could exist where a distant on-station SSN, targeting through organic ELINT and COMINT capabilities, calls in a B2 air strike from Omaha, NE, to establish *air superiority* through destruction of early warning and C-cubed nodes for an approaching CVBGs strike aircraft to whom it passes post-strike bomb damage assessment.

Nuclear powered warships also have the enviable characteristic of being basically no more expensive to operate than they are to own, and for many reasons, an *operating tempo* of about 50 percent has evolved as a near optimum level for highest material and operational readiness, and for best crew morale. Typically, half the time a unit is at sea, it is at sea in relatively short *local operations* for training. For any given total force level, therefore, about 25 percent are *forward deployed*—typically for a period of about 90 days. For a force level of 60 SSNs, this equates to 15 units. If indeed the task is to deter regional conflict on a global basis with CONUS-based forces, and if this amorphous *constellation* of units were to move somewhat homogeneously throughout the world's oceans, than statistically, an SSN would probably be within 1000 miles (2 days steaming) of any shoreline point, and many units could *pile on* within a few more days if needed. Analogous to *antibodies* distributed throughout a bloodstream, these quick reaction forces could watch, *tag* and commence a limited engagement of *infections* while full immune systems defenses are alerted, mustered and deployed. While so employed, individual SSNs would be in a familiar situation not unlike that expected and trained for, had the Maritime Strategy been executed—alone, in potentially hostile waters, with no air cover.

However, with the collapse of the Soviet Union as a credible threat and employment of U.S. naval forces in such Desert Storm-like scenarios, the similarity of the employment algorithm stops there. It is unlikely that the target rich environments of the Soviet *Bastions* will exist, the far greater need to *communicate* with and to National Command Authorities (NCA) and other forces will impact the SSNs primary defensive suite—covertness, and it is clear that the only domestically acceptable loss rate for major naval vessels in such engagements is zero. In this light, even a small probability that an adversary's fixed or rotary wing aircraft

could attack or even detect an SSN unopposed is unacceptable. If submariners have no good response to the *what if* of airborne detection in the shallow waters expected of regional conflict scenarios, then the only acceptable alternative is that they not be so employed—a justified but unfortunate conclusion for such an intrinsically capable platform.

The Air-Delivered Weapon Threat to On-Station SSNs

If a need exists for a submarine based air defense system, then it must be effective, reliable, and as inexpensive as possible. To be effective, the submarine must have the capability to launch such a device upon warning of an actual or imminent attack. Such warning must come from detection of either the air ASW platform before an attack (preferably) or its weapon following such an attack. To initiate an attack, the air ASW platform must detect and localize the submarine.

There are only a few submarine detection phenomenologies available to aircraft, all of which can be categorized as either passive or active in nature (either involve release of energy to the environment or not):

Passive Means	Active Means
• Acoustics	• Acoustics
• Magnetic Anomaly Detection (MAD)	• Radar
• Electro-optical (i.e., forward looking IR - FLIR)	• Electro-optical (i.e., laser)
• Visual	

It is demonstratable that a properly operated SSN is generally assured of being alerted to and of having enough time to deploy a defensive device, before any of these detection methods result in a weapon being delivered from the detecting platform.

First, it is important to realize the significant tactical difference between *detecting* a submarine within some large volume of uncertainty involving tens or evens hundreds of square miles and then *localizing* that position to meet the *attack criteria* of +/-500 yards or so required to release a modern homing weapon. It is also important to note and accept the fact that very real tactical and equipment limitations preclude the aircraft, fixed or rotary winged, from releasing that weapon (essentially *on top* of the

SSN), from an altitude of more than several hundred feet.

In addition, it is stipulated that any viable submarine launched air defense device will have the ability to be launched within a minute or less, and throughout an *operating envelope* of several hundreds of feet through likely on-station speeds, and would be autonomous after launch to permit full evasive action by the SSN. In short, if an SSN can be shown to have a reasonable probability of sensing an imminent attack some few minutes in advance, permitting the launch and deployment of a defensive weapon that would effectively *mine* the airspace several thousand feet above and several thousand yards around his targeted position, then it would have the general ability to preclude the consummation of that attack. If the unlikely event occurs where detection of the ASW weapon itself is the first indication of attack, than the release of a defensive anti-air warfare (AAW) weapon as an integral part of evasion tactics has significant *value-added* to the survivability of the SSN by largely precluding subsequent reattacks.

Since stealth itself is the submarine's primary defensive suite, it is logical that it will employ every means to detect any active emission that represents a potential threat to this vital characteristic. Since basic laws of physics dictate that a given emission will be more detectable following **one way** transmission losses (from emitter to target) than following **two way** losses (from emitter to target and back to a receiver co-located with the emitter), then a generally true statement is that such active emissions will provide the submarine enough time to evade prior to detection, or if received signal strength indicates that detection is likely, to deploy a defensive weapon and commence evasion well in advance of any attack. Even the theoretical capability of employing high powered, blue-green lasers to *see* several hundred feet below the surface (from directly above) is relatively easy for the submarine to technically counter through use of topside mounted broadband blue-green sensors.

As for passive sensors, the relatively short ranged MAD systems require that the searching platforms be at altitudes low enough that significant amounts of acoustic energy will be *coupled* to the water to permit passive acoustic alertment of the submarine at slant ranges of several thousands of yards. Particularly in the case of fixed wing aircraft, such initial detection does not generally result in an immediate release of a weapon, but rather a circling return to that spot (consuming many minutes) for a release at the

next subsequent detection.

Although many submariners can claim they heard sonobuoys hit the water, this is not a reliable means of alertment. However, to have an *accurate* enough knowledge of these buoys positions to support weapon release, they too have to be released from an altitude low enough to result in a high probability that the submarine will key to the presence of the releasing platform. In addition, passive buoys often don't provide sufficient positional granularity to meet attack criteria, and contact by these devices is generally followed up by a MAD pattern, the release of an active buoy or, for a rotary-winged aircraft, a cable suspended dipping active sonar from a hovering condition—all of which the submarine will react to before attack criteria can be satisfied by the aircraft.

Visual observation of a submarine at periscope depth is always a possibility, and probably still accounts for many if not most initial submarine detections. For no other reason than relative physical size of the target (periscopes and masts) and the seeker (the aircraft), a significant visual *cross-section* advantage lies with the properly operated submarine, and the aircraft that *spots* a submarine has most likely been under observation itself for some time. If the *hazard* of the aircraft's presence turns into a *threat* of attack by a turn towards, then the submarine will react accordingly. At night, against a FLIR equipped aircraft, the visual cross-section advantage is largely nullified through a normal periscope. More and more, however, submarines are adapting technology to obtain an integral periscope IR capability themselves, if anything, providing an even greater advantage of relative detection of the hot aircraft engine exhaust over the near ambient temperature periscope. Many previous submarine defensive AAW schemes involved mast mounted weapons to be employed in such a scenario, but this approach fails to satisfy the need for rapid release from a broader range of operational depths and speeds.

In all, a modern submarine can reasonably be expected to detect the presence of an ASW aircraft in advance of that platform being positioned to actually drop a weapon. Equipped with an appropriate autonomous defensive AAW weapon, the submarine could effectively prevent that platform from safely achieving the low altitude *on-top* status required for release of its ASW weapon.

Operational Employment of An SSN Air-Defense Weapon

Many scenarios could be constructed to highlight the employment of a defensive AAW system by an SSN. For the sake of brevity, however, the entire set of such scenarios can be summarized by consideration of a few *first principles*:

- The SSN would employ in either a deliberate or a reactive sense:
  - Examples of deliberate use:
    - *Mining* vicinity where SSN will surface to disembark special forces
    - *Mining* a *datum* generated by launch of offensive weapons such as Tomahawks or torpedoes
    - *Mine* near-water airbases' *end-of-runway* to engage low level departing or arriving aircraft
    - Dispersed *mining* of larger areas where opposing air ASW forces are likely to conduct general searches to discourage same
  - Examples of reactive use:
    - Upon receipt of off-board real time intel message that ASW aircraft or helo alerted and enroute
    - Upon visually spotting or ESM intercept alert of ASW aircraft or helo *coming in*
    - Upon acoustic detection of *low pass* by ASW aircraft or helo
    - Part of tactical evasion guidance if active sonobuoy lights off (prevent a first attack)
    - Part of tactical evasion guidance if air delivered torpedo lights (prevents a second attack).

Characteristics of An SSN Air-Defense Weapon

To complement and summarize the preceding discussions, any device considered for the SSN defensive ASW requirement should adequately address the following concerns:

- Cost. A principal concern, and to reduce or eliminate developmental expenses, maximum use of existing developments should be stressed by employing *commercial off-the-*

shelf (COTS) and *government off-the-shelf (GOTS)* technologies.

- Autonomous operation. Since it is operationally unsatisfactory to be required to target, release or guide any weapon from a vulnerable position (i.e., periscope depth), any considered device must be autonomous in nature, and upon release form a reasonable operational envelope (depths to 300 feet and speeds through 15 knots) be capable of independently detecting, classifying and engaging specified targets of interest.

- Information or control *links* to the releasing platform are not desirable for a number of reasons including cost, post launch constraints on the releasing platform, and salvo size.

- Passive operation. Since the device must be able to be employed in a prophylactic manner (i.e., to establish an air defense *umbrella* just prior to deployment of special forces or a Tomahawk launch), any search, acquisition or tracking phenomenologies employed must be passive in nature.

- Low observables. To preclude the device itself from either initiating or confirming a detection event, it must have credible pre-firing counterdetection envelopes which lie significantly within its capability to detect, classify and engage any threat.

- Target selectivity. Since operations could involve areas where non-valid targets exist, the device's imbedded acquisition, targeting, and weapon release logic must include provisions for selectivity of engagement.

- Self-sanitization. Provisions (i.e, scuttling by means such as dissolvable salt plugs) must be included which limit the time duration of the threat established by the device. Such provisions shall also destroy or otherwise render inoperable any contained armament. A broad *time to scuttle* selection is not required, and all expected employments could be met through the selection of either a *short* (30 minutes or so), or *long* (2 hours or so) option.

- Detection/engagement envelopes. Subject devices should be capable of detecting and classifying appropriate threats at slant ranges of at least 8000 yards, and of engaging such threats to ranges of at least 5000 yards and to altitudes of at least 4000 feet. The device should have intrinsic physical capability limitations which would allow safe overflight by friendly or innocent parties at reasonable altitudes.

- Platform capability. Subject devices should be compatible with planned characteristics of SEAWOLF and CENTURION SSNs, and should be back fittable, at reasonable cost through either internal or external launching means, to Los Angeles and Sturgeon Class SSNs. Compatibility with some existing or planned countermeasure launchers is particularly desirable. Possible SSBN employment is a separate issue with a potentially different set of requirements and considerations, and although likely, is not addressed at this time.

Conclusion

The U.S. SSN represents a far too cost effective and effective component of a post-Cold War National Strategy to allow artificial constraints on its employment due to the lack of a response to a definable, albeit, an unlikely threat to its survival. The synergistic melding of existing sensor, weapon and countermeasure technologies should provide an affordable and effective solution to this problem. ■

IF IT'S JANUARY, IT MUST BE BAGHDAD

by CAPT C.H. Griffiths, Jr., USN

Some would say our nation is barely making steerageway in the current *fog of peace*. Young people just getting underway in the Navy could easily see their careers going aground in the face of media representations of shrinking military forces and the lack of an immediate enemy. But try to penetrate the mists and expand the horizon beyond the bow. That dark shape barely visible up ahead may well be another dire military threat. I would tell today's young warriors "Don't underestimate the importance of your future contributions to our national defense." We may not be able to predict when or even how the shoe will drop, but we can count on you eventually being called upon to make a real difference.

My career and particularly my experience in command of USS PITTSBURGH (SSN 720) during Desert Shield/Storm is a good example. I joined the Navy during the Vietnam conflict but my service selection of submarines precluded my direct involvement. In the post-Vietnam drawdown of the 70s the widespread anti-military feelings in the country rivaled the Soviet Union as our biggest military challenge. I did participate considerably over the span of 20 years in the many exciting roles assigned to the Submarine Force during the undeclared Cold War. Like most military members of my generation, this was my presumed sole legacy until a little country named Kuwait unwittingly became the center of world attention.

August 1990 was to be a quiet month for the crew of PITTSBURGH. We looked forward to catching up on lost time with the families after a rewarding recent deployment and a strenuous period of exercises and examination. Prophetically, one of the exercises involved a successful test launch of a Tomahawk land attack missile in the Gulf of Mexico. When we heard of the invasion, a crewmember approached me and asked if somehow our ship would become caught up in the conflict. I assured him that for any number of reasons there was no chance of our involvement. After all, we were about to enter a three month maintenance period involving prolonged drydocking, three shipyards and considerable resources to accomplish major work. Then there was the geography of Iraq, with little coastline and no navy to speak of. In hindsight I guess I was not yet converted over to the post-

Cold War missions facing our Navy. By the next day I realized just how wrong my answer was!

You can only imagine my surprise when the Commodore told me that we were to surge deploy to the Mediterranean with the first available submarine Tomahawk missiles modified with extra fuel for extended range. The crew's emotions on hearing the news can be summarized by saying they felt honored to be part of our nation's call to arms. The families also rose to the occasion by providing the continuing support we had already grown accustomed to. And it's well their spirits were high, because the next two months were a blur of exhausting industrial effort as all the repair activities converged to get necessary jobs completed in record time. As we raced the calendar we wondered if our efforts would prove to be in time.

When we were finally about ready to go, 30 of the crew took a weekend respite and drove through the night to our namesake city of Pittsburgh to celebrate the Navy's birthday in a VFW Hall. Attendees included reservists about to go to the Gulf and loyal Navy League supporters. In my remarks I told the audience we would do our best to uphold the good name of their fair city and the Navy. The patriotism and support from those wonderful folks was stirring and representative of our countrymen's response when the chips were down. The final trials and workup were devised to try and model the missions and environment we would encounter in the event of hostilities. Special emphasis was given to strike warfare, weapons systems readiness, shallow water/special warfare operations, and communications versatility. The weapons loadout consisted of 37 missiles and torpedoes, including 12 vertical land attack Tomahawks which were literally right off the truck following factory modification. This modification gave the missiles enhanced range to strike land-locked Baghdad from the Mediterranean or the Red Sea, as well as the Persian Gulf. All ships reach a point in preparing to deploy where they just want to cut the umbilical and get to sea. We reached that point on 8 November 1992 as we set sail for the Mediterranean and an open-ended commitment to provide firepower to NAVCENT if hostilities proved necessary.

My previous Med deployment in 1988 focused on countering Soviet warships. During Desert Shield the pattern had altered significantly. Few Soviet ships were in the area, and at any rate practicing command and control, merchant surveillance, and

performing indications and warning missions were now our real challenge. Our stealth gave us great flexibility in carrying out surveillance of military activities by littoral countries who were not clearly in our camp from the outset. On occasion we kept an eye on special interest shipping. Sea borne terrorism also worried the Sixth Fleet Commander, so we had contingencies ranging from protecting the Suez Canal to interdicting terrorist raids. Of course, we practiced strike warfare constantly.

Our first liberty port was to be Haifa, Israel at Christmas. The day before arriving I received a CO personnel message from the Sixth Fleet Commander advising of the USS SARATOGA's boating tragedy. It was a vivid reminder that we were on the eve of even more tragic loss of life should hostilities commence. Weather prevented our port call, so it was a sad and sobering Christmas at sea indeed. Church services were filled to overflowing on the mess decks as we each sought strength and guidance from on high.

PITTSBURGH eventually did get a liberty port call in Toulon, France in early January 1992. The port was very busy getting French soldiers and warships enroute to the Suez. I invited several French submarine officers and their wives aboard for dinner, and the impending conflict dominated the conversation. Not surprisingly, few differences of opinion were discernible amongst us. It was apparent at this point that Saddam Hussein had backed himself into a corner for which there was no escape.

On getting underway we wasted no time racing east. Directed to chop to NAVCENT, we commenced our *war patrol* on 19 January in the easternmost portion of the Mediterranean. It is true that news is never in sufficient supply on a submarine due to message broadcast constraints. Luckily we spent most of the time at periscope depth near our assigned launch basket, allowing augmentation of our normal broadcast with intercepts of commercial stations such as the BBC and of course CNN. However, there is no doubt our families at home were better informed of the general course of the war than we were throughout this period thanks to the miracle of modern television news.

The first day we were tasked to shoot Tomahawks proceeded like clockwork. I observed USS VIRGINIA and USS SPRUANCE launch their missiles first through the periscope, then it was our turn. Our vertically-launched missiles fire *over the shoulder* and required a quick spin of the periscope to keep in

visual sight. They were all flawless launches and made fascinating video. Our targets were several hundred miles away, but we still felt buoyant that we were helping to save Allied lives and shorten the war. Subsequent bomb damage assessment of our targets indicated the missiles were remarkably accurate. It was a historic occasion for the ship and the Atlantic Submarine Force, and was a fitting culmination to five long months of preparation and anticipation.

On a later date PITTSBURGH was again tasked to launch cruise missiles from our Med launch basket. The weather was more adverse this time, including along the flight path based on information provided by NAVCENT. I also had an unsuspecting but pesky merchant vessel steam close to my original launch point requiring a change of plans to meet the tight timing specified for the strike. This particular tasking included one mission received the previous day by satellite data update that targeted a mobile radar site which was determined to threaten our striking aircraft. Again the attack went smoothly, and I was relieved to find out later that detailed bomb damage assessment proved our missile completely destroyed the site.

Prior to the *air war* innovative planning for sustaining Tomahawk strike capability was ongoing in the Sixth Fleet. For example, a deployed submarine tender was worked up to rearm PITTSBURGH's vertical launch missiles in theater as soon as we emptied our magazine. It turned out that the Mediterranean strike platforms performed far fewer launches at a more retarded schedule than were originally planned due to diplomatic considerations, but the potent military capability inherent in our arsenals remained poised until it became clear that Allied aircraft had complete control of the skies over Iraq.

Some small events in the larger mosaic are still fresh in my memory. On one dark midnight between strike taskings, we surfaced to transfer a sailor to USS VIRGINIA enroute to getting him home for humanitarian reasons. I had to chuckle as VIRGINIA's CO asked me on the bridge-to-bridge radio if our *scurvy* was under control as he took the occasion to transfer some fresh fruit to us. Heading back surfaced through the Straits of Messina we passed close aboard a converted ferry jammed with French troops heading to the Suez. Upon seeing our nationality they spontaneously commenced wild cheering in an emotional outburst of brotherhood-in-arms that I will long remember. Most memora-

ble of all was the unique exhilaration of homecoming and being reunited with our families after four roller coaster months of uncertainty. Even the late New England winter blizzard and harrowing last few underway hours of tense navigation in poor visibility did not daunt our spirits. In time honored tradition the crew proudly displayed our homespun *battle flag* on the brow as we streamed across to a pier to happy loved ones.

Current events continue to reinforce the necessity to retain a strong Navy in support of our strategic role among nations. The unpredictability of the threats that lie ahead should more than meet the desire to be challenged in our young warriors of today. So stay trained and ready. As the crew of PITTSBURGH and a large fraction of the Navy relearned during Desert Shield/Storm, the President may call on you tomorrow to do your part in responding to aggression. That's what all branches of our Navy are about, and we will need you aboard to win. ■

SPECIAL NOTES

- The Submarine History Book is expected to be in its final draft form (for NSL review and approval) in early to mid-January, 1994. Turner Publishing should be able to print, bind and mail them shortly after incorporating our desires.

- NSL Directory information may only be used for personal purposes. The information is not to be used for creating mailing lists for marketing, etc. NSL will continue to deny all requests for exceptions to this policy. Instances of abuse of Directory information should be reported to NSL Headquarters.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Shipbuilding

Force Projection

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USS TRITON: THE ULTIMATE SUBMERSIBLE
Part I: Conception and Design

by Robert P. Largess

One of the most unique and unusual submarines ever built was the USS TRITON (SSRN 586). She was a ship of many superlatives and many question marks. When she was launched on August 19, 1958, she took the record away from the Japanese I-400 class submarine aircraft carriers for the largest submarine in the world. The I-400s had been designed to attack the Panama Canal. She still exceeds all attack and many guided and ballistic missile types in size. She remains the only Western nuclear submarine with a multiple reactor powerplant; the first in the world except for that on the trouble plagued Soviet icebreaker LENIN.

TRITON's powerplant may well be the most powerful on any Western submarine, according to Captain Ned Beach, her first CO. She was designed for 34,000 shp but reached 45,000 on her trials. TRITON had the highest surface speed of any submarine ever built. Designed for 27 knots, she broke 30 on her trials. She was the only nuclear submarine designed specifically for high surface speeds, and the only one intended to operate for substantial amounts of time on the surface. Yet her most public moment of fame came with her record 1960 voyage retracing Magellan's circumnavigation of the world almost entirely **submerged**, covering 41,500 miles in 83-1/2 days. And when she was decommissioned on May 3, 1969, she was apparently the first, certainly the first Western, nuclear submarine to be permanently retired from service. Why?

She was the only nuclear radar picket submarine, yet she was launched four months after the Navy announced its intention to end the SSR program. The 12 diesel pickets worked hard and seem to have been considered extremely valuable assets, in spite of numerous problems. TRITON was designed to solve these material shortcomings and design limitations: to be the near perfect radar picket. Yet she was exercised in this role only a few times, and had apparently lost much of her picket capabilities long before she was reclassified as an attack sub on May 1, 1961. Why?

I have been intrigued by TRITON literally since she was built. For 35 years I have been curious about the entire concept of

TRITON. With nuclear power came the realization of the old dream of the true submarine, designed to operate entirely submerged, free from the atmosphere for crew or powerplant, able to equal or exceed the performance of surface ships underwater.

TRITON seemed to be intended to fulfill another old dream, that of the submersible surface ship, able to both equal the performance and serve the functions of a cruiser or destroyer on the surface and to dive and serve as a fully effective submarine. Both have recurred frequently in the history of the submarine. The British R Class killer submarines of WWI emphasized high submerged speed for example, while the steam powered K Class fleet submarines were the nearest approach to the submersible warship. But both concepts required nuclear power to be successful. And while the nuclear powered true submarine early appeared to be the capital ship of the future, the submersible warship, approached only with TRITON, appeared to be a blind alley.

Even so, the questions remain. Just how successful was she? Did she ever really operate in the role for which she was apparently intended—high speed radar picket escort for fast carrier task forces? How did she actually perform on the surface? Was her phenomenal surface speed ever used after the radar picket role evaporated? How did she perform as a picket? Was it a worthwhile role? If so, why did it disappear?

And what were TRITON's characteristics as a submarine, her submerged speed, maneuverability, and quietness? How exactly was she actually used in her later career? Did her size and engine power prove useful in any way then?

And how about her contributions to nuclear submarine and surface ship development? To what extent was her powerplant the prototype for multi reactor surface ship plants? Did her size and her round-the-world trip teach anything that was applied to the ballistic missile subs and their long submerged patrols? What other technology did TRITON pioneer and test out? What was adopted and what abandoned? Finally, was she a failed experiment, an oddball white elephant, or was she a worthwhile unit? Was she worth building in the first place?

To many, the answer was simply no! In his *Proceedings* article The Flip Side of Rickover, Harold Hemond wrote:

> "The TRITON (SSN 586) project concentrated attention on how to install twin reactor plants in a two-shaft ship. The

submarine did not need two reactor plants, but Rickover was anticipating the problems he would have installing multiple reactor systems in surface ships. Much effort was also devoted to the development of steam driven powerplant auxiliaries in lieu of electric motor driven auxiliaries with hopes that the on-board electric powerplant could be simplified. But steam-driven auxiliaries were never again used on submarines, and no significant mission could be found for the TRITON."

Many people have repeated this view, that the radar picket role was never serious and Rickover built TRITON to test a surface ship powerplant **before** actually beginning his political campaign for a nuclear surface fleet. A careful examination of the facts suggests this is a serious oversimplification; the wisdom of hindsight. Rickover and others may have been wrong in some of their choices, but they couldn't know it at the time.

TRITON was borne of a complex process, a rather fortuitous convergence of two strands of development, the fleet radar picket submarine, and the submarine advanced reactor (SAR), as well as early intimations by Rickover of the future value of very large and fast submarines. The answers that I've found are the result of detective work, based on interviews with TRITON's operators and designers. Unfortunately, though most of the TRITON's story seems like ancient history, everything is still classified. Meanwhile, the people personally involved are getting along in years—TRITON's second CO, Captain George Morin, died shortly after being interviewed. The ideal history of these crucial years of submarine development would be based on **both** a study of the documents and the first-hand knowledge of the principal actors themselves, but it appears the opportunity to produce this could be lost.

The Fleet Radar Picket Requirement

First, it should be remembered that until the late 1950s the radar picket submarine appeared very valuable and promising. Fleet air defense was a major problem, never to be absolutely solved. Radar controlled fighter direction gave U.S. carriers a crucial advantage over the Japanese from Midway on. But the kamikaze attacks off Okinawa showed the deadliness of the *guided missile* and the great weakness of shipborne radar, its inability to

see over the horizon and thus warn of very low level attackers. The first solution was radar picket destroyers, place at a distance from the fleet, but they were themselves vulnerable to attack. Radar picket submarines, however, could give early warning and then submerge to avoid attack themselves.

Post war, 10 fleet boats were converted to radar pickets, being given large air search and height finder radars, fighter homing beacons, and complete fighter direction control centers. Accommodating the equipment and personnel was a major problem; others were the electrical connections through the hull to deck mounted antennas, and the fact that their top speeds were still far less than the carriers they were supporting. The best conversions, the *Migraine IIIs* were lengthened to provide space for the air control center, and mounted all antennas above the deck, permitting their operation while awash.

The SAILFISH and SALMON appeared in 1956; still diesel powered, they were not much improvement. Nonetheless, the importance of pickets for early warning is shown by the conversion of numerous DDs and DEs to this role, and the subs were still better because they could operate in more dangerous positions; the heart of enemy controlled waters if need be. But the concept of a radar picket sub able to match surface ship speeds seemed sufficiently attractive to the carrier air community that, according to Norman Friedman, a steam powered SSR was proposed, equipped with a pressure fired plant like that used in the Brooke and Garcia class escorts.

But the real solution was nuclear power; TRITON was laid down May 29, 1956. Yet four months before her launching on August 19, 1958, the Navy announced the end of the SSR program. The reason was probably the great strides being made in airborne early warning (AEW). The first AEW Skyraiders in 1948 demonstrated the greatly expanded horizon of airborne radar; not blocked by the curve of the earth, one airborne radar could provide far greater low level coverage than a picket line of numerous sea level radars. However, early carrier AEW aircraft lacked the capabilities of the fighter-control centers of DDRs, SSRs, and land based PO-1W Constellations. The appearance of advanced digital processing married to AEW radar, however, made possible the E-2 Hawkeye able to track hundreds of targets and control numerous intercepts simultaneously; it entered served in 1964.

Also, the appearance of 3-D radars, scanning mechanically in azimuth and scanning in altitude by frequency modulation, made specialized surface pickets unnecessary. The original 3-D radar tested on the DL-1 NORFOLK in 1957 was the SPS-26. According to Norman Polmar, in his Ships and Aircraft of the U.S. Fleet (14th edition), the only other ship to carry this radar was TRITON. It seems possible that this radar was an important part of TRITON's design as a radar picket. The other pickets carried a 2-D air search radar above the sail, and a height-finder mounted aft, on deck or on a raised pedestal. None of these were retractable, unnecessary because of their low submerged speeds. But TRITON's very high submerged speed required the ability to retract all antennas into her sail, and combining search and height-finding into a single antenna made this possible.

However, according to Captain Bob Bulmer, her first operations officer, she **never** carried the SPS-26, mounting only a BPS-2, the same 2-D search radar as SAILFISH carried, with no separate height-finder. (The first production 3-D radar, the SPS-39, had severe reliability problems; perhaps the SPS-26 was never suitable for operational use.) She carried the BPS-2 the end of here career, giving her a lot more radar and air search capacity than any other nuke, but thus **never** had the full fighter direction capability of the other pickets.

At the Falkland Islands, British nuclear subs lying off Argentine air bases reported Argentine air activity and picket lines of missile destroyers gave the only early warning of the three Argentine Exocet attacks, losing SHEFFIELD in the process. The picket role was absolutely vital because the British had no AEW aircraft. Perhaps TRITON would have been a vital part of the fleet's air defense, in the absence of the E-2. But E-2 gave far better coverage, was far cheaper, and operating behind the fleet's air defenses, was less vulnerable than a surface picket. Of course TRITON could dive to avoid attack, but when she did so she would have temporarily ceased to function as a radar picket.

The Submarine Advanced Reactor

Still, TRITON owed her surface ship lines and speed, her large radar and CIC to the radar picket concept. But her real origin lay with the SAR. According to Captain Beach, the SAR was conceived as a successor to the SEAWOLF's sodium-cooled reactor using even more advanced technology. NAUTILUS' pressurized

water reactor utilized neutrons at so-called thermal speeds, and thus was the submarine thermal reactor (STR); the SEAWOLF plant used neutrons at intermediate speeds, and thus was the SIR (submarine intermediate reactor). The SAR, as originally conceived, would utilize genuinely high speed neutrons for increased power and efficiency. Commander David Leighton, Rickover's longtime colleague, says that at first the nature of the SAR was wide open, with liquid metal and even gas coolants being considered, but very early it was decided that high performance would take priority over advanced technology and SAR would be a twin pressurized water reactor plant.

Leighton says Rickover was arguing for speeds up to 35 knots as early as 1951. The only route to such speeds before the ALBACORE hull was a massive increase in power, and thus size. The submarine community opposed this; it was receiving the short, maneuverable TANGs and wanted its first production nuclear attack boats, the SKATEs to have a similar size and characteristics. This was a mistake; NAUTILUS proved that the sonars and destroyer weapons of the mid 50s were useless against a submarine that could sustain 18 knots submerged indefinitely. Diesel boats needed maneuverability to evade destroyer weapons only because they couldn't escape at their speeds. The SKATEs sacrificed half the power of NAUTILUS for a relatively small decrease in size.

However, Leighton says Rickover also had an important *political* goal in pursuing the SAR. He wanted to bring GE's Knolls Atomic Power Laboratories at Schenectady into the business of naval reactor design as a second source of expertise to Westinghouse's Bettis Lab, source of the NAUTILUS, SKATE, SKIPJACK, and GEORGE WASHINGTON powerplants. Knolls had produced the unsuccessful sodium-cooled SEAWOLF plant.

Leighton says GE originally intended Knolls to pursue a variety of projects, also its people were biased towards pure scientific research and resisted Rickover's approach of *full personal responsibility* for engineering perfection. Thus Rickover had the triple challenge of turning Knolls' capabilities exclusively towards submarine reactor design, converting it to his methods, and bringing it over to pressurized water technology. Progress on the SAR was agonizingly slow; it was only determined it would be water cooled in 1954, and still in the paper stage in 1955.

Meanwhile, Rickover continued to press for the very large fast

submarine, first as a Regulus carrier. This was rejected in 1955, but by 1956 interest in the radar picket was at its peak, and so TRITON was authorized. As Commander Leighton puts it, "We were looking for a customer."

Was this the correct decision? Leighton says, unequivocally, yes. The development of Knolls as a second source of naval reactor design created a vital national resource. True, the Bettis designs proved an astounding success from the very beginning, but beforehand no one could know that would be so. Rickover was determined to see an alternative design under development, and to see that it included two reactors, in case reactors in general proved less dependable than indeed they have.

Both the very fast submarine, in the form of SKIPJACK, and the very large submarine, in the form of GEORGE WASHINGTON and her ballistic missile carrying successors, became realities. Both married a single Bettis reactor to the ALBACORE hull for a more efficient approach to high speed than TRITON's massive horsepower. However, it must be remembered that there was considerable resistance to the ALBACORE design (for example, fears that a single screw would create a dangerous threat to reliability). His early appreciation of the utility of large size and high speed attest to Rickover's foresight. The determination to pursue two alternative lines of development all the way to completion attests to Rickover's familiar characteristic of doing absolutely everything to insure that what he was trying to do succeeded. If Rickover's whole approach was right, then he was right to build TRITON. She was an engineering success, doing everything she was designed to do. Unfortunately for her, she was simply less brilliantly successful than her alternative, SKIPJACK. ■

WHAT IS YOUR VISION FOR THE SUBMARINE FORCE?

by CDR Joe Leidig, USN
Naval War College

As I read the October 1993 Submarine Review, I couldn't help but wonder if the Submarine Force was missing a message from the broadcast files of November 1992. Though I failed to retain a copy of the specific message, I think it went something like this:

FM: THE PEOPLE OF THE UNITED STATES
TO: THE PRESIDENT OF THE UNITED STATES
INFO: THE U.S. CONGRESS
DEPARTMENT OF DEFENSE
UNCLAS//N00000//
SUBJ: NATIONAL CONCERNS

1. THANKS FOR WINNING THE COLD WAR, BUT WHAT HAVE YOU DONE FOR US LATELY.

2. DOMESTIC ISSUES ARE AT THE TOP OF OUR PRIORITY LIST.

3. ENJOY YOUR RETIREMENT.

No longer does the threat of attack by the Soviet Union loom as a major concern for the American public. In fact, when most Americans look across the Atlantic and Pacific Oceans they see calm and tranquil seas. The regional crises of Europe, Africa, and Asia are well beyond their horizon. However, as they turn around, the reality of crime, racism, poverty, sexual harassment, unemployment, lack of health care, budget deficits, and ever-increasing taxes confront them and they ask, "Why aren't we fixing our own problems? AMERICA FIRST!"

President Clinton was not elected because the voters considered him more capable than George Bush, but because his vision of the future was closely aligned with theirs. Many of us in the military could not believe that the citizenry of the United States would elect President Clinton. Why? We failed to recognize that the vision he shared with people around the country was creating excitement

and energy. He proved again that a shared vision can create a common sense of purpose, values, and identity. Ultimately, a true shared vision will compel commitment and courage. People will do whatever is necessary to achieve the vision, if they are truly committed. A shared vision can lift an organization or a country out of the doldrums and carry it to new heights.

Why is this important for the military to recognize? A vision of prosperity, quality education and health care, full employment, crime-free cities, with equal opportunities for everyone, looks nothing like current reality. The gap between the vision and current reality has created tension which, because of limited fiscal resources, has placed the military at odds with the American public. This tension can only be resolved one of two ways: either by pulling reality toward the vision or by pulling the vision toward reality.

If one takes time to examine the American vision, as I've described it, I'm sure some questions will come to mind. Is it correct? Maybe. Is it focused? Somewhat. Is it strong? You bet! It has already driven the election of a new president, forced major cuts in the budget, and provided the impetus for possible future improvements in health care and anti-crime efforts.

Why do we in the military even care? This shared American vision continues to grow in size and strength. As a result, the tension between current reality and the American vision will largely be resolved by pulling reality toward the vision, not by pulling the vision toward reality.

For the Submarine Force this translates into further reductions. As we have already seen, the 1992 National Military Strategy Base Force was only a roadside rest area on the downsizing highway. Much the same, we should expect only a quick pit stop at the levels established in the Bottom-Up Review. Already, some experts project that the DOD budget will decrease further from $260 billion in 1994 to $190 billion in 2000, another 25% cut.

What relevance does this hold for a Submarine Force vision? No longer can we measure our self-worth in terms of how many SSNs and SSBNs we retain in the force. This parochial view of the last few years is a self-defeating vision. Our numbers will undoubtedly continue to drop even below the levels planned in the Bottom-Up Review. Linking our prestige with numbers of submarines will only diminish the elan and spirit of our force.

How then do we build a shared vision for the Submarine Force

that is positive and energizing, while consistent with that of the American public? It starts not by asking how much of the force can we retain (our current mindset) or by defending current force levels by trying to sell our capability to conduct a wide variety of warfare tasks, some of which we don't do very well (e.g. minehunting) or can be done better by other forces (e.g. conventional land strike).

My challenge is to ask yourself, "Does the U.S. military even need submarines?" That's right, why not decommission the entire force? If you start the analysis at this point, you are forced to ask the hard questions, the ones that are crucial to the development of our future vision.

What **unique** capabilities do we provide to the unified combatant commanders (CINCs) and national leaders?

What warfare tasks do we conduct **best**?

If you conclude, after answering these questions, that submarines do bring vital and necessary capabilities to the battlefield, you can then go on to evaluate the threat and the effect of fiscal constraints.

When I answer these questions, I see a future Submarine Force that is **small** and **specialized**. Warships whose mission capabilities are based on **stealth**. Ballistic missile submarines, though limited in number, will be the premier strategic deterrent and, if necessary, strike platforms in the U.S. military. Attack submarines will have no equal in ASW, ASUW, and intelligence collection.

What do I want for this force? I **want** men that are the best trained in the world. I want to be able to send every man on my ship to necessary schools without being told there are no quotas remaining or there are insufficient TAD funds. I **want** a crew that is fully manned, not to 90 percent as the current POM projects. I **want** the best quality of life for my men and their families; for example, improved monetary compensation for junior men, suitable housing or increased housing allowances including BEQs for the single men, well supported MWR programs and facilities, reliable child care, improved education and advancement opportunities. I **want** an operating schedule that allows my crew to train in order to be fully combat ready, but not one that results in excessive out-of-homeport time. I **want** sufficient funding and IMA support in order to maintain my ship in the 4.0 material condition that has been the force's legacy. I want an elite force that is still proud to be called the *Silent Service*.

In summary, I write this article because as the Submarine Force evolves, I want to help shape it. What I don't want is a force that has retained too much structure and, as a result, is undermanned and underfunded. My message is simple: Don't be satisfied with being told what the vision will be. Be part of the process, part of the dialogue, that is essential to the development of a shared vision. Write to this periodical or others, talk with your shipmates, and continue the dialogue. As a current or past Dolphin wearer, it's your responsibility! ■

REUNIONS

USS BANG (SS 385) - October 5-8, 1994, Portsmouth, VA. Contact:

E.H. Kracker
4028 Sea Cliff Road
Chesapeake, VA 23321
(804) 488-8183

USS THOMAS A. EDISON (SSBN 610) - June 2-5, 1994, Puget Sound (TRIDENT) Area, WA. Contact:

Hoyt N. Burrows
7910 Illahee Road NE
Bremerton, WA 98310
(206) 692-2951

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ON PATROL FIFTY YEARS AGO

by Dr. Gary Weir

TANG was commissioned October 15, 1943 at Mare Island. LCDR O'Kane was the first and only Commanding Officer. After training in the San Diego area, TANG arrived in Pearl Harbor on January 8, 1944. TANG's loss on October 25, 1944, on her fifth patrol, was due to her last torpedo circling and exploding in the stern.

While in command CDR O'Kane was awarded the Navy Cross with two Gold Stars and the Legion of Merit. After the war he was awarded the Medal of Honor for his last patrol.

USS TANG - Report of First War Patrol
Period 22 January 1944 to 3 March 1944

NARRATIVE: 22-28 January 1944

Left Pearl at noon on the 22nd and proceeded to Wake Island at one engine speed.

6-7 February 1944

Upon release from lifeguard duty shortly after midnight, proceeded at 15 knots to newly assigned station north of Truk.

8 February 1944

Sighted USS GUARDFISH at 1315 and avoided on the surface. Entered assigned area at 1500 and proceeded toward the western boundary to patrol the Truk-Empire routes.

16-17 February 1944

Conducting submerged patrol east of Mogami and Gray Feather banks with continuous periscope observation, and 17 foot searches. Proceeded toward assigned position 12 miles south of Ulul after sunset.

Attack #1 — At 0025 on the morning of the 17th, sighted a convoy on the SJ bearing 205T distance 31,000 yards. It was tracked at eight and one-half knots on base course 100°, directly into the rising half moon, and zigging forty degrees every 10 to 14 minutes. As viewed on the radar, excluding side lobes, the convoy was composed of two large ships, a somewhat smaller

one, later believed to be a destroyer, a small escort close ahead, two more escorts on either beam, and two more wide flanking patrols.

At 0219, when nearly ahead, with range to convoy 15000 yards, the starboard flanking escort suddenly appeared at 7000 yards closing at four knots. We were forced down, deep, and given five depth charges, but his attack was half hearted and we were able to return to radar depth 15 minutes after he passed by. The convoy was still 9000 yards away and coming on nicely. Our approach from here in was quite routine, except for additional depth charges and patrolling escorts. Went back to periscope depth at 4000 yards, watched the leading escort cross conveniently to the opposite bow, the port escort crossing our bow, and at 0335 fired a spread of four straight stern shots at the near AK, range 1500, 80 port track, speed 8-1/2. The first three hit their points of aim. Watched the freighter sinking by the stern amidst milling escorts.

When she had sunk we went to our favorite depth below the 375 foot gradient and cleared the area. Some additional depth charging followed, but none close, and we were able to search with radar and surface at 0500.

There were still ships in sight on the radar with one large escorted one at 14,000 yards, which we tracked on course 300, speed seven knots. He evidently had been on a northerly leg of a wander zig, for during the submerged approach in the next six hours he presented angles of 50 starboard to 150 port. Our best sustained speed closed the range to 6000 yards at one time, but he then drew slowly away and disappeared. The Asashio destroyer, a Chidori, a PC type escort, and a plane which were escorting him precluded an end-round, so proceeded submerged to our assigned position for the attack on Truk.

22 February 1944

Patrolled submerged ten miles southwest of Aguijan Island, where we would be able to intercept traffic from Saipan to Guam passing north or south of Tinian. Sighted one surface patrol on the SJ on approaching this spot and avoided submerged after daylight. Bombers continuously passed close over us during the day. At dusk we surfaced to observe considerable searchlight signalling in vicinity of Tanapag harbor, so headed north at two engine speed to intercept any escaping ships. At 2200 the SJ

sighted our first ship at 14000 yards. Closed and tracked and soon had five ships in sight on the radar, with another group sometimes visible to the north. The persistent rain squalls were both for and against us at this time, for they changed the relative size of the pips and made visual investigation of the enemy inside 3500 yards essential in selecting suitable targets.

Attack #2 — We found a Kenyo Maru type AK with escorts on starboard bow and quarter. After tracking this freighter zigging on course 255T for another half hour, moved into position on his port bow, 4000 yards from his nearest escort. An unpredicted zig required a *dipsy doodle* to maintain an ideal firing position, but he came on nicely, and at 2349, with range 1500, 90 port track, and TANG dead in the water and holding her breath, let him have four torpedoes spread his length from aft forward by constant TBT bearings. The enemy literally disintegrated under four hits and sank before we had completed 90 degrees of our turn to evade. One escort guessed right and closed to 3000 yards, but these boats always seem to find a couple of extra knots for such occasions, and we made a sandblower out of him.

23 February 1944

Attack #3 — We still had difficulty in identifying the enemy on the radar, and our next approach, in spite of sound, developed into a destroyer at 3500 yards, with TANG backing down 1200 yards off her track. Both sea and visibility precluded anything but a defensive attack on such a ship, so pulled clear with a minimum range 2900 yards. There followed one more approach, a bit more cautious, on what appeared to be a submarine, before we located what was apparently a naval auxiliary, definitely of the Arimasan Maru Class. As her leading escort conveniently moved out to 8000 yards ahead, we moved into position on her port bow, stopped, and kept pointed at her with another nice rain squall for a background. As she came on her guns were plainly visible forward and then aft. At 0120, with range 1400, 90 port track and gyros around zero, let her have four torpedoes spread her length from aft forward. The first two were beautiful hits in her stern and just after of the stack, but the detonation as the third torpedo hit forward of his bridge was terrific. The enemy ship was twisted, lifted from the water as you would flip a spoon on end, and then commenced belching flame as she sank. The TANG was shaken far worse than by any depth charge we could remem-

ber, but a quick check, as soon as our jaws came off our chests, showed no damage except that the outer door gasket of number five tube, which was just being secured, blew out of its groove. We considered this lightly at the time.

As is usually the case when you hit first, the escorts were befuddled and evasion was simplified. It is considered that this ship was either a submarine or destroyer tender, or an ammunition ship.

Further searches and one more approach disclosed only three patrol type vessels, so commenced a retiring search, covering possible positions of the northern enemy group. An all day search on the surface to north and then retiring to the west disclosed nothing.

24 February 1944

Patrolled on the surface, 150 miles west of Saipan, searching with high periscope and radar when horizon was fuzzy. At 1109 sighted smoke bearing 015T and immediately picked up two targets on the SJ at 23000 and 24000 yards. With a clearing horizon the enemy was shortly identified as a freighter, large tanker, and destroyer. Tracking showed them on course 270, so we moved out to maximum radar range to avoid detection and gained position ahead for a submerged approach. Contact was suddenly lost, but a half hour run at full power toward their last true bearing located them again, this time on base course 165T.

Gathering rain squalls made it more apparent that we would do well to maintain contact with the enemy during the remainder of the day, and that the only possibility of destroying both ships lay in night, or night and dawn attacks. The remainder of the day became more trying with the enemy employing wide zigs and all contact being lost in extremely heavy passing squalls. Sometimes he would emerge on a new course, sometimes on the same, but in most cases it was necessary for us to go in after him at full power, and then retire to avoid detection.

Attack #4 — At sunset the destroyer came into a clear spot, sent several signals on a large searchlight to his convoy, lined them up with tanker astern, and started off on course west. As soon as they had faded in the dusk we closed from north at full power to find them on our port bow headed east toward Saipan. The enemy zigs were of the wildest sort, sometimes actually backtracking, but their very wildness was his undoing, for after

two hours of tracking, and two more of approaches on their quarters, with our outer doors open for firing on four different occasions, the freighter, a Tatutaki Maru Class ship, made one of his super right zigs across our bow. At 2230, when the range was 1400, 95 starboard track, gyros around zero, we cold-cocked him with the first three of our usual four torpedoes, spread along his length by constant TBT bearings. The ship went to pieces, and amidst beautiful fireworks sank before we had completed our turn to evade. The tanker opened fire fore and aft immediately, while the destroyer, then nearly 3000 yards away, closed the scene rapidly, spraying shells in every direction. After helping out any possible survivors with 12 depth charges, she rejoined the tanker. During the first flurry some tracer shells came within a thousand yards or so of us, but obviously just by chance.

The destroyer now stayed so close to the tanker that for several hours we could distinguish only one ship on the radar most of the time, from our position 10000 yards on his port beam. The sporadic gun firing and occasional depth charges convinced us on these occasions that both were still there.

25 February 1944

They continued on the same base course, but settled down to moderate zigs. Before dawn we were in position, 10000 yards ahead and still 80 miles west of Saipan. Only a daylight change of base course could prevent our attack.

Attack #5 — At 0548, with skies gray in the east, submerged to radar depth, took a last check at range 7000 yards, then started a submerged approach to close an apparent 30° left zig. Eighteen minutes later the tanker was in sight with an Asashio type destroyer patrolling very close ahead. As we were then 1200 yards from the track, turned and paralled his base course. At range 2000 yards the destroyer gave us some bad moments by crossing to our bow for the second time, pointed directly at our position. But in his attempt to prevent a repetition of his mistake of the night before, he turned right, passed down the tanker's starboard side to that quarter. He was absolutely dwarfed by the length of the loaded tanker, whose details were now plainly visible. She was painted slate gray, comparable only to our CIMARRON Class, but with a bridge and foremast well forward, just behind a bulging bow, which mounted an estimated six inch gun. Her mainmast was close against her after superstructure

which was topped by an extremely large short stack. Her after gun, above her bulging cruiser stern, was similar to the one forward. There is no similar vessel in any of the identification books aboard. All vantage points including guns, bridge, bridge overhead, and rails, were manned with an estimated 150 uniformed lookouts on our side.

A twenty degree zig toward put us a little close to the track, but as we had already commenced our turn away for a stern shot, we were far from inconvenienced. At 0639, with the escort just crossing the tanker's stern to the far side, fired four torpedoes by constant bearings, range 500 yards, 90 starboard track, gyros around 180°. The first three hit as aimed, directly under the stack, at the forward end of his after superstructure, and under his bridge. The explosions were wonderful, throwing Japs and other debris above the belching smoke. He sank by the stern in four minutes, and then we went deep and avoided. The depth charges started a minute later, but were never close.

Our blown torpedo tube gasket, which we considered lightly on the 23rd, now caused trouble, for the inner door gasket rolled out of its groove under the pressure, and pumps would not keep up with the water. With safety tank nearly dry, regained good control at 80 feet and avoided for the rest of the day at this depth, with occasional looks at 60 feet when our destroyer came close. He was persistent, probably hearing our pumps, one of which had to be run continuously, and spurred on, too, by thoughts of a slit belly if he failed. Dark finally came after our longest day, and a new inner door gasket was installed without much trouble after surfacing. T-shaped gaskets, similar to those just installed in hatches, should obviously be installed in inaccessible torpedo tube outer doors at the first practicable date.

With four forward torpedoes left, proceeded northward toward the lower Bonins, our new patrol area.

26 February 1944

Attack #6 — Patrolled on the surface, proceeding to new area. At 1545, when about 180 miles northwest of Saipan, sighted smoke which quickly developed into a four ship convoy. Tracked them on course 160 until dark, identifying one as a two stacker. Remained outside of 10000 yards until moonset, when radar tracking showed them to be worm turning, on base course east. The rear ship of the convoy was small with a patrolling escort

astern that we could not see at 3000 yards, so passed him up in searching for our two stacker. We found her shortly, astern of the leading freighter, and just ahead of a small unidentified vessel.

Escorts on either bow of the leading freighter offered no difficulty in closing the two stacker from the flank. She was now tracked on straight course 090 and we watched her closely from 3000 yards before closing in to a firing position. A column zig brought the leading freighter across our port bow, so twisted left, steadied, and fired our usual spread of four torpedoes covering the entire length of the two stacker as he came by, radar range 1600, gyros near zero, 100 starboard track. All torpedoes, even the one fired at his bow, apparently missed astern, as we failed to detect his increasing speed as he resumed worm turning. Had a little difficulty in evading the escorts as one closed after we thought we were clear. He challenged us with *S8* on a signal searchlight several times, which furthers our suspicion that the lagging escort, which we could not see at 3000 yards, was an enemy submarine.

Though it was disappointing not to destroy this passenger ship, the HORAI MARU, there is no use in crying over spilt milk. The TANG is far from cocky, and just as determined as ever.

Sent contact report on 450, and message to COMSUBPAC concerning expenditure of torpedoes, then headed for Midway. On route prescribed for another of our submarines.

27 February-3 March 1944

Enroute Midway.

■

THE SUBMARINE REVIEW

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

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The content of articles is of first importance in their selection for the REVIEW. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the REVIEW.

A stipend of up to $200.00 will be paid for each major article published. Annually, three articles are selected for special recognition and an honorarium of up to $400.00 will be awarded to the authors. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League.** The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League. In those instances where the NSL has taken and published an official position or view, specific reference to that fact will accompany the article.

Comments on articles and brief discussion items are welcomed to make the SUBMARINE REVIEW a dynamic reflection of the League's interest in submarines. The success of this magazine is up to those persons who have such a dedicated interest in submarines that they want to keep alive the submarine past, help with present submarine problems and be influential in guiding the future of submarines in the U.S. Navy.

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


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USS COD - WORLD WAR II SUBMARINE

12 July 1993

As you may know, COD is now the last remaining unmodified U.S. Navy WWII fleet submarine. She was mothballed following the end of hostilities and escaped the GUPPY program. Reactivated during the Korean *Police Action* she served in a joint program between the U.S. and Canadian Navies.

Following her second decommissioning she avoided the scrap yard and had the honor of being the first non-ceremonial vessel to transit the St. Lawrence Seaway. (The Queen's Royal Yacht was the first.) This voyage was for the purpose of bringing her to Cleveland to replace GAR as the training platform for the submarine reserve group at the Cleveland Naval Reserve Center.

When the diesel electric boats were excessed by the Navy in the early 1970s, most of these vessels again faced the scrap dealer's torch. COD was among approximately two dozen submarines that the Navy turned over to private groups to serve as museums or memorials. A few of these boats were also unmodified from their WWII configuration except for changes made to accommodate the training programs.

All of the groups, with the exception of ours, further modified their boats by installing stairways through the superstructures and pressure hulls to accommodate visitors. Our group did not have the financial resources to pay for the modification, but it was put on the *wish list*.

A few years ago an action by the U.S. Department of the Interior, which declared COD a National Historic Landmark because of her unique status, caused us to realize that COD now had a new mission. Our first response was to change COD's status from **museum** to **memorial**. We then launched a program to reverse the changes made to accommodate the reserve training program.

We reinstalled bunks, removed training gauges from the diving station and replaced them with originals, and renovated compartments and deck spaces. Detailing has included canned goods in storage areas, dishware and utensils in galley, pantry, wardroom

and crew's mess. Blankets, pillows and curtains in wardroom compartments have added to the image that the boat is about ready for sea.

After a good deal of effort and persistence we again have our 5"-25 cal. wet-gun mounted on the after deck. Single 40s are again in place on the fore and aft bridge decks.

Visitors to COD must scramble down the same ladders used by COD's crew to visit the below deck spaces. It is our policy to keep the boat as open as possible to the public so we have very little in the way of barricades or other constraints. While managers and curators of other museum vessels claim they would be *stolen blind* without their safeguards in place, we found that our visitors have treated COD with respect. I don't believe the people of Cleveland are necessarily more honest than others, but rather it is something about the fact that we demonstrate respect and trust in their integrity and they return it in kind.

About two years ago we learned that COD was one of the few boats involved in **Project 3**—the project Admiral Lockwood pushed near the end of the war to produce photo coverage of the *Silent Service*. An intensive effort was rewarded last August when we finally located color movie footage of COD's seventh war patrol. We have approximately 50 minutes of remarkable footage of COD's surface action on her last war patrol, including the rescue of the crew of the Dutch submarine, O-19, which went aground on Ladd Reef. (Referenced in COMSUBPAC nightly news, 17 July 1945.)

Copies of this footage have been put on video tape and distributed to all of COD's WWII crewmen we have been able to locate. When COD's engineering officer for all seven of her war patrols, received his copy—wherein he is extensively featured leading the boarding party that was stranded aboard a Junk in enemy waters for three days when COD was attacked by Japanese aircraft—he was so moved he revealed to me that he had kept a diary covering the entire war. (He was on SAURY in Manila Bay when Pearl Harbor was attacked.) He has given the diary to us to use in our efforts for preserving COD.

It is our intention to utilize all of the above in producing a video tape and possibly a book that can be used to raise funds for COD. As I see it, our mission—the preservation of COD—can best be carried out by maximizing public awareness of this unique National treasure. To that end we recently rechristened COD as

U.S.S. COD Memorial and made the national newswire services. Admiral Eugene Fluckey was our guest of honor, and Tamera White, First Lady of the City of Cleveland, our patron.

I recently learned of the mission of the Naval Submarine League in our conversation with Neil Ruenzel of Electric Boat. While the primary mission of our two groups is somewhat different, there appears to be significant common ground. Our message to approximately 30,000 visitors each summer (we are open 1 May through the Labor Day weekend) emphasizes the importance of the U.S. Submarine Force and the role it has played in preserving our freedom. COD stands as a memorial to the submariners of the WWII era and the price they paid. A visitor to COD is invariably and positively affected by the experience.

Just prior to starting this letter I answered one from a mother who had visited COD with her son last year. In read, in part:

> "Would you please send me a copy of your brochure. My son visited the U.S.S COD when we came to Cleveland last summer and has worn out the copy we have. It has been taped several times and is still falling apart. He reads it over and over and imagines he is on it—complete with sound effects and all. He is 8 years old and already wants to be in the Navy.

From the included donation check I noticed that her husband is a physician. This is just one of hundreds of similar reactions we hear about each year.

My point, in all of this, is that we may be able to assist you with that part of your mission that maintains awareness of our submarine heritage among your members. Our group is a volunteer organization, and is a federal 501(c)3 non-profit corporation and a not-for-profit Ohio corporation. While we are easily meeting our fiscal needs through gate receipts and some donations, we are not in a position to help you financially. If you feel that our organization can help you in any other way please let me know.

I personally believe that a powerful and omnipresent U.S. Submarine Force is the best means for preserving our national liberty in this modern world. There is not a doubt in my mind that the Strategic Defense Initiative in tandem with our competent undersea capabilities provided the pressure that broke the Soviet

back. And in the future it will be the certain knowledge of our resolve and our ability that will deter other fanatics from treading on us.

My apologies for the length of this letter. I have a feeling that serendipity may be playing a part in our learning of one another, and I wanted to be sure to adequately introduce our organization to you.

Sincerely
John C. Fakan, PhD
President
■

MEMORIAL SERVICE FOR WAHOO

31 July 1993

June 1945 saw LCDR C.K. Miller of Williamsport, PA busy carrying out his wartime reconnaissance duties, steering REDFIN (SS 272) on her sixth patrol along the south coast of Hokkaido. His position then about 42°N and 144°E. This correspondent was a ship's company electrical striker, hot bunking in the after battery.

On 29 May 1993 the captain of Japanese tugboat HOKURYU steered her along Hokkaido's northern shores so that Submarine Veterans of the Lehigh Valley Chapter could pay their respects to Dudley Morton's WAHOO (SS 238) by laying a wreath over her remains.

Mr. George Logue, an Air Force veteran and chapter associate member, lost his brother, Robert, a firecontrolman, aboard the crippled boat now at rest in some 20 fathoms in LaPerouse Strait. Joining us in remembering Robert Logue and his shipmates were Mr. Shibata and Mr. Hashimura, one a motor mac, the other a quartermaster back then when they helped sink WAHOO aboard their auxiliary minesweepers. Together at ten o'clock in the morning and at the northern limit of our travels in the strait, limited by the invisible international line that separates USSR and Japan, all paid tribute with garlands.

LCDR C.K. Miller relates in his last patrol report that Soundman First Class Tom Wann, then a student of the ministry, contributed to his peace of mind during his strained sweeps in the

Honshu area. George Logue and this writer got similar comfort in having uncovered Dr. Larry Hagen, a former U.S. Marine and for the last 30 years a Baptist missionary in Hokkaido. His knowledge of local culture extended to his vast familiarity with both custom and language, all of which were indispensable to our memorial efforts in foreign waters.

The service was brief but filled with sorrow for Mr. Logue, who recalled that older brother, Robert, used to carry him on his back, a reminder of the words in the old Boys Town flyer that made the rounds during the '30s: "He ain't heavy, Father, he's my brother." It is also significant that the state of Nebraska long ago adopted WAHOO as its LOST BOAT.

What a Friend We Have in Jesus was directed by Dr. Hagen and sung by all just prior to laying the flowers off the starboard bow. The Japanese followed with their own eulogy, sung in spirited marching fashion as they too offered homage to lost shipmates. Thus the two nations humbly paid their respective tributes as HOKURYU circled on station.

Martin F. Schaffer
1710 Elm Street
Allentown, PA 18104

■

A TRIED SOLUTION TO THE NEW PROBLEM

11 December 1993

Now that the Administration has decided that the U.S. nuclear submarine industrial base must be saved and has requested funding for a third SEAWOLF Class boat as a stopgap until a new attack submarine design has been developed, I sense a feeling within the submarine community that the future is now secure. However, I see two reasons for continuing concern. First, with construction going forward at the rate of one SEAWOLF at a time, unit costs are going to be sky high because of the inherent inefficiencies in shipyard manning and material procurement. Thus we can anticipate further political and budgetary opposition to extending the construction program.

Second, approval of the proposed CENTURION is far from

assured. In order to be cheaper than current types, it has to be less capable, but the reduction in capability will be offset in the first unit by the increased costs involved in introducing a new and unfamiliar design, and in the later units by a low rate of new orders. The Navy will be in the position of trying to defend an expensive submarine with inferior capabilities, which will be widely perceived as unneeded for any military purpose.

On the other hand, it is vitally important that the nation's ability to build nuclear powered submarines be preserved. If the present plan toward that end appears likely to fail, what alternatives should be considered? James George (see The Submarine Review for October 1993) says: "The only solution is some kind of a high-low mix of subs and for the low end that probably means the dreaded *D* word—the diesel SS." I hope that he does not believe that building diesel submarines will help to maintain a nuclear submarine industrial base. The only effective solution is to continue building nuclear powered boats, but why do they have to be attack submarines of inferior military capability?

I am reminded of the situation facing the submarine force after World War II. The Navy had a large fleet of capable submarines, far more than it needed to guard against any immediate threat, yet it had to preserve its ability to build new ones when the need arose. Today we have a surplus number of Los Angeles Class boats, basically capable of meeting any conceivable threat for a decade or so to come. Instead of building *cheaper* (i.e., less effective) replacements, we can upgrade as many as we will need to maintain an active force of 45-50 attack subs along with the three planned SEAWOLF types. However, this will not serve to preserve the new construction industrial base. What we can do is follow the example of the past and build some purely experimental submarines—new *Albacores* if you will. Major savings could be made by eliminating most of the combat suite while still retaining the major characteristics of a nuclear powered boat.

One might ask what experimental features could be tested profitably on such a submarine. Among those that come immediately to mind are automation and reduced manning, titanium fabrication, various types of propulsion plants, modular assembly techniques, replaceable hull sections, new sonars and other sensors, and all kinds of auxiliary equipment. A particularly intriguing problem from the viewpoint of a construction planner would be to devise a way of phasing the work so as to balance the

workload more evenly among the various trades involved. This could lead to significant economies by reducing labor turnover among critically skilled trades, especially when new submarine orders will be few and far between. When the time comes, as it surely will, when we will have to start building more combat submarines, the lessons learned from the proposed experimental boats can be put to use like those learned a generation ago on the ALBACORE.

Sincerely,
John D. Alden
CDR, USN(Ret.)
39 Sunnyside Avenue
Pleasantville, NY 10570

IMPORTANT DATES TO REMEMBER IN 1994

STS'94
May 10 - 12

Annual June Symposium
June 15 - 16

THE SUBMARINE REGISTRY AND BIBLIOGRAPHY

by CDR John D. Alden, USN(Ret.)

The late Dr. Thomas O. Paine was best known for his management of the space program under NASA, but submarines were his first and last love, stemming from his experience on seven war patrols aboard USS POMPON (SS 267) and as executive officer bringing the captured Japanese submarine I-400 to the United States. His project was nothing less than "to build an on-line cross-indexed submarine database" listing every submarine ever built and every book and article about submarines ever published, "available to any and all interested researchers." At the time of his death in May 1992, he had recorded data on some 8,000 submarines of 50 nations cross-referenced to 6,000 books and articles, about half of which he held in his own library.

This massive undertaking was sufficiently complete to warrant its early publication as a research resource, while efforts are continuing to find a suitable repository in the U.S. or abroad for the Paine library and database. The Submarine Registry and Bibliography, by Thomas O. Paine, assisted by Frederic C.M. Paroutaud, of 828 pages, has been published privately by Thomas Paine Associates, 2401 Colorado Avenue, Suite 178, Santa Monica, CA 90404 (price not given). A commercial edition is expected to be available in the near future.

This book will be an invaluable resource to any serious researcher on submarine operations and technology. Even more valuable will be the database and library if a qualified institution takes over the project and continues to expand and update it in the years ahead. ■

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