JULY 2011

EDITOR'S COMMENTS

There has been a lot of information about the USN Submarine Force generated during this current year, both by official sources and by outside knowledgeable commentary. THE SUBMARINE REVIEW is endeavoring to serve the wider submarine community by bring many of these efforts to the attention of all. The April issue carried presentations given by the Commander, Submarine Forces, CNO's Director of Submarine Warfare and the Director of Strategic Systems Programs at the Naval Submarine League's Corporate Benefactors Day in February. They outlined their approach to defining the challenges to be met in the coming years and the methods to be taken in meeting those challenges. That was presented in these pages as a *Way Ahead—An Integrated Strategy*.

In June the US Naval Institute's PROCEEDINGS presented its annual Submarine Warfare, ASW and Mine Warfare issue. They carried seven articles or commentaries concerning the management of costs and benefits entailed in the acquisition and operation of our current and near future Submarine Force. PROCEEDINGS has consented to the republication of that body of work and a large portion of this issue is devoted to them. The purpose of this republication is as much for the benefit of re-reading as it is for the introduction of the information to those who have not read it in the original form.

Admiral Jerry Holland summed up the priority challenge facing the Navy, as well as the Submarine Force, in his *Now Hear This* column at the front of the issue about the replacement of the OHIO class SSBN force. His last words tell the real story to those who see the costs as unduly impactive to the rest of the Navy, and those who are not clear about the need for such an effort: "The mission needs the Navy more than the Navy needs the mission". Well done! It is the biggest deal of the first half of the 21st Century.

Admiral Mike Conner, then the Pentagon's Director of Submarine Warfare, addressed *The Integrated Strategy* necessary to accommodate solutions to development/replacement needs across the spectrum of Undersea Warfare; SSBNs, SSNs, SSGNs, undersea unmanned vehicles, weapons and people. This is where the facts about the future are faced and dealt with in terms of our current and foreseen national security environment.

Admiral John Butler here tells the story behind the VIRGINIA class of submarines in what the PROCEEDINGS, in its intro to the article calls "...one of the most talked-about cost-saving acquisitions in Department of Defense history." Captain Mike Jabaley, the VIRGINIA class Program Manager, backs up John's descriptions of reducing acquisition costs with a detailed commentary of a reduction in *Total Ownership Costs*. Management, engineering and organization all played a part in this integrated approach by ALL parties involved in the VIRGINIA class. It is a story well worth the re-telling and re-reading

Many in the national security world believe that providing for Deterrence is the priority need for the United States. The *Deterrence* article here is an attempt to articulate the meanings and mechanisms of the concept. Although much has been written about it the tendency has often been "...either over expansive or over simplified." On reflection, it is apparent that a major emphasis of the nation's deterrence stance has to be placed on the Submarine Force.

A very interesting, and instructive historical footnote is provided by LT Joel Holwitt with his description of the between-the-wars discussion about the correct submarine to build for the US Navy's future. The role played by the informal advisory group, the Submarine Officers Conference, was very effective in coming up with the right answer.

Finally, there is an excellent article by LCDR Brent Johnson and VADM John Richardson about the future of UUVs in Undersea Warfare. This has been a recurrent interest over the years but it seems now that the means and the technology are coming together in a meaningful way. It's an exciting prospect which deserves thoughts about operations and control as well as engineering.

Jim Hay
Editor

April 2011 Submarine Review Correction: Book Review: The Scorpion Story How She was Lost (page 144). To order the book the address appeared on page 146, the correct address should be: C.A.K. McDonald, PO Box 3331, Bellevue, WA 98009-3331.

FROM THE PRESIDENT

The Naval Submarine League began the fiscal year in a sound financial and program foundation. The generous contributions of Corporate Benefactors and individuals and the overall improvement of the stock market have restored the League's corpus to the pre-2008 value. The investment portfolio was revised recently to reflect current economic conditions.

The 10th Annual History Seminar, *The Rise of the Submarine Launched Ballistic Missile*, was held jointly by the NSL and the Naval Historical Foundation on 14 April 2011 at the National War College as part of the Commandant's Lecture Series. The Seminar addressed the navy's response to the 1955 decision to put strategic missiles on submarines. Supported by Seminar Chairman RADM Jerry Holland and Moderator CAPT Peter Boyne, the Honorable Frank Miller, VADM Jerry Miller, and Mr. Phil Lantz discussed the national policy, strategic targeting, and program management activities that provided this capability in five years.

These History Seminars continue to be well received and provide an opportunity to present first person reports on significant historical events of interest to the Submarine Force.

The 2011 Submarine Technology Symposium (STS), *Maximizing Capabilities: Technologies to Enhance Submarine Effectiveness and Availability,* co-sponsored by NSL and Johns Hopkins Applied Physics Laboratory, was a resounding success. VADM George Emery, the Chairman of the STS, did a superb job organizing the 17-19 May 2011 classified forum at JHU-APL. This year, STS featured an active duty first session describing the technology shortfalls in five areas and the Submarine Force leadership presented a robust assessment of their strategy for conducting Undersea Warfare, delivering three integrated presentations over the three days. This information was sent to all members of the League by email the third week of July. If you have not received it please contact the League office and it will be sent to you. In addition, the attendees benefitted from presentations by ADM Roughhead, ADM Donald and ADM Harvey as plenary speakers, while VADM Bird, VADM McCoy and Mr. Ronald O'Rourke provided focused messages on key issues associated with the operation, support and funding the Submarine Force. Some of these remarks are in this issue of the *Review*.

The Annual Symposium and Submarine Force Cocktail Party starts on Wednesday, 19 October 2011. Please look for your registration package in early September. It will include registration information, a draft agenda, and a ballot for the election of the NSL Board of Directors.

The sustained, generous support provided by our Corporate Benefactors for our major events has allowed the League to minimize the cost to attendees for participation in these symposia. I ask that when you see a Corporate Benefactor at a League event, please join me in thanking them for their support. The 70 current benefactors are listed in this issue.

The League continues to address issues of importance to the Submarine Force. Your support in establishing the build rate for VIRGINIA Class submarines at two submarines each year was rewarded in this year's budget. Also, the program for the replacement of the OHIO Class Submarine Program has been approved and is in the Five Year Defense Plan. I encourage you to continue your strong support for the preeminent leg of our nation's strategic deterrent. Ongoing budget discussions will significantly affect how the nation responds to the challenges of sustaining a viable strategic deterrent.

Please encourage friends and colleagues to join the NSL. Refer them to the webpage and click on "Join NSL." I ask for your literary contributions to THE SUBMARINE REVIEW. CAPT Jim Hay, USN(Ret), Editor of the *Review*, welcomes your input to maintain its quality and currency. In addition to members, this journal goes to all submarines, members of Congress, and selected industry leaders. Your experiences are valued and needed to keep the *Review* relevant in these changing times.

Please join Bobbie and me as we continue to pray for the safety of our forces and particularly those deployed around the world. Enjoy your summer.

John B. Padgett III
President

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NAVAL SUBMARINE LEAGUE

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Annual Symposium

19-20 October 2011

SUBMARINE TECHNOLOGY SYMPOSIUM

LUNCHEON ADDRESS FOR SUMBARINE TECHNOLOGY SYMPOSIUM AT JHU/APL

Mr. Ronald O'Rourke
May 18, 2011

Thank you for the introduction. And thank you also for the opportunity to speak once again at this symposium. I very much appreciate the chance to share my views, and as I've mentioned on past occasions, I think it reflects well on the submarine community that it welcomes outside perspectives, even when they're critical.

At the outset, I need to mention the standard disclaimer that these views are my own and don't necessarily reflect those of my employer.

I want to start today with a few comments about individual submarine programs, and then proceed to some more-general issues that I think are of pressing importance for the submarine community.

688s

In terms of individual submarine programs, I want to start with the 688s, because, when it comes to discussions of the future of the Submarine Force, they're a bit like Rodney Dangerfield: The focus is usually on the Virginia and Ohio-replacement programs, and the 688s often go unmentioned, even though they'll be a significant part of the attack boat force for many years to come.

So let's repair that a bit by starting with the 688s for a change, and here I want to make two points. The first concerns the ARCI program. The Navy is building a new attack boat force over time largely through the Virginia-class program, but to no small degree, it's also building that future force through the ARCI program. You can't see that in the sand charts of the projected attack boat force – all you can see are the numbers of 688s steadily declining, and not the fact that, at the same time, the significant numbers of remaining 688s are having their capabilities substantially increased through the ARCI program, thereby substantially improving the capabilities of the future force.

This program is something the Submarine Force might consider talking about more. I know I said that at last year's symposium, but I'm saying it again because I didn't see much change in this regard since last year. The reason to talk more about this program is not just because of its cost effectiveness, or because it's a case study in open architecture, but also because it demonstrates good stewardship of existing assets, which can be important as part of a larger argument about investing in Submarine Force's future, which is a topic I'll get to later.

The second point I want to make about the 688s is to suggest again, as I did last year, that the Navy might consider examining the option of mitigating the projected attack submarine shortfall by refueling a handful of the final 688s and extending their service lives by something like 10 years.

I don't know whether this would be feasible or cost effective, and I won't be surprised if the answer that comes back is, "No, it wouldn't be feasible, or "It would be feasible, but not cost effective." But if that's the answer, it would be helpful to reach it after a proper study, rather than an intuitive judgment, and then report that answer to others, because doing so is something that could help in an effort to win support for mitigating the attack submarine shortfall by putting additional Virginia-class boats in the shipbuilding plan.

Stated differently, I can't imagine why someone would agree to put additional Virginia-class boats in the plan to mitigate the shortfall unless the Navy had already shown, through a formal study, that the alternative of SLEPping some 688s wasn't feasible or wouldn't be cost effective.

SSGNs

Let me turn now to the next submarine program, the SSGNs. And on this program, I again want to make two points.

The first concerns their role as cruise missile platforms. That role was put on display at the start of the recent Libyan operation, which was a feather in the cap for the SSGNs, and for the Submarine Force generally.

The point I want to make here is that the Navy might consider showing more widely to others the huge drop off in the number of Tomahawk-sized weapons that can be carried by the general-purpose Submarine Force that will suddenly occur when the SSGNs leave the force. That drop off is fairly startling, and even though it won't occur until the late-2020s, it can be helpful to acquaint more people now with those numbers, in connection with discussions of the Virginia-class procurement rate in coming years, and the proposal to build at least some Virginias in the future with an additional mid-body section containing some large-diameter vertical tubes.

Of course, it's easy enough for others to calculate the drop off in these weapon numbers on the basis of open-domain information. But it carries more weight when the numbers come in a Navy briefing. If the submarine community doesn't take the time to show these numbers to others, then others might conclude that it's not an important issue for the submarine community.

The second point I want to make about the SSGNs concerns their role as SOF support platforms. This was one of two key warfighting roles, along with firing Tomahawks, that was emphasized to policymakers when the decisions were made to spend about $4 billion to refuel these boats and convert them into SSGNs. And it's a role that policymakers may begin paying even more attention to, given the increased interest in the SEALs following their raid on Osama bin Laden's compound.

The SSGNs, of course, can perform the SOF support role today. But if this role takes on increased importance to policymakers in the future, then it might be helpful for the Submarine Force to show that it has a program in place to give the SSGNs – and the SSNs, for that matter – an ability to perform it better in the future through production of more-capable replacements for the dry deck shelters.

The Navy and SOCOM have now had two bites at this apple – first with the ASDS, and then with the JMMS, which was cancelled last July.

The FY12 budget submission says that, as a replacement for JMMS, a new SOF Underwater Systems acquisition strategy was approved in November. But that's all it says—no details are provided on what this acquisition strategy might lead to, or when.

In the same way that the ARCI program and other efforts to improve submarine sensors and payloads show good stewardship of existing SSNs, it may be helpful for the submarine community, particularly in connection with requesting funding future platforms, to show that it is maximizing the utility of the SSGNs in one of their two core advertised warfighting missions by putting into place a program for, finally, replacing the dry deck shelters with multiple copies of a delivery system that meets the requirement for a manned, dry combatant submersible that can act as a clandestine mobility platform.

Virginia class

I want to turn now to the Virginia class. As you know, earlier this year, there was a possibility, given the unsettled situation concerning the FY11 budget, of losing the second FY11 boat and breaking the multiyear contract. That did not happen.

Given overall budget pressures, however, I believe there remains a chance that one or more of the second boats in the years FY14 through FY18 might be dropped from the shipbuilding plan, and that some—or even most or all—of the Virginia class boats shown in the 30-year plan in the years when Ohio-replacement boats are procured might also disappear from the plan.

I outlined this concern in my address to this symposium last year. And in a follow-on lunch address to the National Capital chapter last September, I detailed some of the specific potential implications that the submarine community might need to begin thinking through to be prepared for a scenario in which most or all of the Virginias that are opposite Ohio-replacement boats are dropped from the plan.

I don't want to repeat what I said in those two talks—I only want to state that developments since September have not caused me to alter my conclusion that these boats are at risk of disappearing from the plan—unless current circumstances shift in some way, which I'll get to shortly.

The second point I want to make concerns the proposal to build at least some future Virginia class boats with additional mid-body large-diameter tubes as a replacement for the large-diameter tubes on the SSGNs, and for increasing the strike capabilities of the attack boat fleet generally. Whether this proposal gains support from policymakers remains to be seen—it may depend in part on what effects it would have on unit procurement cost and on the total number of Virginia-class boats that can be procured within available resources. And as I mentioned earlier, it may also depend on how well the submarine community explains to others just how large a drop in Tomahawk-sized weapon capacity the general-purpose Submarine Force will experience when the SSGNs retire.

Ohio-replacement program

The final individual program I want to talk about is the Ohio-replacement program. I have spoken here in the past about the need to make sure that the design for this boat has no unnecessary bells and whistles, so as to make it as affordable as possible, and it appears that the Navy is on this path. As you know, the Navy has reduced the estimated unit cost of follow-on boats in the program from more than $6 billion in FY10 dollars to $5.6 billion, and is examining options for getting the cost down to the target of $4.9 billion.

Whether the Navy will be able to achieve that target cost isn't clear. Getting closer to that figure would ease the overall affordability equation for Navy shipbuilding, but even achieving the $4.9 billion target would not, in my view, eliminate the risk of losing some, or even most or all, of the Virginia class boats that currently appear in the 30-year shipbuilding opposite the Ohio-replacement boats. And if some of the Virginia class boats in these years are dropped from the plan, it could, other things held equal, increase the cost of the Ohio-replacement boats by reducing economies of scale in submarine production.

Last year, in the 111th Congress, there appeared to be an emerging interest among some in the House in the idea of making the boat substantially smaller and less expensive by designing it around a C-4-sized missile. This year, in the 112th Congress, there has been a shift in oversight focus on the program, and there's now a concern in the House that the Navy may have taken its cost-reduction efforts too far in one area by reducing the number of tubes on the ship from 20 to 16. The House version of the FY12 defense authorization bill contains a provision that would require the Navy to justify the reduction to 16 tubes in greater detail.

The issue about the number of tubes is rooted in a concern about whether the planned fleet of Ohio-replacement boats will have sufficient capability to perform their deterrent mission out to the year 2080. But in terms of performing their deterrent mission over their entire service lives, there's another issue to consider, and that's whether a force of 12 Ohio-replacement boats, rather than 13 or 14, will be enough to keep the required number at sea at any given moment during the middle years of the class' life cycle.

Since the boats will have life-of-the-ship cores, they won't need a mid-life refueling. But the Navy has not yet found a way to eliminate the need for a mid-life overhaul, so one or two of these boats might still be hard down in such an overhaul during the middle years of the class life cycle, which in turn could prevent a force of 12 boats during those years from meeting the requirement for having a certain number at sea at any given moment. The Navy is currently skating by on this issue, but unless the Navy can find a way to eliminate or significantly reduce the length of that mid-life overhaul, this issue may eventually need to be addressed in terms of either adding one or two boats to the program or reducing the at-sea deterrent requirement during the middle years of the class' life cycle.

A final point about the Ohio-replacement program concerns the way the lead boat is being funded in the budget. In the FY12 submission, for the sake of smoothing out the R&D funding profile for the program, the Navy was allowed by OSD to shift some of the detailed design and nonrecurring engineering (DD/NRE) costs of the program from the procurement cost of the lead ship to the Navy's R&D account.

The amount of funding shifted was relatively small compared to the total amount of DD/NRE costs for the program, but the permission that the Navy was granted to do this renews, in my mind, the question of whether any of these DD/NRE costs should be attached to the procurement cost of the lead ship. The practice of attaching the DD/NRE costs of a new class to the procurement cost of the lead ship goes back many years, but is not followed in other areas of defense procurement, and can lead to distorted understandings about what the second and following ships in a class might cost to procure.

If a small portion of the ship's DD/NRE cost can be shifted to the R&D account, then I think it's fair to ask why it all couldn't be shifted there, and not just for the Ohio-replacement program but for other shipbuilding programs as well. Doing this wouldn't reduce the cost of the Ohio-replacement program, but it could make it easier for people to understand the relationship between lead ship and follow-ship procurement costs.

More-general issues

I want to shift now to the second part of my talk, which focuses on some more-general issues of pressing importance to the submarine community. These issues concern the debate over the future of the federal budget, the future of the defense budget, and the Navy's share of the defense budget. These issues are matters of wide-ranging discussion right now. They overshadow—and can affect—everything I've said until now about the specific submarine programs.

Right now, we're in the midst of what is shaping up to be a historic debate over the future of the federal budget. It's a debate so fundamental that, among other things, it has given rise to a potential scenario of the country defaulting on its debt for the first time this coming August.

What this debate might mean for the future defense top line is unclear, though the range of possibility appears to be bounded on the high end by a defense top line that in real terms remains about where it is, or perhaps grows by a little bit, and on its low end by a reduction of about $100 billion per year, or roughly one-sixth. Where things might wind up within that broad range of possibility is difficult to predict with much certainty, because it will be affected by decisions on entitlements, domestic discretionary spending, and taxes.

The possibility of a declining defense budget, however, has led to talk about a roles and missions review, and about the need to make strategic choices in defense spending, as opposed to across-the-board cuts.

If that's the case—if we're entering into a basic reexamination of defense spending of this kind—then it seems to me that this would be best debated by the country as a whole, as opposed to just within DOD. A debate of this scope and importance would benefit from a broad participation that is informed by strongly presented competing views.

It's in the context of this unfolding debate that I want to focus on the large projected shortfalls in the 30-year shipbuilding plan.

The largest of these shortfalls—the one projected for cruisers-and destroyers—just got 6 ships bigger, because the Navy recently announced that it has increased the cruiser-destroyer requirement from 88 ships—where it had been for five years—to 94 ships.

The shortfall in cruisers and destroyers is projected to span most of the years of the 30-year plan, and to bottom out at 68 ships in 2034. That's a peak shortfall of 26 ships, or 28% of the goal. If the Navy doesn't SLEP some of its existing destroyers, then ensuring that the cruiser-destroyer force doesn't drop below 95% of the stated requirement would entail adding 22 more destroyers to the shipbuilding plan.

The second largest projected shortfall is in attack submarines, and I don't think I need to give you the details on that. And there are projected shortfalls in other ship categories, including amphibious ships.

Except for the shortfall in amphibious ships, which affects a client service, these shortfalls haven't received nearly as much attention one might expect. Perhaps that's because they look to be far in the future. But doing something about these shortfalls is not necessarily a far-term issue, because adding ships to the shipbuilding plan might be easier to do in the years prior to the Ohio-replacement boats—meaning the period starting now and extending for the next few years.

At bottom, these projected shortfalls are an expression of a fundamental imbalance between Navy program goals and projected Navy resources.

Now at this point, you might hear the argument that these projected shortfalls aren't that important, because it's impossible to know with certainty what exact kinds of ships we might want to procure 20 or 30 years from now, so the 30-year plan's just a fantasy anyway. I've heard that argument a few times.

The people who make this argument either don't understand the purpose of the 30-year plan, or they understand it perfectly well, but want you to discount its importance by offering you a false idea about what the plan is supposed to do.

The purpose of the 30-year plan isn't to make predictions about the exact kinds of ships we will be procuring 20 or 30 years from now. It's to bring to the surface long-range planning pressures that would otherwise be easy for the Navy or others to ignore or sweep under the rug. By surfacing these planning pressures, the 30-year plan gives policymakers a chance to do something about them, before it becomes too late to do anything, at least at reasonable cost.

The combination of, on the one hand, a wide-ranging debate about the future of defense spending and strategy, and, on the other hand, a fundamental imbalance between Navy goals and resources, suggests that if there was ever a time for supporters of naval forces, including Navy leaders, to make a strong and explicit public argument for preserving or even increasing planned spending on naval forces, it's now. Not when the next QDR debate gets underway inside the Pentagon, but now, because the public debate on the future defense spending is already underway.

As a CRS analyst, I can't take a position on what the outcome of that debate should be. But my hope is that the outcome will be informed by strong presentations of competing views, because that approach is more likely to result in the best possible decision.

For supporters of naval forces, what might those arguments include? Well, elements have been presented over the years, but it seems to me that supporters of naval forces are so familiar with these elements that they have forgotten how to integrate them into a logical chain that is coherent to other audiences.

So if you were to bring together these elements into an integrated argument, what might it sound like? Well the opening parts might sound something like this, if you'll bear with me for a moment:

"Most of the world's people, resources, and economic activity," the argument might begin, *"aren't in the Western Hemisphere, but in the other hemisphere, particularly Eurasia. Consequently, a key element of our national strategy, going back many decades, is to prevent the emergence of a hegemon in one part of Eurasia or another, because a hegemon could deny us access to the other hemisphere's resources and economic activity.*

"Preventing the emergence of a hegemon in the other hemisphere is a big reason why our military is structured with significant naval forces, long-range bombers, and long-range airlift. And we're unique in this regard: We're the only country whose military is designed to move itself to another hemisphere and conduct large-scale military operations there. The other countries of the Western Hemisphere don't do it because they can't afford to, and because we're already doing it for them, and countries in the other hemisphere don't do it, because they're already in that hemisphere, where the action is, and they instead spend their money on forces for influencing events in their own neighborhood.

"That's important to keep in mind when you see our military compared to those of other countries. Our military includes a significant Navy, and also long-range aviation forces, because it's designed to do something that other countries don't aim to do.

"More than two-thirds of the world is covered by water, much of which is international waters. So even though our naval forces are not inexpensive, they give us the ability to convert a major part of the world's surface into a huge, globe-spanning medium of maneuver and operations for projecting power ashore and protecting our interests in various parts of the world, particularly Eurasia.

"This wouldn't be so important if less of the world were covered by water, or if the oceans were carved into territorial blocks, like the land. But most of the world is covered by water, and most of it does exist in the form of international waters. So it's not that naval forces are inherently special or privileged – it's just a consequence of the physical and legal organization of the world. At a time when a lot of people are talking about other countries' asymmetric capabilities, our own naval forces, because of how the world is organized, arguably represent one of the biggest asymmetric advantages enjoyed by any nation. Given that leverage, one can imagine an argument being made that funding for naval forces should be protected – or even increased – not in spite of a flat or declining defense budget, but precisely because the budget is flat or declining, on the grounds that naval forces are a high-payoff investment that preserves a lot of options for U.S. leaders."

Of course, supporters of other military force elements will bring their own arguments to bear—and that's just the point: Everybody brings their best arguments to the table, and decisions on how to spend defense dollars are then made on the basis of those strongly made arguments.

As a part of a process for putting forward an argument for naval forces like the one above, the submarine community could consider explaining to others not just the ability of submarines to penetrate enemy defenses and perform their missions but also, in doing so, their ability to magnify the effectiveness of the surface fleet and of naval aircraft, and thus our naval forces in general.

And perhaps most important, this process could involve stating plainly to others what the submarine community would need to more fully meet its requirements under the 30-year plan, as opposed to what the community might think the traffic will bear. Some might say that in the coming defense budget environment, the Navy as a whole, including the submarine community, should be more modest about what it asks for. That is certainly one logic, but there's an alternative logic which says that the coming budget environment is exactly why the Navy as a whole, including the submarine community, should ask for what it needs to more fully meet its requirements, because otherwise, people attempting to make strategic choices on defense spending will not fully understand the operational consequences of their decisions.

If there's any sense to that alternative logic, then why ask for only 1 or 2 additional attack submarines? Why not ask for 3 or 4, which is what would be needed to prevent the attack boat force from dropping below 95% of its stated requirement? Five years ago, the Navy stated that 4 more boats were needed to meet the wartime demand for being able to generate 35 boats within a certain amount of time, and would also eliminate most of the 7-month deployments that would be needed to support a certain level of forward presence on a day-to-day basis.

In this view, in other words, if 48 is the required number, then why not ask for a procurement plan that gets closer to supporting it, in conjunction with a broader argument about the value of naval forces in a flat or declining budget environment?

Right now, the projected shortfalls in the 30-year plan are the elephants in the room that aren't being talked about. But sooner or later, someone is going to start paying more attention to them—and to what the Navy is, or is not, planning to do about them.

As my CBO colleague Eric Labs has pointed out, the longer that the Navy, including the submarine community, doesn't ask for a procurement plan that gets the force closer to the stated requirement—the longer, in other words, that people think that the Navy is OK with a force that bottoms out at 40 boats, or perhaps 41 or 42 boats—then the greater the risk becomes that others will begin to doubt the validity of the 48-boat requirement.

In this view, the coming defense budget environment is precisely the reason why the Navy, including the submarine community, should be asking for more, not less. In the coming defense environment, supporters of this view might argue, if the submarine community asks for 1 or 2 more boats, what do you think the community will wind up getting—and where would that leave the Submarine Force years from now?

Again, I can't take a position on the outcome of this debate. But I'm of the view that decisions on debates that are this wide-ranging and important to the country's future are better made with broad participation, and after weighing strongly made arguments from competing points of view, rather than arguments that are made partially, or not at all.

And that's the final thought I want to leave you with. Thank you again for the chance to speak today, and I hope you found these comments of value.

SUBMARINE TECHNOLOGY IMPROVEMENTS: A KEY ELEMENT TO FUTURE CAPABILITY

by VADM Al Burkhalter, USN(Ret)

The 2011 Submarine Technology Symposium (STS), held at Johns Hopkins Applied Physics Laboratory and cosponsored by the Submarine League, was one of the best that I have ever attended.

ADM Kirk Donald set the tone of the meeting with his realistic assessment of the strengths and challenges that we face today with the now evolving pressure for reductions in the defense budget against the costs for both two VIRGINIA Class SSNs and the OHIO Class replacement. The eventual retirement of the four SSGNs only compounds this problem as the Submarine Force today is the principal contributor to sea-based land attack as was aptly demonstrated at the beginning of the Libyan conflict. (more later).

VADM John Richardson, the SubForce Commander, RADM Mike Connor, then Director of Undersea Warfare on the Navy Staff, and RADM Frank Caldwell, ComSubPac, then presented their integrated strategic plan for the way ahead. The reputation of the Submarine Force has never been higher in recent years with the continued success of the VIRGINIA class building program and the SSGN conversion as was presented by RADM Dave Johnson.

These briefings set the tone for the excellent technology presentations that followed which addressed the principal issues of improved ISR, stealth, and weapons capabilities as we focus on more forward presence in the littorals, clearly an important mission for future warfare.

I suggest that industry and the Force should now strive to take advantage of these evolving technologies, many examples were given during the presentations, to make our platforms even more capable. RADM Mike Connor's presentation on improving our weapons is the best example of exploiting evolving technologies to enhance the capabilities of our platforms. I have long advocated a strong focus on developing smaller and more effective torpedoes thus increasing the kill potential for the force. The SSBN/SSGN transformation is the prime example of this issue and has given our Submarine Force an entirely new capability. This was so realistically demonstrated in the utilization of FLORIDA to completely suppress the Libyan air defenses at the beginning of that conflict. Technology improvements to the SSN weapons payload must be equally pursued.

The Submarine Force has worked closely with such organizations as Penn State and MIT/Lincoln Labs in developing and improving the capabilities of both the SSN and the SSBN weapons systems. I recommend an increased effort to reach out to other universities, and possibly to the Naval Academy, to pursue technology enhancements for the Force. The Submarine League could play an important role in this process by working closely with both the Force and with NavSea in developing these initiatives.

In concluding let me quote from Mike Connor's recent excellent article, "Investing in the Future", that was published in the June issue of the Naval Institute Proceedings. "A lethal, survivable undersea force is essential to the current and future national security of the United States and its allies. The challenge we face is how best to address essential warfighting issues...in the face of extremely tight fiscal realities. We need a coherent plan that addresses platforms, payload, payload volume, and people."

The 2011 STS symposium presented us with the challenge to develop improved payloads and payload volume. We should seize upon that opportunity.

(And may I add a Postscript kudos the former Force Commander George Emery and Sub League Executive Director Mickey Garverick for these superb efforts in organizing the 2011 STS.)

FROM USNI's PROCEEDINGS—JUNE 2011

THE ARTICLES FROM THE NAVAL INSTITUTE PROCEEDINGS

An Editorial Note

Each year the US Naval Institute devotes an issue of the PROCEEDINGS to an emphasis on each of the Navy's major warfare specialties. Submarine Warfare is usually paired with ASW and Mine Warfare in the USNI categorization. In some of the past years the contributions from the submarine community have not shown much benefit from coordination toward addressing the very real issues involved in the evolution of the distinctly American nuclear submarine and its effect on naval forces in peace and war. Probable reasons for this include, of course, concern for sensitive classified matters and the lack of substantive information in the public domain about US submarine operations during the Cold War.

For this year's issue a significant effort was made both within the submarine community and the USNI's editorial office to present meaningful discussion of matters of importance and interest. It was recognized that some issues about our nuclear submarine force are of paramount national concern, particularly those issues about real cost in all its components and real benefits on a national level. It was also recognized that those issues can and should be discussed in a public forum without compromise of sensitive operational matters. Naturally, that had to include active duty authorities for both their programmatic knowledge and their judgment about sensitivity.

Rear Admiral Jerry Holland, a retired submarine officer who is a respected writer for both THE SUBMARINE REVIEW and the PROCEEDINGS was the organizer , sparkplug and in many cases the first reader, on the retired side of the submarine community. The N87 staff of the CNO's Submarine Warfare Directorate provided a very valuable service in coordinating the effort on the active duty side. A special kudo in that area is due to

LCDR Matt Boland for his effective role as 'shepard' for the active duty contributors

Mr. Paul Merzlak and his staff of editors in the PROCEEDINGS's office did a masterful job in putting all of this material together and treating these issues with understanding, knowledge and professional editorial skill. Mr. Merzlak followed up on the success of his effort with an enthusiastic endorsement of the request by THE SUBMARINE REVIEW for permission to republish these important articles. We thank him, his staff and the leadership of the Naval Institute.

It is appropriate to take the occasion of this effort to encourage all with interests in the Submarine Force past, present and future into putting their ideas in writing. Where they pertain to the Navy at large and national interests, the PROCEEDINGS is probably the widest read and most influential outside the Submarine Force and its supporters. Such essays need not await the annual submarine issue but are appropriate at any time. The Naval Institute has been generous in allowing reprinting those essays in the Review. In cases where the audience is primarily other submariners, The Submarine Review seeks such material. Undersea Warfare, the official publication of the Submarine Force, publishes material germane to the present active duty force but also welcomes submission of historical material on subjects still pertinent to the Force.

LIKE IT OR NOT, HERE IT COMES

by RADM William J. Holland, USN(Ret)

Admiral Holland once served as the director of Strategic and Theater Nuclear Warfare on the staff of the Chief of Naval Operations. He is a frequent contributor to PROCEEDINGS and THE SUBMARINE REVIEW.

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The cost for the replacement of Ohio-class ballistic-missile submarines sends shivers throughout the Navy, builders of aircraft carriers and destroyers, and defense analysts in general, as they straight-line the shipbuilding budget. All visualize the construction of these ships absorbing a third to half of the total appropriations for new ships over ten years. For many naval officers and supporters, their price tag represents a threat to the Navy that they know, serve, and support.

Their concern is voiced in suggestions that the program be scaled down, stretched out, or canceled. But those who hold such opinions must come to terms with the realization that no amount of economic turndown, competition for other ships of more apparent and immediate utility, or concerns for maintaining a shipbuilding base in other yards will make a difference in the ultimate decision whether or not to build these submarines.

The Defense Department's investment costs in the next decade are staggering. The Ohio replacement submarine, estimated at $72 billion, is just one major investment. The F-35 program is estimated currently at $382 billion, but is behind schedule and over budget. The estimate for the three Gerald R. Ford-class carriers (CVN-78, -79, -80) is $45.5 billion; for the aerial tanker program, $35 billion.

In addition to such big-ticket items will be the expense of replacing the equipment worn out by the operations in Iraq and

Afghanistan. But regardless of arguments from supporters of other programs, the highest levels of government will ask for the Ohio replacements as the first order of business. The importance of this facet of national defense and prestige can be seen in Great Britain's plan to replace its SSBN force in the face of even more severe budget cuts and force reductions than those expected in the United States.

When development of the submarine-launched ballistic missile began in 1956, the Navy was still suffering from drastic reductions following the Korean War. Funds for everything from personnel to repair parts were scarce in an atmosphere of penury that enveloped all the services. Yet in these dire circumstances, Admiral Arleigh Burke, then Chief of Naval Operations, sequestered monies from every part of the Navy's budget to fund the first fleet ballistic-missile submarines within existing budget caps. The Fiscal Year 1956 through 1959 budgets were stripped of much, including a nuclear-powered aircraft carrier, to fund the SSBNs in what naval analyst Norman Friedman described as a wartime mobilization program. This historical record testifies to the unique importance, strategic value, and national prestige that these ships embody.

The recent nuclear arms reduction pact is not likely to be the end of efforts to further limit the numbers of strategic nuclear weapons or their launchers. Predicting the number of weapons and launchers that will be needed or allowed in 2025 is difficult, but certainly it will be fewer than are deployed now. As the number of weapons declines, the value of each remaining one increases; therefore, its security, survivability, and reliability becomes even more important. These features are the hallmarks of submarine-based nuclear weapons; in these attributes, SSBN basing far exceeds its fixed-point land-based cousins.

Because only a small fraction of the Navy's officers are employed in submarine-based strategic weapon systems, and because the activities of fleet ballistic-missile operations are isolated from routine naval operations, the importance of the submarine-launched ballistic missile goes unrecognized and unacknowledged by most in the Navy and among its supporters. In the four essays on the future of the Navy in February's Proceedings, there is no mention of nuclear weapons, strategic forces, deterrence, or SSBNs.

But recognized or not, strategic nuclear deterrence is the first and most important DOD mission. No unit, effort, or force is as valuable as the strategic weapons based in submarines. The Ohio replacement will go forward regardless of the state of the budget or top-line caps on total allotments. The mission needs the Navy more than the Navy needs the mission.

INVESTING IN THE UNDERSEA FUTURE

by RADM Michael Connor, USN

Admiral Connor is director of the U.S. Navy's Submarine Warfare Division. His prior assignments include command of USS SEAWOLF (SSN-21), Submarine Squadron Eight, Task Force 54, and Task Force 74.

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In a world where defense budgets are shrinking but the U.S. Submarine Force remains vital to security, viability tomorrow requires stringent planning today.

A lethal, survivable undersea force is essential to the current and future national security of the United States and its allies. The challenge we face is how best to address essential undersea warfighting issues of a very complex world in the face of extremely tight fiscal realities. To do that we need a coherent plan—a long-term investment plan that addresses the full span of undersea capability—platforms, payloads, payload volume, and people—and makes integrated decisions about them in a way that helps us thin out options, focus resources and time, and still end up with the capabilities required by the future joint force. This plan allows us to make future decisions in a coordinated way so that gaps are not created and overlaps and hedging are reduced to a minimum to maximize capability in a time when we have resource constraints.

Characterizing the Future

Setting the stage for the undersea force of tomorrow requires an assessment of challenges beyond today's horizon and the tools required to meet them. While the future is uncertain, some trends are very likely and useful for planning.

First, the relative importance of naval forces likely will increase as the global economy depends even more on access to the global maritime commons and as access to forward-basing ashore becomes more challenging.

Second, it is fair to assume that the high end of warfare will be defined by state entities, but small conflicts will frequently arise on short notice from an ever-changing array of non-state adversaries.

Third, national-security requirements will be increasingly cost-sensitive. Cost will be a requirement in itself and will affect the size and mix of our future maritime forces to an even greater degree.

Finally, anti-access/area-denial (A2AD) systems will continue to proliferate and may at times impede joint-force freedom of action. Submarines are less vulnerable to A2AD than other forces and will, therefore, continue to play a key role in establishing access for other forces. In low-intensity conflict, this capability minimizes friendly losses. In major conflict, it will determine whether the joint force succeeds or fails.

With these considerations in mind, the Submarine Force developed an integrated strategic plan that forecasts future roles and missions best provided by undersea forces and the platforms, payload volume, payloads, and people required to meet our responsibilities to the joint force. This strategy is designed to guide long-term planning and investment decisions. The planning horizons vary.

It takes more than a decade to design and build a new class of ship. It takes five years to implement a change in force structure by adjusting procurement rates. Completely new weapon payloads take more than five years to put in place, while critical adjustments to existing weapons can be implemented in months, provided that the architecture of the weapon is designed with rapid-change potential in mind. People are our most versatile resource. While it takes years to prepare an officer for command, a talented crew can prepare for and execute a radically new mission in the course of a single deployment cycle.

Current Trends

The trajectory of undersea force structure over the next 20 years is already well defined because ships are large investments with long service lives. The trajectory is downward. The recent implementation of two-per-year construction of Virginia-class attack submarines will slow, but not arrest, the force-structure decline that occurs as submarines constructed in the 1980s and 1990s reach end of service life. Therefore, the strategy starts with the proper prioritization of the force structure. There are three well-defined challenges that the integrated undersea strategy must address.

Nuclear-Powered Ballistic-Missile Submarines (SSBNs): Action is needed to preserve SSBN-force strategic deterrence as the centerpiece of the nation's nuclear strategy. The Navy operates submarines carrying nuclear-tipped ballistic missiles in support of U.S. Strategic Command. The SSBN fleet forms the largest and most survivable leg of the strategic triad. The need for the United States to retain a survivable nuclear deterrent (SSBNs) will continue as long as other nations, or non-state actors, retain nuclear forces. The United States and Russia have been able to cooperate in reducing nuclear weapons from Cold War levels, but other nations have entered the nuclear arena. Therefore, we must plan for the continuing requirement for an SSBN force and the responsibility to operate it at the highest levels of safety and security.

The retirement date of Ohio-class SSBNs is set by the expiration of submarine hull life after 42 years of service. This fixed retirement schedule effectively determines the procurement schedule for the replacement SSBN. Having set the major requirements, we are conducting technology development now for a class of ships that will start construction in 2019, be delivered in 2026, and go on patrol in 2029. The cost of this major investment in national strategic deterrence will have implications for the Submarine Force and the Navy as a whole.

Nuclear-Powered Attack Submarines (SSNs): Action is needed to compensate for an inevitable SSN-force shortfall. Per the current Navy shipbuilding plan, the attack-Submarine Force will shrink by 30 percent to a low of 39 hulls in 2030. This is the program of record—it is the starting point as we enter into consideration of defense-budget cuts.

From a warfighting and deterrence standpoint, this drop in SSN-force size and forward presence carries important consequences for day-to-day operations. It will reduce intelligence collection and lengthen response times for contingencies and warplan surges. When combined with the impact of all four nuclear-powered guided-missile submarines retiring in the 2020s, tactical submarine forward presence will drop by some 43 percent between today and 2030. When considered in light of (1) the increased future reliance on naval forces, (2) the increased dependence on undersea forces to gain access, and (3) the emergence of regional challengers with naval capabilities, it is clear that if no action is taken the Navy will lose its ability to have SSNs operating in many places where they are currently the only credible U.S. military force.

Nuclear-Powered Guided-Missile Submarines (SSGNs): Action is needed to sustain undersea payload volume as SSGNs retire. We have four dual-crewed SSGNs with a forward-based crew change-out CONOPS that allows us to get on average about 2.5 submarines of forward presence from these four ships. Each ship carries in excess of 100 Tomahawk missiles and is capable of carrying up to 154. In addition, these platforms have the capacity to support Special Operations teams with covert insertion-and-extraction capability that is unique. All four of these ships are going to decommission by 2028.

As a result of this SSGN retirement and, to a lesser degree due to the reduction in the SSN-force size, our Navy's undersea strike capacity will decrease by 60 percent by 2030. This reduced payload volume will impact not only strike but also large-diameter payload volume needed for deploying and retrieving large unmanned undersea vehicles, future distributed systems, and special-operations forces (SOF) support. The undersea investment strategy addresses this undersea payload gap in order to ensure that we can continue to fulfill our responsibility as the force that opens the door for access by other joint and maritime forces.

SSGN retirement affects peacetime forward presence, wartime strike volume, and the ability to execute a number of SOF missions. To replace the 2.5-submarine forward presence provided by our SSGNs would require adding 13 SSNs to our construction plan over the next ten years. That is unrealistic. To replace the 600-plus Tomahawk strike capacity of these four platforms would require adding 50 SSNs to our force structure. That's also not viable. And from an SOF standpoint, no number of SSNs can re-create the value of consolidated command-and-control of SOF teams consisting of scores of SEALs.

An Integrated Strategy

These separate problem areas are highly interconnected and require an integrated solution. This solution must fit within the fiscal and industrial constraints facing the Navy and the country. The investment plan outlined here represents the culmination of a focused effort over the past year to develop a blueprint to guide key decisions affecting future undersea warfighting capability. The goal has been to develop an integrated approach that does not solve problems piecemeal but instead solves them in a coordinated and complementary way that is both effective and cost-efficient.

The "Integrated Undersea Strategy" has six main elements.

1. Field the Ohio-replacement SSBN without disruption or delay. The Ohio replacement is our highest priority, and all other facets of the integrated undersea future-investment strategy are subordinate to it. The existence of a reliable and survivable nuclear deterrent is critical to deterring conflict between major powers. The current procurement plan is executable, and we want to make sure that the Ohio-replacement SSBNs enter service on time, with the right performance, and on budget. The size of the fleet and the missile capacity are smaller than the current fleet and consistent with the *New START* treaty between the United States and Russia. Twelve replacement SSBNs will fulfill the same responsibilities that 14 SSBNs have serviced these past ten years.

Cost is a critical issue. Therefore, the next SSBN will be delivered with the correct capabilities, and nothing more. Further, the existing, proven technologies in the D5 strategic weapons system, Virginia-class tactical systems, and other Seawolf- and

Virginia-class components will be leveraged to achieve aggressive cost goals.

That said, it must be recognized that as the country reduces the number of nuclear warheads, thereby increasing the premium on safeguarding this highly valued inventory, the Ohio-replacement SSBN will be called on to carry the vast majority of the national strategic-deterrent arsenal. It will serve as the dominant deterrent against major war for the bulk of this century, at a fraction of the cost of the security value it returns.

2. Take affordable steps to arrest the decline in SSN force structure. There is almost no practical plan that would add SSNs to the force in sufficient numbers and early enough to forestall the force falling below the minimum requirement of 48 SSNs established by the Chief of Naval Operations. However, adding two SSNs to procurement plans over the next decade will result in a stable two-SSN per-year procurement schedule through 2023, which will provide attendant efficiencies in economic-order quantities and in shipyard manning. If additional ships are added as a tenth ship to planned *block buys*, unit prices for the block purchases would be reduced.

If we move quickly, we can deliver these ships in time to minimize the depth of the force-structure trough in the critical period between 2020 and 2030. In terms of "SSN years," adding two ships, one in 2018 and one in 2023, eliminates almost half of the projected SSN shortfall.

3. Add a Virginia payload module (VPM) to 20 already planned Virginia-class SSNs. Stretching 20 of the Virginia-class SSNs already in the Navy shipbuilding plan to support the addition of four large vertical-payload tubes will provide the force with near-equivalent undersea payload volume currently provided by our four dual-crewed SSGNs. This sustainment of undersea payload volume will be vital to our future security by supporting an increased volume of strike missiles and other asymmetric payloads. The payload tubes increase Virginia-class SSNs' strike volume from 12 to 40 Tomahawk missiles while protecting the full torpedo-room payload volume for sea-control missions.

This design option has been technically studied and is feasible. It would cost-effectively employ tubes like the large 87-inch bow tubes on Block III and later Virginias, making payloads that could be used in SSGN tubes and existing Virginia bow tubes able to be used in these tubes. In addition, the hardware and support equipment would match other large tube applications to a significant degree. Because these tubes would be added aft of the sail near the longitudinal center of the ship, they would be accessible to operators reaching through manway hatches (similar to SSBN tubes today). This would be an important advantage over the large-diameter bow tubes in Virginia Block III, which are not accessible.

If all 20 of the Virginia SSNs starting with Block V (beginning construction in 2019) were stretched to include this VPM, the gap in undersea strike volume would be reduced by more than three-quarters. This strike volume would be a little late, leading to a *notch* of reduced undersea strike volume from about Fiscal Year 2028 to FY 34.

Adding a payload module is a significant investment, adding about 20 percent to the cost of each ship. However, it is possible to stretch ten Virginia SSNs for the cost of a single new Ohio-like SSGN.

The Virginia class is currently planned to be a 30-hull class. The undersea investment strategy would extend the Virginia class beyond 30 hulls, allowing the Navy to exploit the cost-efficiency of continuing to build a highly effective and proven cost-efficient design while enhancing it with weapon-payload growth to help compensate for the reduced SSN force structure and the retirement of SSGNs.

4. Integrate a large-displacement unmanned undersea vehicle (LDUUV) into the undersea force. The development and fielding of capable LDUUVs will increase the productivity of the undersea force because they will do some of the tasks currently accomplished by submarines. To permit the effective integration of LDUUVs into the force, a number of technical challenges will need to be confronted. Although unmanned aerial vehicles (UAVs) are in many cases remotely piloted, the connectivity

challenges associated with UUVs do not permit that option. The vehicles must be autonomous. As the technical challenges of future LDUUV missions grow, the complexity of the necessary autonomy must also grow.

In addition to autonomy, there is the well-known challenge of extending LDUUV endurance. There is good reason to believe that the aggressive investments of the automobile industry in battery technology may result in improvements that can be leveraged for LDUUVs, but this is not a given.

These vehicles need not be operated from submarines, but their greatest value in helping pick up gapped submarine taskings will, by definition, arise from forward employment in areas accessible by submarines. Submarine launch and recovery of LDUUVs forward, close to the desired operational site, will permit effective military utility even for craft with limited endurance. As their endurance grows, they will be capable of being launched by other platforms at standoff ranges. Until this endurance is achieved, forward LDUUV operations will be best supported by submarines. Even after long endurance becomes a reality, some missions will continue to require submarine launch and recovery in order to achieve the required timing and positioning. Waiting for vehicles to transit in or out from long standoff would introduce time delays that may be unacceptable in fast-moving contingency or combat operations.

The most operationally useful LDUUVs will be capable of launch and recovery from a variety of platforms, will have long endurance, will be guided by sophisticated autonomy, will have strong information-assurance capabilities to prevent risk even if the vehicles were lost, and will be capable of deploying a variety of payloads that are adaptively tailored to the mission.

5. Open the aperture on revolutionary and evolutionary payload enhancements. With a smaller force, each submarine will need to be able to hold a broader set of targets at risk and do so over a broader geographic area. Beyond LDUUVs, we must make investments in our undersea payloads and off-board capabilities as a way to further compensate for force-structure shortfalls.

Incremental evolutionary changes in existing systems will be the key to producing disruptive revolutionary effects in an affordable manner and at a rate fast enough to outpace the most sophisticated adversaries. In many ways, existing submarine-delivered missiles and torpedoes are functioning as unmanned vehicles. Emerging technology developed for UAVs and UUVs can be incorporated into the existing space and weight capacity of today's weapons to produce revolutionary effects. We will not earn the maximum return on our force structure until we fully realize the autonomous potential in some of our existing systems while we develop future unmanned systems. When we produce or upgrade our systems, we need to ensure that we use open architecture in order to easily leverage the ability of our technical community to produce and install an application or *app* for a new mission on short notice.

There are a variety of opportunities that can be investigated on relatively short timelines at low cost. Decoys, deception devices, mine countermeasures, and non-lethal weapons are all possible and being considered as part of the strategy. This category of *payload enhancements*, unlike the platform-related areas, will involve a substantial degree of adaptation and, therefore, cannot be firmly defined in advance. The added capability of newly evolved payloads will greatly complicate adversary planning, make it possible for the United States to more effectively leverage the assured access resulting from undersea concealment, and deter aggression.

6. Evolve the undersea warrior. In the same way we have described the evolution of undersea payloads, the undersea warrior of the future must also evolve. To be effective, he or she must not only understand the mission, but also exercise boldness, initiative, and the ability to selectively apply the capabilities of both the submarine and unmanned assets to take full advantage of the extended reach of diverse undersea payloads. The undersea warrior must be granted the greatest possible operational autonomy to most effectively operate far forward in areas that are denied to other naval forces, exploiting subsurface concealment for military effectiveness.

The future undersea warrior will leverage remote undersea sensors for planning and targeting as seamlessly as we do today with third-party targeting of Tomahawk missiles. The smart payloads of the future will in many cases give the submarine the vertical and horizontal standoff to enhance mission safety. Other payloads may require teams of special equipment operators because of their specialized or classified capabilities. The future undersea warrior will require a diverse knowledge of the ship, its payloads, and the optimal way to coordinate the joint force in the undersea domain.

Taken together, the elements of the long-range undersea strategy minimize the decline in force structure, prioritize the investment of scarce funding to build the right ships with the right payload volume, develop innovative payloads, and evolve the skills of undersea warriors to maximize the impact of each submarine. These goals are all important, because financial constraints and the limits of industrial capacity mean that the Navy must get greater undersea effectiveness out of a shrinking force of manned platforms. The Integrated Undersea Strategy provides the nation with effective naval forces that can assure access despite future threats, sustain our undersea payload capacity affordably despite the retirement of SSGNs, preserve powerful nuclear deterrence with survivable SSBNs, and employ off-board vehicles and improved payloads to create operational and tactical flexibility even as the Submarine Force shrinks.

THE SWEET SMELL OF ACQUISITION SUCCESS

by RADM John Butler, USN(Ret)

Retired Rear Admiral Butler was Program Executive Officer (Submarines) until his retirement from the U. S. Navy in 2005. He is currently vice president for Fleet Ballistic Missile program requirements for Lockheed Martin Space Systems Company.

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A former submarine procurement guru details what was behind the Virginia-class program, one of the most talked-about cost-saving acquisitions in Department of Defense history.

In 2011, Congress authorized the Navy to build two Virginia-class submarines, marking the first time since 1989 that two submarines of the same class were authorized in the same year. While at press time the two ships scheduled to begin construction in Fiscal Year 2011 had not received full funding, Congress seems intent on providing the funds so the Navy can move forward.

Originally, the Navy planned to increase production from one ship per year to two starting in 2002. However, changes to the shipbuilding plan, budget cuts, and cost growth delayed such production by nine years—and even that was not guaranteed. To reach this point, the Virginia-class program had to execute a one-of-a-kind cost-reduction effort to remove nearly 20 percent from its acquisition costs. What made this endeavor both extraordinary and difficult was that it had to occur on a mature program already in serial production. That the program could successfully execute this task serves as a model for other acquisition efforts facing more constrained budgets as the government looks to reduce spending.

Program History

From the time the program started in the mid-1990s to now, its total obligation authority—the amount of money required to fully fund construction and delivery of 30 submarines—grew by about one-third. The reasons behind this growth have never been fully explained.

The cost grew for four primary reasons:

- Originally, the Navy intended to use a single shipyard, but to ensure that the nation retained a viable nuclear shipbuilding industrial base, Congress passed a law requiring that General Dynamics Electric Boat and Northrop Grumman Shipbuilding (formerly Newport News Shipbuilding and Dry Dock) each build parts of every Virginia Class submarine. While this added roughly $200 million to the cost of each ship, the move had an unexpected benefit.
- Restarting submarine building at Northrop Grumman Shipbuilding—which had been out of submarine production since the delivery of the last Los Angeles-class boat—and general shipbuilder learning curves added approximately $300 million to each ship.
- Unexpected material-cost growth, coupled with an estimated inflation rate that was well under the real inflation rate, added $300 million to the cost of each ship.
- Delaying increased production to two ships per year from 2002 to 2011 added approximately $200 million per ship as boats originally scheduled for construction over that span were moved to later years. Such shifts made the submarines more expensive because of inflation, increased material costs, and the loss of economies of scale.

All told, each boat's final cost increased by approximately $1 billion on average and, over the 30-ship program, the total obligation authority went from approximately $60 billion in the mid-1990s to $90-plus billion in the mid-2000s.

The Writing on the Wall

With an average ship-construction budget of about $15 billion a year from the early 2000s out for the immediate future, the Navy could not afford to build two Virginias per year while recapitalizing the surface fleet at the same time. This problem did not escape either the Navy's or its shipbuilders' attention.

The Navy took steps early in the program to reduce costs and in so doing laid the foundation for the Virginia-class program's successful money-saving efforts. In the second, or Block II, construction contract signed in August 2003, the Navy included a clause that would allow both shipbuilders to draw from a capital-expenditure incentive pool to make infrastructure improvements at their facilities. To earn the fee, the companies had to submit a business plan for how proposed improvements would reduce the Virginia class' acquisition costs. If the Navy agreed, it would fund half of the cost for making the enhancements.

Once the company proved that the project reduced construction costs, the Navy would pay for the second half of its investment in the project. In the end, both companies would have more modern and efficient production facilities at no cost to themselves, and the Navy would save money over the life of the program. The $91 million set aside for capital-expenditure improvements in the Block II contract allowed the Navy to avoid more than $400 million in acquisition costs—a greater than 4 to 1 return on investment. It is important to emphasize that the companies had to prove the cost savings before the Navy paid for the second half of the improvement project. Those savings are, therefore, accounted for by both the Navy and its industry partners and cannot be questioned.

The Block II contract had another clause that with congressional authorization would allow it to transition from a block-buy contract into a multi-year procurement agreement. In a block-buy contract, the Navy is not obligated to purchase all the ships listed in the deal. Consequently, the shipbuilders lacked incentive to buy material in bulk for multiple hulls, as they would put themselves at risk should the Navy decide not to exercise all of the contract's options. In a multi-year procurement contract, the Navy commits itself to buying all the ships listed in the deal, thereby removing the companies' risks associated with making bulk purchases. While the first ship of the Block II contract remained as a block-buy boat, Congress allowed the Navy to transition the Block II to a multi-year procurement agreement in January 2004, saving $400 million over the remaining five ships of the contract because of the improved buying power.

When Congress authorized the change in contracting strategy, the first ship, USS VIRGINIA (SSN-774), had not yet been delivered, and the second ship of the class, USS TEXAS (SSN-775), was showing significant cost growth and schedule delay. Traditionally, Congress had waited until an acquisition program was more mature and established before authorizing it to award multi-year procurement contracts.

Congressional Trust

At the time, the Virginia was likely the most immature program ever to receive multi-year authority. However, it had shown a real understanding of what needed to be done to get on track, and its ongoing and preemptive work gave Congress confidence that things were moving in the right direction. The trust exhibited by Congress was, and still is, well placed as evidenced in the dramatic improvements in reducing the construction span.

Both of the Virginia–class shipbuilders understood the Navy's budgetary constraints and, in addition to taking full advantage of the capital-expenditure incentive, began working on how they could reduce costs. General Dynamics Electric Boat led the charge on two ideas that would end up paying significant dividends. In 2004, it presented a concept for a modified bow-sonar array to the Navy. Instead of the traditional transducer-populated, SUBSAFE-boundary sonar sphere, it theorized that a horseshoe-shaped passive bow array that used hydrophones, coupled with a small active array, could be used on Virginia–class submarines. Electric Boat's concept had two significant characteristics: It was not a SUBSAFE boundary and therefore much less expensive to build and maintain, and it used less costly components.

Electric Boat followed up with an equally impressive idea that would replace the 12 vertical-launch tubes aft of the sonar array with two large-diameter tubes. Essentially, it proposed using the guided-missile submarine's multiple all-up-round canisters in the Virginias. While there would be no reduction in weapons, as each tube would still hold six Tomahawks, replacing the 12 smaller tubes with two large ones would simplify construction, making them less expensive to build while also reducing life-cycle costs because of fewer moving parts. While those new ideas still required significant engineering and design work, they laid the foundation for the Virginia–class program's next phase.

A Thousand Voices, One Message: 2 for 4 in '12!

In September 2005, then-Chief of Naval Operations Admiral Mike Mullen issued a statement that began one of the most successful cost-reduction efforts undertaken by a Department of Defense program. While acknowledging that the Navy needed to increase production of the Virginia class, he also asserted that the service could not afford to do so at the current cost.

Admiral Mullen then challenged the Virginia program by saying that the Navy would budget $4 billion, as measured in FY 05 dollars, in the FY 12 budget for two Virginia–class submarines. The Virginia–class submarine authorized in 2005, the USS MISSOURI (SSN-780), was budgeted for $2.4 billion. Therefore, the Navy had to find a way to remove nearly 20 percent of the ship's cost to meet Admiral Mullen's goal of two Virginias for $4 billion in FY 12—or "2 for 4 in '12."

The phrase "2 for 4 in '12" became the Virginia class' rallying cry. The mantra spanned not only the Navy, but also infected the shipbuilders, their suppliers, and even members of Congress who used the term during testimony. That all parties involved with the Virginia class bought into the message proved highly beneficial, as the Navy cut the program's total obligation authority in anticipation that the program would succeed.

To meet the CNO's cost goal, the Virginia program instituted a three-pronged effort that it believed would reduce acquisition costs by $400 million (in FY 05 dollars) per hull. First, the Block III contract would have to be a multi-year procurement pact that increased production to two ships per year in FY 12. The economic order-quantity savings associated with a large multi-year procurement contract would allow the shipbuilders and their vendors to negotiate the best price possible, while increasing production would spread overhead costs across two hulls. All told, increasing production to two ships in a multi-year procurement contract would account for about one-half of the savings required.

The Virginia program office, then, had to find roughly $200 million per hull in savings. First, the program and shipbuilders investigated how they could redesign parts of the ship to make them less expensive without adding to the class' total life-cycle costs. The Virginia-class team evaluated more than 1,000 separate design changes and implemented more than 200 modifications, from the mundane to the extraordinary.

Pieces of the Puzzle

On the less-complicated side, the engineers determined that they could use a composite main seawater pump impeller and save $400,000 per ship. They also found that they could save $2.6 million per ship by using different paints and coating and improving how they are applied. Possibly the most significant effort came in the Virginia class' bow, where Electric Boat's ideas of replacing the sonar sphere with a large-aperture bow array and using two Virginia payload tubes in the place of 12 vertical-launch tubes became reality. Those changes in the bow alone will save $40 million per ship, starting with the two boats authorized in 2012.

The third piece of the cost-reduction puzzle involved reducing the Virginia–class construction span from 84 months to 60. Once again, the Navy and the shipbuilders collaborated on ways to make the vessels more efficient to build. One of the most significant changes involves constructing the ships in four *super modules* instead of the previous ten modules. Reducing the number of modules moved between the shipyards not only saves on transportation costs but also allows the shipbuilders to more completely populate the hull cylinders. The more work completed before the hull sections are joined together, the easier and faster it is to complete final assembly and test.

The Virginia program also benefited from the $91 million set aside for capital-expenditure improvements. Without the more modern facilities at the two shipyards, it would have been far more difficult for General Dynamics Electric Boat and Northrop Grumman Shipbuilding to improve their throughput while maintaining the high degree of quality required for submarine manufacturing.

In December 2008, the Navy signed its single largest submarine-construction contract in dollar terms. The Virginia-class Block III contract is a five-year, eight-ship agreement worth a total of $14 billion. Most notable, though, is that it meets the program's 2 for 4 in '12 goal in FY 12, and it includes the two ships authorized in FY 11. The Virginia–class program's successful cost-reduction effort is singular in DOD. No other program has been asked to reduce its acquisition costs by nearly 20 percent while already in serial production. The two ships authorized in this fiscal year, one year earlier than planned, demonstrates the confidence both the Navy and Congress have in the class. How the program accomplished this feat is worth noting. With every indication that the government will be tightening its fiscal belt, lessons can be applied to other acquisition programs.

Lessons Learned

It takes money to save money: The Virginia-class cost-reduction effort was not accomplished in a fiscal vacuum. The Navy provided $600 million between FY 08 and FY 13 to reduce the costs. The $3 billion-plus return on investment shows what can happen when motivated people are given a task with proper funding and reasonable schedule expectations. Without that investment, the Virginia class would not have been able to conduct the studies needed to reduce costs to the required levels.

Programs must have a clear, unchanging goal: The Virginia class had a well-conceived and accepted set of requirements at program inception and therefore was successful in avoiding change since the beginning of the construction program. Admiral Mullen provided a very clear goal for the Virginia–class program, and from 2005 to 2008, "2 for 4 in '12" remained constant. With a stable requirement, the Virginia–class team could focus all of its efforts on a single result without having to make contingency plans to address new requirements.

Acquisition is a team affair: The long-standing synergy between the Navy and its submarine builders proved integral in the cost-reduction effort. From the start, the major players on the acquisition team bought into the cost-reduction effort and worked in concert to ensure that their mutually beneficial goal—increasing production—became a reality. During the redesign efforts, the Navy, prime contractor General Dynamics Electric Boat, and primary subcontractor Northrop Grumman Shipbuilding all had to agree on the amount saved with each change. In doing so, they were able to track cost-reduction efforts using the same metric so that there could be no question on where they stood in relation to their goal.

Competition can take many forms: One of the criticisms of the teaming arrangement between shipbuilders has been that there can be no competition. While that is true from a pure cost standpoint, the reality is that competition is ongoing between the two shipyards. Both take pride in their craft and they both believe that they are the best at what they do. To prove that, they have seemingly entered into a contest on which yard can deliver a submarine more quickly. In fact, the last five submarines have been completed in record time. That said, quality of work is also improving with each ship, and the ships are delivered within the Navy's budget. The shipbuilders are working harder and smarter to reduce the construction span, not cutting corners, and holding the line on cost, and the Navy is reaping the rewards.

Know your program inside and out: From the Navy's program office to those at the shipyards, the people who oversee the Virginia-class program know their product. When the time came, they knew where to look for efficiencies and savings. Without such knowledge, it would have been far more difficult to execute the cost-reduction efforts in time to meet the deadline for awarding of the Block III contract.

Cost reduction does not have to mean capability reduction: The Navy let it be known in no uncertain terms that it would meet the CNO's cost-reduction goals. The preferred method would not have reduced the Virginia class' capabilities, but if that was the only way to bring costs down by nearly 20 percent then that was what was going to happen. Through hard work and diligence, the cost-reduction efforts allowed the Navy to meet its goal without reducing the submarines' capabilities.

Cost reduction does not have to increase operational costs: The Virginia–class cost-reduction efforts preserved warfighting capability and reduced total ownership costs. The large-aperture bow array and the Virginia payload tubes will both allow the Fleet to realize real life-cycle savings. When done correctly, a savings in acquisition does not result in a requirement to pass a bill to the Fleet.

Don't fold with the winning hand: The Virginia–class program expended considerable effort to put the right people together to successfully reduce costs. This winning team now is working on a new goal: further streamlining the total ownership costs of the class by reducing the number of major shipyard availabilities the boats will undergo during their life cycles from four to three and increasing the number of deployments they can conduct from 14 to 15. This "3:15," as the Virginia program office is calling the effort, must be completed by the time of the Block IV award, which will likely occur in December 2013.

The Virginia–class cost-reduction effort, like the program overall, will forever stand as an acquisition success story. It reduced the average per-unit cost by nearly 20 percent for each submarine starting with the two ships in 2012, despite the program already being in serial production, and did so without reducing warfighting capabilities or passing future maintenance costs on to the Fleet. The program's success is not a secret, and in fact several other programs have requested lessons learned and advice. In a time of tight federal budgets, more programs will likely be calling in an effort to learn from this hallmark program.

2005 Dollars versus 2012 Dollars: The Virginia Program Office is always eager to point out that the "4" in "2 for 4 in '12" is in Fiscal Year 2005 dollars. This is important because when seven years of inflation is applied, $4 billion in 2005 becomes approximately $5.2 billion in 2012.

3:15 A ROADMAP FOR REDUCING COST

by CAPT Michael Jabaley, USN

Captain Jabaley is the Virginia–class program manager.

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The "2 for 4 in '12" cost-reduction effort Rear Admiral Butler discusses here reduced the unit acquisition cost of the Virginia-class submarines by almost 20 percent while ensuring operating and support (O&S) costs would remain at least constant. In 2008, as my predecessor, Rear Admiral Dave Johnson, handed over the program to me, the challenge became broader—to analyze total ownership cost (TOC) and determine how best to reduce it.

That year, it became increasingly evident that the Navy was experiencing a TOC increase chiefly because of cost increases in O&S. The Navy chartered a reduction of total ownership cost (RTOC) pilot program under the leadership of Admiral Patrick M. Walsh, the Vice Chief of Naval Operations, and the Assistant Secretary of the Navy for Research, Development, and Acquisition Sean J. Stackley, selecting four acquisition programs as pilots. As one that already had a proven framework for reducing acquisition cost, the Virginia program was a logical choice.

Since then, the program has expanded that framework to include all stakeholders in TOC, a much broader and more difficult endeavor than focusing solely on acquisition cost. Based on a validated analysis of the cost drivers, the program has settled on depot-level maintenance as the most significant contributor to O&S cost, and focused approximately 75 percent of the RTOC effort on reducing that maintenance.

This extended culture and unprecedented business model provide a broader perspective of maintenance drivers to ensure that select components and systems are redesigned with increased sensitivity to maintenance objectives. This effort also offers an opportunity to lay the groundwork for the next evolution in the Virginia–class lifecycle maintenance plan (LCMP).

By reducing the amount of depot-level maintenance, the Virginia program can return man-days to the Fleet while allowing for a re-prioritization of that capacity. In addition, even with the increased construction rate of Virginia–class submarines, the decommissioning rate of the Los Angeles class will result in a decrease in the number of SSNs below 48 in the 2020s, calling for an effort to improve operational availability to support the combatant commanders. A depot-level maintenance reduction will allow additional deployments, thereby diminishing the impact when the Navy falls below the 48-SSN requirement.

The Virginia–class RTOC project stood up in February 2009 and focuses on submarines procured in the Block IV contract (authorized in Fiscal Years 2014–18). The key to this project is a plan for how to transition the current LCMP from 72-month operating cycles with 4 major depot availabilities and 14 deployments over a 33-year ship life, to a Block IV and forward plan of 96-month operating cycles with 3 major depot availabilities and 15 deployments over the same ship life. Although this plan includes much more than just those goals, for simplicity it has been labeled *3:15* to reflect the main targets of 3 depot-level availabilities and 15 deployments.

A submarine-class LCMP evolution is not new. For example, the Los Angeles–class plan has evolved three times from initial development in 1974, starting as a 24-month operating interval, 70-month operating cycle plan with 11 depot availabilities (8 minor and 3 major) and 12 deployments, to the new plan with a 72-month operating interval and 120-month operating cycle with 6 depot availabilities (4 minor and 2 major) and 15 deployments.

An operating cycle is the time between overhauls/major depot availabilities, while an operating interval is the time between any depot availabilities and is a specified period only for submarine life cycles that employ both minor and major depot availabilities, such as the Los Angeles class. With the exception of post-shakedown availabilities, all Virginia–class availabilities are major, and therefore operating intervals are not specified. A minor depot availability is less than six months; a major is greater than six months.

Each evolution was accomplished through analysis of maintenance documentation and performance histories to determine which inspections or preventive maintenance could be performed less frequently or eliminated, thus allowing for longer periods between depot availabilities and less maintenance. In each case data were already available *on-the-shelf* to support revisions.

How is the Virginia–class evolution different? First, it took the Los Angeles class 35 years to extend the LCMP operating interval to 72 months. The Virginia class achieved this benchmark in five years. The second key difference is that the project is not working from on-the-shelf data. Rather, the Virginia–class RTOC project will continue to take advantage of opportunities to accelerate the process. This will be done by employing the same analysis process used in previous LCMP evolutions, which will then identify systems or components that are not likely to perform as needed with a 96-month operating cycle and will use that information to develop near-term mitigation plans.

In addition, long-term events will be scheduled to review maintenance documentation and performance histories to ensure that the data support the extended operating cycle. Far from just-in-time, the analysis by the Virginia–class Block IV RTOC project can result in the new LCMP becoming effective on delivery of the first Block IV ship, the SSN-792, in 2019.

Acceleration of maintenance cannot be accomplished by sacrificing technical rigor. Specific studies are chartered either in delivered ships or in the laboratory to assess the ability to extend time between maintenance. As with the 2 for 4 in '12 efforts, the Navy will make investments in system redesigns and lifecycle maintenance processes to reach 3:15. But the return on this investment will be obvious.

In terms of cost, the value returned to the Fleet associated with eliminating one depot availability from the 12 remaining ships of the 30-ship Virginia class can be determined based on the cost of

USS VIRGINIA (SSN-774) depot availability now in progress. That will cost just under $120 million, making the return on investment from one fewer availability for 12 ships roughly $1.4 billion in FY 10 dollars, equivalent to a 10 percent reduction of average annual O&S cost over the life of those 12 ships. A concurrent benefit results from improved operational availability.

Each of the 12 ships will be able to complete one additional deployment over the course of their 33-year lives. In effect, those 12 *extra* deployments provide the Navy with operational availability nearly equivalent to one additional SSN.

The Virginia class has become a model for program cost control and reduction. Vice Admiral Kevin McCoy, Commander, Naval Sea Systems Command, recently cited examples of cost-reduction efforts, summing up by saying, "Under every rock that gets turned over in these cost-reduction efforts there's been money." The Virginia-class program will continue to look under every rock.

DETERRENCE FROM THE DEPTHS-IN THE 21ST CENTURY

by CAPT Jim Hay, USN(Ret)

Captain Hay, a retired submarine officer, has served in an SSK, an SS, an SSRN, two SSNs, and two SSBNs—commanding the last two. He was a military assistant in the Office of the Secretary of Defense, commanded Naval Submarine Base New London, Connecticut, and was chief of staff of Submarine Group Eight in the Mediterranean. Currently he is editor of THE SUBMARINE REVIEW.

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U.S. submarines have long given pause to would-be aggressors. But as the subsurface fleet ages, retaining our edge will be a challenge.

Deterrence is widely accepted within America's body politic as a prime objective of our national- security structure. That is not to say, however, that it is a widely understood concept. Indeed, commentary on the topic is often either over-expansive or oversimplified. The truth about deterrence is this: Of all the forces the nation needs, only those capable of taking the right action at the right time are effectively deterrent. The deterrent force is the warfighting force that keeps the peace. It is, therefore, a critical force.

It is one thing to recognize a general need for deterrence, but it is not useful to discuss it in vague terms. Today there is great pressure on government funding, and the future can be expected to offer stress on national security in many and varied ways. Now is the time to reassess the costs of all programs versus the needs of our society. Accordingly, every aspect of the national-security structure should be examined closely. In any such examination a firm understanding of the nature of deterrence—and the hardware and policy requirements necessary for its clear use—is fundamental.

The nature of deterrence is subjective. Those being deterred must understand that their unwanted actions will result in very serious and unaffordable consequences. Given that we wish to induce that kind of understanding in those with the potential to do us great harm, we can look for some guidance to our Cold War experience—even if the situations then, now, and in the future are not completely parallel. Some of the threats to be deterred in the 21st century may be quite different; others may bear striking similarities to the Cold War. In either case, the general concept followed in that era is worth examination.

The Cold War Model

A generally accepted Cold War planning objective for deterrence was to have the credible capability to deny an aggressor success and at the same time hold at risk his assets of vital interest. Not surprisingly, given the lethality of modern weapons, the hard part was to make credible any strategy with those broad objectives. In the 1960s NATO recognized the problem in relying mainly on the launch of U.S.-based ICBMs to deter Soviet aggression against Western Europe. The deterrent strategy was changed to a sequential one that employed three forces: First, meet Soviet armies with NATO ground forces; next, back that up with in-theater nuclear forces; and finally, introduce the threat of intercontinental nuclear force. Thus a credible deterrence stance of appropriate response was based on a credible warfighting stance, should deterrence fail.

A further development within that strategy came when the Soviet Union fielded its SS-20 mobile intermediate-range ballistic-missile system in the late 1970s. NATO's countermove was to install land-based cruise missiles in Western Europe—an appropriate response that enhanced the credibility of NATO's deterrence.

NATO's strategy modifications of the 1960s and '70s point to one of the key aspects of credibility in deterrence: The will to use the poised response has to be believable. That is, a potential aggressor might well presume that the United States would not initiate an intercontinental nuclear strike in response to a relatively minor aggression. But that aggressor could be deterred by the knowledge that a less-violent (non-nuclear) force was in place and prepared to strike him decisively.

Effectiveness and Survivability

If the nature of deterrence as a concept is subjective, the actual military capacity required can be quite objective. Qualitatively and quantitatively it may be addressed in terms of effectiveness and survivability. To be effective, any military system has to be seen as having the range, firepower, and performance necessary to get to the target and do what is necessary—whether that is denying the success of aggression or wreaking unacceptable havoc on vital assets. Those deterrent systems must also be regarded by the potential aggressor to be survivable, in both the pre-launch phase and during execution. Thus, if the deterrent force to be employed is non-nuclear in armament it still must have the range, firepower, performance and survivability to stop the aggressor or destroy his vital assets. The U.S. Navy's Submarine Force provided a significant part of American deterrence in the Cold War. It now is able to accept a greater role for the 21st century, that of a critical deterrent force.

The effect with which the critical deterrent force threatens a potential aggressor must be of sufficient strength and demonstrated accuracy to deliver a blow that is unacceptable to the aggressor. Such strength usually can be estimated by an aggressor in terms of the munitions to be expected and the damage they can cause. The delivery of those munitions also has to be viewed as a timely occurrence; it cannot be something dependent on lengthy transit from home base to launch point.

The mobility of submarine-based weapons makes them uniquely effective for deterrence. Launch can be from an unknown location, perhaps avoiding early initial detection. Variation in attack azimuth, short times of flight, and freedom from the pressure to use the striking power before losing it—these all contribute to the certainty of success, should that force have to be used. Knowledge of such peacetime readiness—lurking in undetected locations and having weapon systems of known capability and reliability—must then be a part of a potential aggressor's consideration before he takes an action that will invite response from that submarine-based force.

Along with effectiveness and timeliness, it is necessary for that critical deterrent force to have credible survivability. That is, it must not be vulnerable to an aggressor's preemptive or disarming strike of any sort. The U.S. Submarine Force convincingly demonstrated that invulnerability/survivability during the Cold War. The stealth of an individual submarine is vital, and the United States continuously appraises that performance, operationally and technically, as well as evaluating possible threats. That is all done through a rigorous, well-funded submarine-security program. On a force-wide basis, independent operations, the range of land-attack missiles, and the wide dispersion of units all reduce the potential for significant simultaneous force attrition.

Coupled with the military capacity needed for deterrence is the national will to use that appropriate force should an aggressor actually initiate the action(s) we want to deter. How that national will is made known to those who may wish to initiate aggression is a decision made by the National Command Authority; it reflects a fundamental war-making function of the nation. Thus a clear declarative policy statement can be a vital part of a deterrent posture.

The Submarine's Evolving Role

As the strategy of deterrence evolved during the Cold War, the place of submarines in that strategy also evolved; it can be expected to evolve further during the 21st century. The introduction of submarine-launched ballistic missiles (SLBMs) in 1960 added a new capability to the U.S. deterrent posture of land-based ICBMs and bombers, but only in small numbers of relatively short-range warheads. The first five submarines so equipped nevertheless were deployed during the Cuban Missile Crisis and were credited with having a substantial influence on the Soviet Union's backing down.

By the end of the 1960s the United States had 41 SSBNs, many carrying multiple-warhead missiles. The Polaris weapon system evolved into Poseidon—bigger missiles, each carrying multiple independent re-entry vehicles—and then finally into the Trident system, with very long-range missiles carrying multiple sophisticated warheads capable of destroying hardened targets. Throughout that period submarine stealth was exploited to ensure the survivability of the SSBN force. Currently the sea-based SLBM force is made up of 14 Ohio-class submarines, each having 24 tubes loaded with D-5 Trident II missiles. Four of that class have been modified as SSGNs—cruise missile launchers—with 22 of the 24 installed tubes each capable of carrying and launching seven non-nuclear Tomahawks, a total load of 154 cruise missiles. (Two tubes on each of those ships are for special operations force use.)

By the final phase of the Cold War the U.S. Navy's fleet of attack submarines (SSNs) was also in play in our deterrence posture. Although not entered as a strategic force asset in any of the various listings of naval ship categories, SSNs demonstrated that they could hold Soviet strategic submarines at risk. The resultant asymmetry in assured survivability between the widely spread, non-detectable American SSBN force and its Soviet counterpart—deployed relatively tightly near home waters—was apparent to Soviet authorities. Also apparent to the Kremlin was the long-term presence of U.S. attack submarines in waters far from their homeports and out of usual U.S. Fleet operating areas.

Diverse New Threats

The threats we may face today and in the near- to mid-term future are not as focused as those of the Cold War. One very obvious added factor is the diffuse non-state threat, such as that which so tragically succeeded on 9/11. That sort of enemy and attack may not be susceptible to deterrence from nuclear armed forces. There also is the potential of nuclear attack by a rogue state, be it Iran, North Korea, or even an extreme Islamist regime in Pakistan.

Perhaps the most serious threat, however, is that of two peer, or near-peer competitors, Russia and China. There is no guarantee that Russia will not eventually re-emerge with significant attack potential, backed up with ominous indications of aggressive intentions. The United States has experience, however, with Russia. Deterring any perceived threat from China may not be as straightforward. Time could well be the telling factor in how to handle a simultaneous dual-peer threat. China continues to build quite competent land- and sea-based nuclear forces. Russia could regain strength and feel the need to reclaim its superpower status by challenging the United States. Having those two powers in very strong positions to oppose the United States sometime soon—say the 2020s—could be stressful indeed for our deterrence forces.

China is an unknown in how much of a direct threat it may become. Indirectly it can pose a threat to our allies in the Middle East, South Asia, and East Asia. Even if not actually the attacking state, China could well be senior guarantor for an attack by North Korea, Iran, or Pakistan. As for being a direct threat, it is well known that the Chinese are building a strategic Submarine Force of new- generation SSBNs, and most observers believe that force will comprise at least five or six submarines.

Since those vessels are still being built, one can only speculate as to their operations, which would disclose some idea of China's intentions. It does seem possible, even probable, that whatever those operations reveal, or what declarations are made by Beijing, Chinese SSBNs will be able to access the open-ocean areas of the Pacific and put targets in the United States at risk. American attack submarines, therefore, must maintain an ability to track any and all such Chinese SSBN deployments; an effective antisubmarine warfare support structure must exist for day-to-day coverage of all Chinese submarines and detection of any operational moves toward deployment.

Looking at the mid-term future of the non-trivial threat of non-state terrorist action against the United States it is probably safe to assume a resurgence of that potential once U.S. and allied ground forces stand down from proximity to terrorists' safe areas. In that case deterrence by non-nuclear force will not be the same as postured by NATO in the 1960s, '70s, and '80s—or by the strong air/land posture now in force in Afghanistan. Without a secure base infrastructure from which to launch, the deterrent striking force will have to be based at sea with either carrier-borne tactical air, or cruise missiles, or perhaps both.

Constant, Undetected Deterrence

The SSGN force of four cruise missile-launching submarines can provide that formidable-but-less-than-nuclear (and therefore believable) deterrent force needed to cover terrorist cells in the central Asia area and, if necessary, around the Horn of Africa. With Blue and Gold crews those four ships are fully capable of maintaining the constant undetected at-sea presence necessary for real deterrence, although some time/range relaxation may be necessary during alert patrol. The very sophisticated command centers on those ships are capable of processing intelligence and formulating in-theater strike planning in real time. With that force, enduring presence within range of launch equals constant pressure on those to be deterred.

Additionally, the SSN force is capable of providing cruise missile coverage for reactive fires while conducting intelligence, surveillance and reconnaissance (ISR) patrols in ocean areas adjacent to major and minor threats. Once again it is a case of enduring presence/constant pressure. The advantage of having an SSN force capable of launching land-attack cruise missiles is so compelling there is active discussion about increasing that capability in construction of the new Virginia–class submarines. That advantage is in the increase of in-theater deterrence during peacetime deployments and in wartime firepower.

Submarine participation in the deterrence of major threats will continue to be carried out by the present SLBM force of Ohio–class submarines. Day-to-day coverage by those submarines consists of target packages that are part of the national Single Integrated Operational Plan, which can be executed by the submarine within very stringent time requirements. It is not strictly true, however, that the SLBMs are of use only in scheduled strikes at fixed targets. There is flexibility in target assignment that can be directed by the National Command Authority and introduced on board.

The currently deployed Trident II missile has long range and excellent accuracy. Each multiple independently targeted warhead has enough explosive power, when coupled with the high accuracy achieved, to make a hard-target kill; i.e., it can destroy a silo and most hardened bunkers. The missile's range also lends itself directly to the survivability of the SSBN since it permits the submarine to operate in very large areas of the ocean yet remain within range of targets.

Three Challenges for Two Decades

Our naval Submarine Force is fully capable of doing its part in today's deterrence. The problem is not in execution but in planning and building the ships and weapons needed by 2020 and 2030. Three major challenges face the nation as it plans for the deterrence needed to prevent war in that span.

- The primary challenge is to build the ships necessary to replace the Ohio class of SSBNs as they, in turn, reach the end of their useful lives. That program is proceeding through the required process for acquisition of major defense programs. There appears to be broad-based recognition of the need for the replacement program and significant support. The problem, of course, is the projected cost, given that spending is under close scrutiny and unusual pressure. On one hand the individual cost per unit is an attention-getter. On the other is the matter of relative cost in terms of the overall Navy and Defense procurement programs—and what may not be funded because of the cost of the program.
- The second challenge has to do with the well-known shortfall in the SSN force level. This will occur over several years, as the current Los Angeles–class attack submarines continue to be decommissioned. The current building program of Virginia–class SSNs, even at the recently extended rate of two per year, cannot

keep up with the decreasing numbers; the force level of attack boats will hit a historic low.

- The third challenge (arising at about the same time) will be a shortfall in strike assets available as the entire SSGN force (in the oldest of the Ohio–class hulls) will have to be decommissioned as its functional lifespan ends.

The potential, of course, is that the period 10 to 15 years in the future, when all these shortfalls could come upon us, will prove to be a very real problem for the United States, and the many allies who depend on its strength. Earlier, a worst-case scenario was postulated: a dual-peer confrontation that could be faced around that time. It's even possible the non-state terrorists will have recovered enough strength by then to again be flexing their muscles in a worrisome manner.

Worst case or not, U.S. deterrence will have to be up to the task of convincing those wishing to do harm to the United States and its allies that the consequences of their actions will be real, timely, and drastic enough to be unacceptable to themselves and their people. Fortunately, the naval Submarine Force, the Navy's submarine acquisition community, and their industry partners are treating those three challenges as just that—problems to be met and solved.

Overcoming Hurdles and Shortfalls

The highest-priority SSBN replacement program is recognized as needing constant attention at all levels and real discipline in keeping to all details of requirements, schedule, and cost control. The submarine community was cited for doing all of that in the on-time, below-cost production of the Virginia class, and it knows that the level of effort for the SSBN replacement program will have to exceed that performance.

To avoid making the shortfall in attack boats much worse, it is crucial that performance in the Virginia–class production be of such a high standard that policy makers continue the two-ships-per-year program. In addition, there are some programmatics being studied to level out the anticipated shortfall. The importance of the SSNs, in quantity and quality, is very real. It is their everyday constant and enduring ISR presence/reactive pressure that can produce useful fruit in the minds of potential opponents.

The matter of a shortfall in strike assets on retirement of the SSGNs is not a simple one to solve. One obvious partial solution is the increase of the cruise missile capacity of new-construction attack submarines by adding extra launch tubes. Increasing the capability of the cruise missile itself to permit multiple warheads to be carried and individually targeted might be another solution.

A final observation may well be the most important: Probably the best deterrent is having the force most likely to win the final battle in place and ready to fight—and triumph decisively—at the first flash of combat. The aggressor has to be able to see the resultant end game before he initiates action. U.S. Navy submarines play a major role in that deterrence.

HOLY MACKEREL, NOT AGAIN

by LT Joel Holwitt, USN

Lieutenant Holwitt is the Navigator/Operations Officer on board USS NEW MEXICO (SSN779). He served as a division officer on board USS HOUSTON (SSN 713), based out of Apra Harbor, Guam, from 2007 to 2010. A 2003 graduate of the U.S. Naval Academy, he earned a Ph.D. in naval and military history from Ohio State University in 2005. He is the author of "Execute Against Japan": The U.S. Decision to Conduct Unrestricted Submarine Warfare, published by Texas A&M University Press in 2009, and reviewed in April 2010 issue of THE SUBMARINE REVIEW. His book was also named as one of the 20 most "Notable Naval Books of 2009" by the U.S. Naval Institute PROCEEDINGS Naval Review issue.

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As the U.S. Navy's Submarine Force faces tighter budgets, it could learn a thing or two from solutions that surfaced from an informal Submarine Officers Conference in the 1920s.

Rear Admiral C. S. Freeman, Commander U.S. Submarine Force, could not believe it. Despite a decade of development on the Navy's fleet submarine, some senior naval officers still insisted on building smaller, cheaper, but far less capable versions. In response, Freeman wrote to Admiral William D. Leahy, the Chief of the Naval Operations:

> While it is true that we have some very large and some very small submarines, this is the result of prolonged experimentation to determine the size most adaptable to our needs. In other words, this experimentation has not represented an objective search for a large submarine or a small submarine as such, but a seeking for the submarine to fit our special requirements, much as we have sought after a battleship type and a destroyer type to meet the needs of the fleet . . . this command believes that our energies should be concentrated on the development and perfection of a single type submarine sufficiently flexible to carry out any of the duties as outlined by our war plans. . . .[1]

The date was 27 July 1938. Freeman's opposition to the small submarines proved prophetic: The 800-ton (surfaced displacement) USS MACKEREL (SS-204) and MARLIN (SS-205) proved to be utterly unsatisfactory for operations and ended up as training vessels during World War II.[2]

Freeman's words could have been written today by almost any career submariner in response to the frequent argument, made on an annual basis in the pages of PROCEEDINGS, about adopting conventional attack submarines (SSKs). But as we enter an age of limited budgets and tough choices about what weapon systems are truly necessary, the Submarine Force is going to be pushed to strongly consider cheaper alternatives like the SSK.

Consequently, it's worth reviewing how the interwar Submarine Force, faced with similar choices regarding limited tonnage and funding, determined the right characteristics and produced the fleet submarine that won the decisive undersea campaign in World War II.

Submarines between the World Wars

The interwar force was charged with supporting the rest of the Navy by scouting ahead of the battle fleet and skirmishing with the enemy, presumably in the Western Pacific Ocean. This was a tall order, given that the predominant type of submarines built at the end of World War I (the S-class) did not have the surface speed or endurance to make a long trans-Pacific transit and stay ahead of the battle fleet. Therefore, the Navy used a 1916 congressional authorization to build nine *fleet submarines* to investigate the characteristics necessary for future subsurface vessels.[3] Those were known as the V-submarines, though they were all different from each other in design.

After significant disappointment with the first three V-boats, which were designed with limited input from the Submarine Force, Secretary of the Navy Curtis D. Wilbur and Admiral Edward W. Eberle, Chief of Naval Operations, directed the Submarine Officers Conference—an informal advisory group established after World War I—to advise the Navy's leadership in 1926.[4] By 1930, the conference had identified the ideal characteristics of a fleet submarine: long range, high surfaced-speed, and sufficient weaponry.[5]

Achieving the necessary range required a large enough displacement to carry the fuel and supplies needed for extended operations. In terms of speed, submarines had to be able to keep ahead of the U.S. Fleet under normal conditions. In 1930, Admiral William V. Pratt, Commander-in-Chief of the U.S. Fleet, identified the optimum speed as 15 knots, the cruising speed of battleships. As long as the submarines left before the Fleet, they could stay far ahead of it.[6]

But just as the Navy finally settled on the characteristics it wanted in its submarines, the submariners found their ability to experiment limited by treaty restrictions. In 1930, the United States signed the London Naval Treaty, limiting the amount of tonnage displaced by all American submarines combined to only 52,700.[7]

Unfortunately, the Navy had already devoted a significant amount of tonnage to submarines. As the service continued to build V-boats, they had become progressively larger, with the V-5 and V-6 displacing an incredible 3,158 tons when fully loaded on the surface. The massive displacement had been considered necessary to install large diesel engines for the V-boats to achieve surface speeds up to 17 knots.[8] Because of the bulky handling characteristics of those large submarines and the constraints of the treaty, submariners began looking for smaller designs that could still operate with the necessary speed and deliver a significant load of torpedoes.

Downsizing, Speed-Rising

The first of the smaller and experimental submarines was the USS DOLPHIN (SS-169), displacing only 1,550 tons on the surface. Its layout foreshadowed the future Fleet submarines. In a continuing trend to decrease size in order to make as many as possible, the next two submarines, USS CACHALOT (SS-170) and CUTTLEFISH (SS-171), displaced only 1,110 tons on the surface.[9]

Unfortunately, their twin foreign-made MAN engines performed poorly, and commanders were uncomfortable with the thought of being in enemy waters with only two main engines.[10] Consequently, the Submarine Force reversed the trend of decreasing size. Using CACHALOT and CUTTLEFISH as a bottom line, the force started adding better engines and additional components to meet the required characteristics.

In 1933, with new technology available from the General Motors Winton diesel division, the Bureau of Engineering installed four engines and an all-electric drive into the new Porpoise–class submarines. The all-electric drive transferred energy directly from the diesels to the electric motors that turned the propeller shafts, allowing the USS PORPOISE (SS-172) to reach 19 knots on the surface, a speed American submarines had never attained before.[11] The all-electric drive went on to power the mainstay U.S. submarines of World War II, far surpassing the modest 15-knot speed requirement Admiral Pratt had called for in 1930. In fact, starting with the 1940 Tambor class, American submarines regularly made up to 20.25 knots on the surface.[12]

A combination of submariners and industry together created innovative technological advancements that made the smaller fleet submarines more capable than their larger V-class predecessors. For example, in 1930 submariners were using rudimentary *is-was* circular slide rules to aim torpedo salvoes.[13] But starting in 1932, the Bureau of Ordnance coordinated with Arma and Ford Instruments to develop a small but advanced analog fire-control computer. The Arma Mk 1 torpedo data computer, or TDC, was completed in 1938, and further competition between Arma and Ford Instruments produced the Arma Mk 3 TDC, which turned out to be pivotal to the success of the U.S. submarine campaign during World War II. [14]

And perhaps the most important advance that allowed for operations in the tropics of the Pacific Ocean was the inclusion of air conditioning. In addition to eliminating electrical short circuits, metal corrosion, and mildew in mattresses and clothing, that technology genuinely improved the habitability of U.S. submarines.[15]

The Right Submarine for the Job

When war came, the 1,500-ton (surface displacement) Gato-class fleet submarine fully met the Navy's needs in the Pacific. Its high speed not only allowed it to proceed far ahead of American surface forces and maintain contact with the enemy, but it also allowed submarines to outflank slower merchant convoys. With their displacement, fuel capacity, and technological innovations, submarines had the range to shadow Japanese movements all the way from the Sea of Japan or stay on station for almost two months. U.S. submarines eventually sank 55 percent of all Japanese shipping.

Those characteristics still guide our submarine design. With the exception of three permanently forward-deployed fast-attack nuclear-powered submarines out of Guam, and the four Ohio-class guided-missile submarines that operate forward-deployed and periodically return to Bangor, Washington, and King's Bay, Georgia, for upkeep, the rest of the force still has to transit long distances, remain on station for extended periods, and carry enough weapons and sensors to make the trips worthwhile. To a degree that could not have been imagined in the 1930s, nuclear power permits U.S. submarines to accomplish these tasks with remarkable high speed and long range.

Any one of the Fleet's nuclear-powered submarines can transit continuously at speeds that even the best conventional submarines can only maintain for a brief time, and they can do it for weeks on end. As a result, much as Admiral Freeman opposed the MARLIN and MACKEREL, our current Submarine Force has strongly resisted any attempt to adopt a less capable design.

But much as the London Naval Treaty forced the U.S. force to develop a smaller submarine that incorporated most of the desired capabilities, our current force faces a similar challenge over the coming years with a combination of the budget crunch coupled with the need to replace the retiring Los Angeles–class submarines. Secretary of Defense Robert Gates summed up the budgetary shortfall at the Eisenhower Library in May 2010: "Given America's difficult economic circumstances and parlous fiscal condition, military spending on things large and small can and should expect closer, harsher scrutiny. The gusher has been turned off, and will stay off for a good period of time."[16]

Only a few days before, Secretary Gates had specifically targeted the Navy's spending: "At the end of the day, we have to ask whether the nation can really afford a Navy that relies on $3 to $6 billion destroyers, $7 billion submarines, and $11 billion carriers."[17] He was referring to the expected cost per unit of the next-generation ballistic-missile submarine. But meanwhile, the Virginia–class submarines cost about $2 billion, with some expected cost savings as more are built. Because of these high costs, our force is constrained to making only two additional attack submarines a year, with possible additional pressure coming from the development of the next-generation ballistic-missile submarine.[18]

What's the Mission?

This means that our force will fall below the minimum number of 48 attack submarines, which provide the unified combatant commanders their daily requirement of 10 fast attack submarines, sometime around 2024. The numbers will drop into the 30s and may remain fewer than 48 indefinitely. If we do not find a way to cut costs and build additional capable but cheaper submarines, our force will be stretched thin for an unacceptable amount of time.[19]

Today's force needs to replicate the successful response to the London Naval Treaty of 1930 by seriously considering what sort of missions our submarines must carry out and what sort of capabilities they entail. Anything extra must be removed in the interest of reducing cost.

In addition, the very size of our submarines should be seriously reconsidered. From SKIPJACK (SSN-585) to VIRGINIA (SSN-774), our nuclear attack submarines have jumped in size from 3,500 tons to 7,800 tons submerged. Admittedly the size increase was accompanied by a boost in capabilities, sensors, weapon load-out, and auxiliary equipment like water-distillation plants and oxygen generators. But this expanded crew size by almost 50 percent and required an increase in engine-room size to allow newer submarines to make the same speed as the much smaller Skipjack class.

So it seems worthwhile to investigate if we can build a smaller submarine, using a true Albacore-like teardrop hull and hydrodynamic advances to maximize propulsion as well as using the advances in engineering technology and modular design showcased by VIRGINIA. And just as the original Los Angeles–class submarines were not built with a retractable towed array or ARCI (acoustic rapid commercial off-the-shelf insertion) systems, which were installed well after construction, we can leave open the possibility of backfitting cutting-edge technologies.

Similarly, this might mean eliminating capabilities like vertical launch tubes or Special Operations Forces transport. But reducing some optional capabilities should be considered if we can possibly construct two smaller nuclear attack submarines for the cost of one Virginia class. After all, every submarine does not need to do everything.

The Trouble with SSKs

Some naval thinkers, such as Naval War College Professor Milan Vego and then-Navy Commander Henry J. Hendrix, argue that the answer to this pressing question is the SSK. In recent articles in Proceedings, both Dr. Vego and now-Captain Hendrix argued that a few SSKs could supplement the current SSN force and prove to be more capable in the littorals. Current foreign-built SSKs have the advantage of being much cheaper than the Virginia–class submarine, costing between $365 million to $500 million. They require a smaller crew of about 30 people, as opposed to the 150 personnel on board a U.S. Navy fast-attack submarine. Moreover, advances in air-independent-propulsion technology, fire-control computer systems, and sonar systems have arguably shrunk the tactical gap between nuclear attack submarines and SSKs.[20]

But before we blindly accept these promised advantages, we need to ask the following questions:

Will these submarines really be significantly cheaper? Does the cost savings of foreign SSKs stem from the lack of a nuclear power plant and nuclear-related components, or are the savings actually realized because foreign countries do not build their submarines to the high but expensive standards of SUBSAFE shipbuilding and maintenance practices? In short, will this really be a worthwhile and cheaper option if we take into account the stringent requirements, tested in blood, of the U.S. Submarine Force?

When we ask these questions, we need to look at not just the construction but also the life costs of the ship. A nuclear reactor may cost a significant amount of money, but advances in reactor design and technology mean that current reactors will never have to be refueled for the life of the ship, while the only direction conventional fuel prices seem to be going is up. Another question to ask is: How much will the fuel for a conventional submarine cost in 30 years?

Can this submarine provide the necessary power to support the fire-control, sonar-processing, and crew amenities we desire? Advances in sonar sensors and fire-control computer processing provide U.S. nuclear submarines with a decided advantage against many adversaries. A conventional submarine without sufficient electrical power to run and cool the advanced-sonar and fire-control processing of a nuclear submarine would be a definite drop in capabilities and not a worthwhile investment. And once again, the cost involved with installing and maintaining these systems must be taken into account. If foreign-built SSKs are significantly cheaper because they do not have this sort of processing, then maybe they're not worth buying.

Will a reduced crew be able to deal with the challenges of intense missions vital to national security? A smaller crew means less space required for berthing, messing, and stores, as well as diminished trash production. But this also means that even with automation, there is still a lot of strain each crew member must deal with, including day-to-day tasks such as field days, stores loads, preventive maintenance, and all-hands evolutions like mooring and under ways. And during periods of high stress, such as war and overcoming major casualties, the small crew size will mean each person will be cycled excessively.

More Subs for Less Money

To their credit, Dr. Vego and Captain Hendrix acknowledge that conventional submarines would take too long to reach their operational areas without being based in forward-deployed foreign ports. Among logical candidates for such places are ports in Japan and Bahrain. The question is, can we make this long-term concept work at those ports with a minimum of lifetime maintenance back in Pearl Harbor or on the mainland? And can we be sure these ports will remain open to us in the future?

The SSK concept is only worthwhile if it is genuinely cheaper and can be based out of areas that will make up for the SSK's lack of sustained speed and endurance. If the absence of nuclear components means only a marginally cheaper submarine with less processing, weapons, and sustained speed, then it isn't worth it. Instead, the better option is an innovative and cheaper nuclear submarine applying a number of the lessons that have been learned on board other innovative nuclear submarines, such as the NR-1, and incorporate the technological advances of the Virginia.

The bottom line is: We need to buy more submarines for less money. But to do so, we need to seriously ask what missions and capabilities we absolutely require. Having decided that, we can move ahead and produce an innovative and cheaper submarine, with a minimal loss of capabilities, that is our era's Gato-class fleet submarine, not an ineffective MARLIN or MACKEREL.

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UNMANNED, UNSEEN & UNDER THE SEA

by LCDR Brent Johnston, USN
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Lieutenant Commander Johnston serves on the staff of Commander, Submarine Forces Atlantic, in Submarine Warfare Development, where he has assisted in developing the U.S. Navy Fleet Unmanned Undersea Systems concept of operations. Vice Admiral Richardson serves as Commander, Submarine Forces, and Commander, Submarine Force Atlantic.

How will high-tech undersea robots change the way we fight?

Like nuclear-powered submarines and submarine-launched ballistic missiles, unmanned undersea vehicles (UUVs) have the potential to radically change warfare below the surface. They can not only extend the reach of submarines, but also introduce new missions. This fresh potential requires us to closely examine, and where necessary change, the doctrine, tactics, techniques, and procedures we use to fully exploit this opportunity.

A well-thought-out experimentation plan will sharpen understanding of these rapidly developing systems. Through exploring, testing, and validating concepts of synergized platforms, sensors, and weapons, we will guide future payloads, payload volumes, and launchers into submarines and ships. At Commander Submarine Forces headquarters, the focus is on moving briskly to test not only the technology, but also the command and control architectures that will optimize future operations and warfighting. We want to be ready when more advanced systems come on line—and many of the technologies are already available.

Through conducting limited-scope experimentation with the existing generation of manned and unmanned systems, we can learn a tremendous amount about their capabilities and limitations. At the same time, we can gain insight into the command structures at sea and ashore needed to man, train, and equip a truly combined undersea force; even unmanned systems require maintenance, support, and in some cases remote operators. Learning about the communications and physical interfaces will enable us to launch, control, and recover these unmanned systems. It's an exciting time to be participating in the next step of undersea warfighting. UUVs can become invaluable force-multipliers, as the following fictional scenario illustrates.

Caribbean Sea, 26 April 2021, 1035 Local Time

At the Joint Interagency Task Force–South headquarters in Key West, Florida, the watch team is riveted on the P-8 maritime patrol aircraft video feed. It has been a busy morning: A UUV conducting an intelligence, surveillance, and reconnaissance (ISR) mission near a small fishing village has made the first detection of a cocaine-laden mini-sub leaving the coast. These drug submarines, built in the deep jungle, have become increasingly sophisticated over time and are now the vehicle of choice for narco-trafficking. Often they net $75 million per trip between North America, Africa, and Europe.

The joint task force's large-diameter UUV (LDUUV) has sufficient range and speed to track the drug sub, but the team prefers to maintain it on station to continue collecting intelligence while planting and recovering more remote audio and video sensors. Informed by audio and video feed from the LDUUV and its network of remote sensors, and communicating through real-time chat with the area undersea warfare commander watch team in Norfolk, Virginia, the Joint Interagency Task Force–South shifts drug-sub tracking to the supporting P-8, while coordinating an interdiction with Coast Guard and other Navy assets.

The task-force commander then exercises previously delegated undersea domain authority (granted by the area undersea warfare commander) to extend assigned water space to the LDUUV at the port entry. The mini-sub, its crew, and illegal cargo will soon be in custody, while the LDUUV continues its covert mission. Several weeks later, Joint Interagency Task Force–South will release it from ISR tasking. The unmanned vehicle will depart its surveillance area and rendezvous with a transiting destroyer for recovery.

Indian Ocean, 26 April 2021, 2235 Local Time

Halfway around the world, tensions have been escalating over the previous month and are nearly at the breaking point. A particularly troublesome coastal nation is flexing its muscles by announcing it will control shipping traffic through a major international strait. A U.S. carrier strike group is en route to the strait to back up U.S. diplomacy with military force. Captain Slade Cutter, the area undersea warfare commander battle-watch captain in Yokosuka, Japan, has the mission to support the Joint Force Maritime Component Commander as he works to maintain access to these critical sea lanes.

Captain Cutter reviews the assets available in the area: two undersea gliders, one ISR LDUUV, two subsea surveillance LDUUVs, and USS NEW HAMPSHIRE (SSN-778). Because of the level of tensions and the anti-access area-denial threat to surface ships, no independent U.S. warships are present in the area—the inbound carrier strike group will be the first surface operations in the strait since tensions have begun escalating.

Oceanographic gliders have been patrolling area for months, collecting hydrographic data and feeding a database of environmental conditions used to improve undersea sensing and weapon effectiveness. NEW HAMPSHIRE is on patrol, armed with 12 Tomahawks, 16 ADCAP (advanced capability) torpedoes, and eight long-range strike torpedoes. She is carrying an improved drydeck shelter capable of automated LDUUV launch and recovery.

The ISR LDUUV has been operating in theater since deployment by the departing USS FORT WORTH (LCS-3) some 45 days ago. To extend its endurance, NEW HAMPSHIRE has used her drydeck shelter to briefly recover the unmanned vehicle and recharge its batteries, download all of its intelligence data, and restock its payload dispensers with additional deployable sensors and communications nodes. Topped off with energy and payloads, the vehicle was redeployed three days ago in anticipation of another two months of on-station operations.

Two subsea surveillance LDUUVs were deployed 20 days ago from USS CORONADO (LCS-4), operating 400 miles off shore. Each was recharged by NEW HAMPSHIRE and operates under the control of the CORONADO, which processes their exfiltrated data and retasks the vehicles when necessary.

As the pace of developments picks up, Captain Cutter needs more continuous monitoring of the belligerent nation's submarines, which are still in port. He tasks the ISR LDUUV to lay a distributed acoustic and video array at the mouth of the adversary's major naval submarine port nearest the strait, and securely exfiltrate the data to NEW HAMPSHIRE. The unmanned vehicle navigates to the harbor via GPS and bottom contours, and deploys its sensors and communications nodes. Captain Cutter knows this distributed sensor network will provide immediate indications of a hostile submarine heading for the strait and enable NEW HAMPSHIRE to take appropriate action consistent with the rules of engagement.

The American submarine assumes a covert posture just off the coast of the hostile nation, collecting data with her organic sensors, monitoring LDUUV collection highlights in real time, and remaining positioned to take action if necessary. The unmanned vehicle pushes data securely to the submarine by using a combination of high-frequency acoustic communications and semi-submerged relay nodes, enabling NEW HAMPSHIRE to maintain her intelligence, surveillance, and reconnaissance posture closer to the strait while remaining aware of collections that the vehicle continues to make.

If further resolution is required, the SSN can launch a small unmanned aerial vehicle (UAV) on short notice to provide the continuous video feed required for positive target identification. On the area undersea warfare commander watch floor in Yokosuka, Captain Cutter has good situational awareness. The combination of manned and unmanned systems gives him an up-close picture of the tactical and operational environment. In addition, he has manned platforms in the theater that are connected to even more data and capable of taking the action dictated by the situation.

Technology with Revolutionary Potential

These scenarios are not as futuristic as they may seem. We already have much of this technology. As is the case for many other military innovations, it is the creative combination of existing technologies that will be decisive. Secretary of the Navy Ray Mabus recently issued a series of unmanned systems goals, framing the Navy's investment strategy in this area for ground, air, surface, and subsurface systems for the next decade. The objective in the undersea domain is to "deploy large-diameter unmanned undersea vehicles (LDUUVs) from an operational UUV squadron, on independent missions, by 2020." In support of this vision, the Navy is moving to achieve two milestones by 2018:

- Commission a UUV squadron. This team will continue operational experimentation; develop tactics, techniques, and procedures; and begin mission planning.
- Achieve longer endurance and greater autonomy, building to a goal of fully autonomous operations for 70 days submerged.

Admiral Gary Roughead, Chief of Naval Operations, has been pressing for some time for advanced development and rapid fielding of unmanned systems. He has articulated a clear vision of the pivotal role that unmanned systems will play in the Navy's future force structure, and in 2008 he tasked the Strategic Studies Group to examine how unmanned systems will complement manned systems in the future. Under his direction, the Information Dominance Directorate has developed a detailed roadmap that supports the secretary's goals. Not only does this cover UUVs, it also includes fixed and mobile sensor networks like those employed in the scenarios presented here.

Fleet experimentation and limited real-world operations have demonstrated the potential of unmanned maritime systems to support force multiplication and mission accomplishment using fewer manned platforms. The secretary's ambitious—but achievable—goals highlight the Navy's commitment to expand the range of UUV capabilities and apply them in a wide variety of warfighting roles. The projected advances in these vehicles, distributed sensing systems, and communications will create opportunities limited only by our operational imagination.

Working Far Forward Clandestinely

Identifying the command and control requirements for integrating UUVs and manned submarines will ultimately provide the framework for implementing many of these anticipated changes. As we define these command, control, and communications (C3) structures, however, we must remember that the fundamental role of undersea forces is to operate far forward in areas that are denied to other naval forces, exploiting concealment for their military effectiveness. Forward undersea operations within an adversary's anti-access and area-denial perimeter have emphasized limited communication transmissions, stealth, independent operations, and a high degree of operational autonomy.

The C3 structure for integrating manned and unmanned undersea platforms must align well with this kind of operational posture, as these same factors will continue to control the frequency, duration, and predictability of submarine and, ultimately, UUV communications. Advances in communications technology can at times bridge the gap, but determined adversaries will continue to develop detection and geo-location technology.

History provides many examples of undersea forces that were destroyed because they mistakenly believed their communications to be secure. Accordingly, it is important to identify some foundational principles that should guide our development of C3 structures for integrating undersea systems. To accomplish this, the following points need to be kept in mind.

- Manned undersea platforms should continue to be granted the greatest possible operational autonomy. For submarines, this means operational commanders must craft their Guidance and Intent statements in a way that allows commanding officers not only to understand the mission, but to exercise boldness and initiative, discriminately applying the capabilities of the sub and unmanned assets to seize fleeting opportunities to achieve mission goals.

- True receive-only communications methods must push information to forward undersea assets. No acknowledgement should be required unless militarily necessary.
- Transmissions from forward undersea platforms need to be minimized and conducted via expendable communications buoys or other unmanned systems whenever possible. Transmissions directly from stealthy manned platforms forward should also be minimized; when necessary, they must be sent via the least exploitable medium.
- Undersea systems can use short-range local communications to coordinate operations and share information whenever possible. Reach-back, long-haul communications should be used only when specifically necessary. For unmanned systems, the ability of UUVs and remote sensors to operate under the control of a manned submarine is particularly attractive in this context.
- We need to assume for the foreseeable future that unmanned systems will expend ordnance only under the specific direction of a human with some ability to validate that a correct target is being engaged. This means unmanned systems with weapons will need a more robust C3 structure than unweaponized systems.

Some command and control issues are not unique to the undersea domain; they simply become more complex as the environment becomes more crowded. Just as the employment of widely varying unmanned aerial systems has complicated the task of controlling and coordinating air sorties, so the proliferation of UUVs that vary in size, range, payload, host platform, and mission area could make the job of undersea traffic control more challenging. This analogy suggests that an undersea tasking order similar to an air tasking order might become a necessary tool for coordinating and eventually optimizing undersea activity. Such an order would be a next logical step, building on the concepts of water-space management (preventing fratricide from undersea weapon employment) and prevention of mutual interference (undersea collisions). The undersea tasking order must go further, however, because it has to optimize the collective warfighting capability of forward undersea systems without unduly detracting from their autonomy.

Clearly, the full warfighting potential of manned and unmanned underwater systems working together requires overcoming numerous technological and conceptual challenges. The magnitude of these technological challenges in particular should not be understated. Our efforts to address the concepts, therefore, must be balanced with reasonable expectations about what is technologically feasible in the near term while remaining flexible enough to adapt to future developments. We will continue to use experimentation and fleet operations to evaluate and validate potential solutions that address the doctrinal and organizational issues raised by introduction of widespread unmanned vehicles.

Indian Ocean, 28 April 2021, 1821 Local Time

The crisis in the strait has worsened considerably. The belligerent nation has stepped up its hostile rhetoric by threatening to attack any U.S. forces that attempt to intervene, a clear message directed at the inbound carrier strike group. Demonstrating its resolve, the enemy launches salvos of anti-ship missiles while the carrier strike group is still 200 miles from the strait. With these defeated, the strike group continues inbound.

But then the situation changes fundamentally. In 12 hours it will be morning, and the carrier strike group will be entering the strait. By then, Captain Cutter and his watch team must have taken decisive action to ensure security of the strike group from undersea threats. This necessity is substantiated by reports from multiple intelligence streams, including the ISR LDUUV, that one of the hostile submarines is preparing to get under way. It will be destroyed before exiting the harbor; it will not even be allowed to submerge. NEW HAMPSHIRE is the best candidate to conduct such a surgical attack.

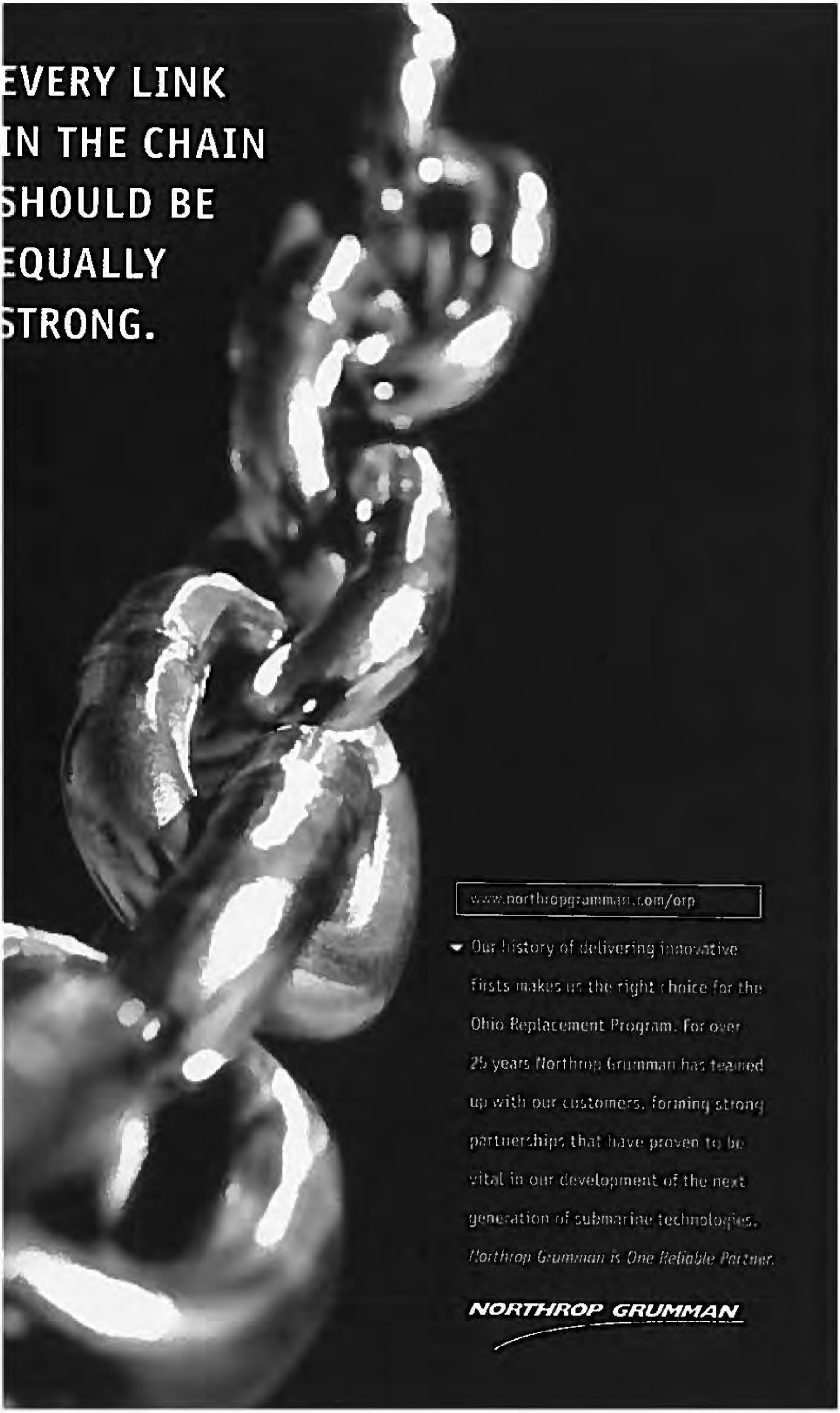
Captain Cutter exercises a *freeze* command to contain the LDUUV in a collapsed area. This immediately frees up water space for use by the American submarine and her weapons. From miles away, NEW HAMPSHIRE launches two extended-range strike torpedoes that maneuver like undersea Tomahawks, following predetermined paths into the harbor and to the submarine piers.

Infrared imagery from a small UAV deployed by NEW HAMPSHIRE enables the submarine to monitor the target while the strike torpedoes are inbound. If the enemy sub gets under way, one or both of the torpedoes can be shifted from strike mode to acoustic mode to complete the attack. The crew of NEW HAMPSHIRE follows the progress of the torpedoes via data returned by the fiber-optic wire connection. After viewing the target image fed back by the weapon, they authorize it to complete its attack. The first weapon works flawlessly, breaking the enemy submarine in half at the pier, as confirmed by UAV real-time video battle-damage assessment. The second is diverted to its secondary target, a floating drydock with another enemy submarine.

Captain Cutter releases the ISR LDUUV from its freeze condition. In the strait, the subsea surveillance unmanned underwater vehicles confirm there are no changes on the seabed that might indicate the presence of mines. With both the submarine and mine threats eliminated, the carrier strike group is able to enter the strait unmolested by threats below the surface.

As this scenario shows, future naval operations and maritime security will include an increasing mix of unmanned systems, and the need to effectively coordinate their operations will become even more important and challenging. UUVs will introduce revolutionary capabilities, but their full potential will be achieved only if their command and control provides for successful integration with manned platforms. The concepts and supporting principles presented here aim to accomplish this level of integration while at the same time allowing undersea forces to operate autonomously, preserving their greatest asymmetric capability of stealth.

With UUV technical development moving forward, we must use these guiding principles to ensure that doctrinal and organizational arrangements, as well as C3 structures, allow the revolutionary potential of UUVs to be realized so that they become true force multipliers.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ARTICLES

THE MAKING OF A MYTH

by RADM William J. Holland, Jr., USN(Ret)

RADM Jerry Holland is a frequent contributor to THE SUBMARINE REVIEW.

Those who build, sell or operate any product or equipment are predisposed to find opportunities to promote their equipment or product favorably against the best or benchmark in their field of endeavor. In the case of conventionally powered submarines, these actors, both persons and organizations, are particularly eager to seize any situation in which their ship compares favorably vis-à-vis nuclear powered submarines. For years an undercurrent has inferred that modern conventional submarines could not only hold their own but in some circumstances could perform even better than nuclear powered ships. Those occasional essays or advertisements touting conventionally powered submarines that have appeared in professional and trade magazines generally have avoided direct claims, relying on vague allusions of operational capabilities and focusing on acquisition costs.

An enlargement of this idea can be found in a report on Swedish armed forces in the February edition of SIGNAL magazine, the house organ of the Armed Forces Communication and Electronics Association. In the article reporting on an interview with Jan Pie, the Secretary General of the Swedish Industry and Defense Group, a trade association, the following claim is made:

> "In 2005, the U. S. Navy requested permission to borrow a *Gotland* class submarine and managed to detect the submarine only once in a two year period, Pie reports."

Mr. Pie offers no evidence for this assertion nor does he quote any authority. There is no citation to substantiate his claim. While similar intimations have appeared in various news media and advertising material from time to time, usually such writings have been purposely vague. Situations or circumstances in which direct comparisons could be drawn between the two types have been rare and analysis of their comparative performance unavailable. This SIGNAL article is the first time this wishful thinking has been presented in an authoritative and attributable document.

However, this version of GOTLAND's performance is unquestionably wrong. Mr. Pie's announcement is a myth, part of attempts to promote sales of conventionally powered submarines, of which the Swedes are exporters. That Swedish naval personnel would like to believe this version reflects the capability and performance of their submarine while providing services in the San Diego Operating Areas was evident in reactions to lectures on Cold War ASW at the Swedish Defense College in 2009.

A brief review of six of the exercises that included GOTLAND off San Diego in 2005 revealed that she was detected and tracked by Maritime Patrol Aircraft (P-3), by helos from cruisers and destroyers, by surface ASW ships and by U.S. attack submarines (SSNs). While active sonar made detections, most contacts were generated by visual sightings or by radar from air and surface ships. GOTLAND's operating condition (battery, AIP or diesel) at the time she was detected passively by the American submarines is not clear in the report of this analysis but clearly both submarines were submerged. While GOTLAND was certainly a challenging target operated by proficient crews, American ASW forces definitely were able to detect, track and engage her.

A major limitation of a conventionally powered submarine was demonstrated by the predominance of visual and radar detections reported in these exercises. Only in rare circumstances with a cooperative target can the battery alone provide enough sustained propulsion power to relocate to a new area of interest or close a suspected target of opportunity. Without the ability to reposition quickly, to close or open by running fast, the conventionally powered submarine's discretion rate, the need to expose the periscope or to run harder at shallow depths to get a good look or achieve a shooting solution before the target gets by, is much higher than that of a nuclear powered submarine. In the latter's case, "...the only way the target can get away is to go in port."[1] A key tactic in combating conventionally powered submarines is to maneuver such that the submarine must move an appreciable distance smartly to engage. Conventionally powered submarines lose much of their stealth when having to move fast or far. [2]

In creating any version of the interaction between a submarine and ASW forces, the view of the submarine crew should be suspect. When submerged, a submarine crew can never determine that it has been detected unless the opposing ASW force changes its mode of operation in a manner that the submarine can observe, e.g. changing ping interval on active sonar, dropping explosive charges, turning smartly and changing speed. Airborne ASW vehicles give no clues except for dipping sonars from helicopters. In that case, when two or three helo's are *ringing* the ocean in the submarine's vicinity, it's a sure bet that they have the submarine *nailed*. Fixed wing maritime patrol aircraft have tracked many submerged submarines for long distances and periods without the submarine crew suspecting they were under surveillance. The crew's analysis of the interactions when explosives have not been used, i.e. in exercises, often boils down to hopeful determinations that "he never laid a glove on me".

On the other hand, many exercises are structured to ensure contact is generated in order to provide useful training. Drawing broad tactical conclusions from such exercises creates expectations that are almost invariably false, wrong-headed or stupid. Tactical development exercises differ from training exercises in their structure, expectations, careful analysis and conclusions. The conditions applied to the various exercises in which GOTLAND participated varied from specified conditions and operations to free-play within given boundaries. The specific vulnerability under these various circumstances and conditions cannot be determined without detailed analysis. But in any case, *never detected* is wrong.

Hampered by short legs and low speeds of advance, the conventionally powered submarines' effectiveness and utility is limited to narrow seas or coastal waters. These attributes hamstring their utility for the United States where the deployment horizon is not limited to the Gulf of Mexico. Even in the short duration cruises off California, the toll on the small crew of GOTLAND was harder than anticipated. Standing port and starboard watches plus regular *General Quarters/All hands to action stations* for weeks become as limiting on these small submarine's endurance as their fuel supply or battery capacity. Reporting to the local Submarine Senior In Command, one of the Commanding Officers of GOTLAND expressed his weariness by reporting he had spent the longest deployment of his career, seventeen days. The American ISIC thought but was too polite to say, "Seventeen days! I could hold my breath for seventeen days!" Perhaps, but only because his submarines were well manned with alert crews and other experienced officers on whom he could rely while he slept.

ENDNOTES

1. CDR Norman B. Bessac, USN, Commanding Officer, USS SCORPION (SSN 589), 1960 during initial exercises with Task Group Alfa, Western Atlantic.
2. See Holland, "Battling Battery Boats", U.S. Naval Institute PROCEEDINGS, June 1997, page 30 et.seq.

ESTABLISHING A "CONNECTIVITY ADVANTAGE"

by CAPT Jim Patton, USN (Ret)

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

Background

The nearly half-century *Cold War* was arguably won by NATO because the U.S. Submarine Force held a 40 dB (a 10,000 to 1 ratio) acoustic advantage over Soviet Submarines. As identified by author Tom Stefanick in Strategic Antisubmarine Warfare and Naval Strategy[1], this put the Soviet "Strategic Nuclear Reserve" – their deployed SSBNs—totally at risk, while the U.S. SSBN counterparts remained essentially invulnerable. Because of this detectability mismatch, U.S. SSBNs were able to use the increased ranges of improved missiles to employ even more of open ocean in which to conduct their patrols, further complicating any search attempts by Soviet SSNs, while Soviet SSBNs were forced to employ increased missile ranges by pulling further back into *home waters* where they created a *target-rich environment* for U.S. SSNs.

In the new strategic environment, the SSBN is still an important player in the sense that a strong and secure nuclear deterrent will be required as long as weapons of mass destruction are still held by other entities, and acoustic advantage remains an important metric. However, there is also a new and perhaps equally important measure of effectiveness—that of a submarine's *Connectivity Advantage*, be it pertaining to an SSBN, SSN, SSG, SSK or Air-Independent Propulsion (AIP) SSP.

Discussion

At first blush, one might assume that connectivity advantage is entirely a function of available bandwidth—a simple but entirely wrong assumption. In returning to first principles, the *goodness* of all naval communications is a function of the following:

- Reliability
- Robustness
- Flexibility
- Ubiquitous – global coverage
- Capability *(for submarines – adequate capacity)*
- Quickness *(for submarines – fast enough)*
- Timeliness *(for submarines – soon enough)*

Capability

While the first four items above are self-explanatory and apply universally to all naval platforms, the italicized reclamas to the last three highlight the exceptional nature of submarine connectivity which must be understood and exploited if connectivity advantage is to achieved and maintained—even under modern combat duress, where many connectivity options could be degraded or totally eliminated.

More so than any other community with the exception of Special Operating Forces (SOF), submariners realize that it is not so much the diameter of the comms *pipe* (bandwidth) that matters, but rather the time-bandwidth product—the *volume* of information that flows through that pipe. Higher bandwidths are still much appreciated by those communities, for that means that the same volume of information can be passed using a smaller dimension of time. Obviously, a key to keeping this time-bandwidth product small is to *package* the information as tightly as possible, leaving little or no room for adjectives, adverbs and other extraneous material. Please, thank you, save the "Happy Navy Day" messages from the Secretary of the Navy for us to read when we get back to port, rather than adding them to the broadcast.

Quickness

All other things being equal (really a poor phrase, since they seldom are), quicker is better for transmission (or reception) of necessary information for SOF and submarines because of considerations of stealth and restrictions on mobility. In fact, there is room in the scheme of things where *timeliness* (to be discussed next) is traded off for quickness when a half hour is spent preparing a piece of information that is then transmitted in a few milliseconds. This trade-off is justified in that the half-hour plus a few milliseconds is *quick enough* for the process or situation at issue, and the same attention to detail as above in minimizing the total package size is an important element of the process.

Timeliness

Other situations exist where the *receipt* of information by the submarine needs to begin almost as soon as the originator authorizes its transmission, but it is permissible that the time taken for receipt of all of the even very simplest of messages can take some time. A classic example of this would be a 3-symbol alphanumeric code directing weapons release by an SSBN that could take 10 or so minutes to copy via Extremely Low Frequency (ELF). This time required for receipt can still be classified as *near real time* since it is quicker than the time it would take to make the rest of the ship's systems ready to launch.

In fact, a *holy grail* of submarine connectivity would be the ability to tell a transiting submarine, anywhere in the world, who wasn't due to *copy the sked* for another 12 hours, that there was an urgent need for him to establish a better communications stance as soon as possible, even if that action took 20-30 minutes.

Connectivity Advantage versus Submarine Type

It might seem from some of the references above that a submarine connectivity advantage benefits most *high end* nuclear-powered submarines. Counter intuitively, just the opposite is true. The less ability a submarine platform has to reposition itself quickly, or the less *extra* electricity it has to power sensors and to support onboard computer power to process and exploit their data, the more that platform benefits from superior connectivity—particularly as the recipient of pertinent tactical intelligence and targeting data. High-end platforms can often find themselves more the *suppliers* of tactical information *to the grid* than as *users* of information from that same grid.

Submarining Culture as a Vital Component of the Connectivity Advantage

There are two distinct segments of a proper submarine culture as it pertains to connectivity. Commanding Officers (COs) must understand and share the broad operational concepts of his masters ashore to include knowing when those masters would not only approve, but expect him to *deviate from the norm* in executing a mission without *asking for permission*, and those masters ashore must have the confidence (and patience) to assume that their COs are operating in the *best interests of the Queen* in the absence of reassuring messages that confirm that. An important mantra of a successful Submarine Force is that "The COs will tell you something when they have something to say".

Persistent, Passive, Low Data Rate Connectivity

A big deal was made in several paragraphs above of the desirability to keep unnecessary or redundant information or data from *filling* an available comms pipe. In the best tradition of the wisdom that there is an exception to any rule, there is an important exception in this case which contributes markedly to a connectivity advantage for submarines.

If connectivity can be described as either persistent or non-persistent, and either passive (receive only) or active (two-way), and also either high or low data rate (like pornography, you know it when you see it), the mode of the $2^3 = 8$ thus possible combinations which *enabled* the reliable and survivable nuclear deterrent mentioned in the first paragraph was the Persistent, Passive, Low Data Rate (PPL) option. In this PPL option, the submarines while in an *alert* status were receiving, via a Buoyant Wire Antenna (BWA) or a towed buoy, a continuously stream of encrypted data and information only a tiny percentage of which was of tactical or strategic significance, and most of which was news, ball scores and *familygrams* from loved ones. The purpose of *intentionally* filling this pipe was to insure that there would be no strategic warning to potential adversaries given by a circuit of this sort *coming up*.

The *Holy Grail* of submarine connectivity for SSNs, SSGs, SSKs and SSPs would be the same PPL that SSBNs enjoy but while operating at tactically meaningful depths and speeds. It is available at slower speeds and shallower depths if the platform is equipped with a good BWA installation—either internally or, on smaller boats, externally mounted. A Program of Record for the US Navy has been the "Comms at Speed and Depth" (CSD) program with the goal of expanding that part of the speed/depth envelope available for some form of connectivity.

Conclusions

As surface warships are put more and more at risk from ground, air, surface warship and submarine-launched Anti-Ship Cruise Missiles (ASCMs), and in some cases, purported Anti-Ship Ballistic Missiles (ASBMs); and as aircraft face more and more capable, long-range Surface to Air Missiles (SAMs), the burden falls increasingly upon submarines to conduct offensive operations against targets of value ashore, and for other submarines to attempt to prevent them from doing so. In this head-on-head confrontation, it is unlikely that an acoustic advantage will carry the day as it did in the last half of the 20th century, since all modern submarines at slow speeds are virtually incapable of detecting one another at more than ranges expressed in shiplengths, but rather it will be which force has connectivity which is more reliable, robust, flexible and ubiquitous, and has adequate capacity, is fast enough and conveys information soon enough.

ENDNOTE

1. Stefanick, Tom, *Strategic Antisubmarine Warfare and Naval Strategy*, 1987, Lexington Books, Rowman & Littlefield Publishing Group, Lanham, MD.

SUBMARINE OPERATIONS IN A DEGRADED SPACE-BASED ENVIRONMENT

By CAPT Jim Patton, USN(Ret)

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

Background

Over the last several decades, the employment and exploitation of space-based capabilities has made a number of evolutions far easier and much more effective. This is particularly so in the realm of naval forces, and within that group, submarines have been among the greatest beneficiaries.

For example, because a submarine typically only had sensors above the air-water interface for a fraction of an hour a couple of times a day, particularly while in transit from one location to another, even such things as determining a navigational position became far more difficult than would be on a surface warship, and often drove the total length of time a mast or periscope had to be exposed during an infrequent trip to periscope depth. The Global Positioning System (GPS) now permits an extremely accurate position to be determined in seconds.

Similarly, copying message traffic from a once every two hours Very Low Frequency (VLF) broadcast could be very time consuming—particularly if other submarines sharing the same broadcast had higher precedence traffic that pushed *your* messages to the bottom of the queue. With Ultra High Frequency (UHF) satellite downloads, (or Extremely High Frequency [EHF] when fitted with a High Data Rate [HDR] mast) a message *dump* of everyone's traffic occurs every fifteen minutes, and a particular submarine can copy its messages very quickly. (A *downside* of these bigger communications *pipes*, understandably but unfortunately, has been that the total quantity of traffic has tended to expand to fill the now greater available *bandwidth*).

Space-based assets have also greatly increased the quantity and quality of near real time intelligence to be sifted and forwarded to deployed submarines, and made it easier and quicker for these submarines to pass time-critical intelligence they have generated back to shore nodes.

It is human nature to not only embrace, but become virtually addicted to new ways and means that make life easier and more productive. It is sometimes difficult to revert to older methods and techniques when the newer ones are removed for some reason or because of some adversary's actions. If two near-peer adversarial entities were to have their space-based assets (i.e. navigation, intelligence, communications) significantly but equally degraded, the one of them who best remembered (and had practiced) how to operate *before* these assets had become available and *indispensable* would have a significant advantage—particularly as regards submarine operations.

Discussion

Navigation

As the line goes "…in a distant galaxy a long, long time ago", a SUBPAC nuclear submarine was groping her way back to Pearl Harbor from the northwest Pacific with no electronic (LORAN) navaids available, a broken periscope sextant and an absolutely flat and featureless ocean bottom that eliminated bottom contour navigation as an option. Latitude was being determined at night by finding Polaris and with a zero bubble on the boat, reading elevation (+/- a degree) on the left hand periscope handle. Longitude determination was a little trickier, and involved marking the time of sunrise, then working backwards the equation that tells you when the sun will rise if you know where you are. All uncertainties taken into consideration, these procedures *nailed* the ship's position down to a square about a degree of latitude and longitude on a side—about 3600 square miles (keep in mind that the state of Rhode Island is about 1200 square miles).

Technology has steadily transitioned open ocean and inshore navigation from an art to a science. From the days of sail, when Nathanial Bowditch was able to conduct a transatlantic voyage and arrive (in the fog) off New England within a mile or so of his dead reckoning track, to today, when even one's automobile GPS will provide you a continuous readout of position to within a hundred or so feet plus altitude and speed, there has been a shift of emphasis from how to interpret a set of partial and often contradictory data to the *buttonology* of a hi-tech gadget. In addition to teaching the *hows* of traditional navigational techniques, individual ships should stress their navigation team by frequently going to sea with the GPS tagged out, and with scopes lowered as the ship enters and leaves port in good weather. Good correction curves should be developed for those who still have scopes with an internal sextant capability, and bottom contour navigation should be practiced often. Even the back of periodically received Pilot Charts should be reviewed for information regarding expected oceanic set and drift in the areas of operation.

Intelligence

Or more specifically ISR (Intelligence, Surveillance, Reconnaissance)—is the most enduring and important missions of a submarine. In past times, the majority of these ISR products would be collected, but, for reasons of covertness and a lesser need for urgency, not delivered until return from the mission. With the much shorter *time constant* (significantly shaped by bilateral constellations of space-based assets) of modern conflicts, it now is frequently necessary for the submarine collector of those ISR products to selectively forward them to other users in near real time. In addition, the submarine itself is a user of ISR collected by other (particularly space-based) assets.

In the absence of space-based assets it is a reasonable assumption that the time constant of collected ISR products would probably increase somewhat, but also that the necessity of being able to spot the truly time-critical and forward by whatever means required would become more important. Less *incoming* ISR from analysis nodes ashore would require better pre-deployment study and preparation by the crew.

Communications

Submarine connectivity has always been an issue, and to a large degree, its difficulties have been the motive force which has significantly *shaped* submarine culture. Because submarines were difficult to command or control from shore, a greater level of *individual initiative* was expected from their Commanding Officers, and this spirit of independent operations *in the best interests of the Queen* was inculcated into even the youngest officers and reinforced repeatedly until *they* reached the level of command. Even after that, Squadron and Force Commanders shared this same *common culture* which enabled individual ships to function pretty much as the Force Commander would have had them function if he had 24/7 connectivity to these submarines—strangely enough resulting in a situation where *individual initiative* was more predictable by the Force Commander than it would have been without this common culture. An existential hazard of the *better* (more, quicker and frequent) connectivity enabled by space-based assets is that the common culture that previously enabled independent operations and individual initiative is weakened.

Conclusions

To maintain a significant qualitative superiority in spaced-based military assets over potential adversaries is an urgent and necessary requirement. At the same time, the *queen-swapping* loss of these assets by *both* friend and foe alike *must* result in a competitive advantage to the good guys—a situation in and of itself would create a deterrent against any hostile actions against those constellations by an opponent.

To create a credible capability of operating adequately following the loss of space-based assets, it is not enough to just list the actions and skills that must be taken and honed. They must also be practiced. As mentioned in the opening paragraphs, boats must navigate at sea without GPS and leave/enter port without periscopes raised, Force Commanders should declare periodic SATCOM *holidays*, where all normal operational and administrative functions are conducted via the VLF broadcasts. In addition, everyone in that vast and powerful intellectual entity called "The Submarine Force" should be expected to continuously think of other ways to enhance and practice the *common culture* which enables uncommon performance as an almost psychic phenomenon.

If, as a Navy, there is a serious interest in recreating/maintaining a capability to operate effectively in a degraded space-based environment, there are many things to consider. Should such as Loran C and Extremely Low Frequency (ELF) sites be reconstituted? Should periscope variants be manufactured that again have an integral sextant capability? Should *Chirp-sounder* and *Meteor Burst* comms be implemented and practiced?

It is within the realm of technical credibility that a near-peer competitor could degrade or disable a significant portion of our military space-based assets (and in retaliation, we, quickly, do the same to theirs). As contained in the same logic of deterrence that saw the world safely through the Cold War—that there would be no lasting advantage to taking rash actions—it is incumbent on U.S. Forces, particularly the Submarine Force, to develop, practice and make well know that they are entirely capable of functioning at a very high level in the absence of these space-based assets—a clear competitive advantage.

THOSE PESKY, PLUCKY PICKET BOATS
Part II of II

By Mr. John D. Alden

Editor's Note: Part I appeared in the April 2011 issue of THE SUBMARINE REVIEW.

All of the attacks described this far were made by Pacific Fleet boats on their way to or from Empire waters, frequently on the actual picket line. The next two, however, were made by SoWesPac submarines far to the south.

GATO (SS 212) with Robert J. Foley in command was off Rabaul on her eighth patrol heading from Fremantle to Pearl Harbor and a welcome overhaul when on 15 February 1944 a heavily-built wooden trawler of about 150 tons was sighted, bearing antennas on its two masts, a 20 mm gun forward, and a machine gun on the deckhouse. The sub's battle surface caught the enemy by surprise, and its guns were never manned. GATO's 3" hits set fire to the engine spaces, the fuel tanks blew up, and the gutted craft burned to the waterline with about 10 bodies on deck and 30 crewmen in the water. (The victim was the 36-ton picket TAIYO MARU #3, assigned to the 4th Fleet. Apparently it was unable to make a radio report and no survivors were recovered.)

On 4 April 1944, SCAMP (SS 277) under John C. Hollingsworth on her seventh patrol was near Palau on the way from Brisbane to Pearl Harbor when she encountered a 200-ton armed trawler with an antenna strung between its masts. Hollingsworth moved in, firing his 4"/50 deck gun and starting a fire with two hits. The trawler fired back at 4,500 yards, but its shots fell well short. It then maneuvered skillfully to keep its stern toward the sub. Hollingsworth broke off after firing 91 rounds when the gun failed to return to battery, leaving the enemy with a small starboard list and the fire under control. "This was the first gun action for this boat," he wrote, "and was good training and a boost for morale." (The opponent was the picket boat SUITEN

MARU of 131 tons, which was also assigned to the 4th Fleet. Following its damage by SCAMP it ran into a mine at Palau and sank.)

Back north a month later, on 4 May TUNA (SS 203) under James T. Hardin on her tenth patrol was heading toward her assigned area when a small trawler was sighted. Hardin decided to attack it with his 5"/51 deck gun. He commenced fire with both 20 mm guns at about 1800 yards and when the trawler responded, opened up with the big gun. After the first 5" hit, the enemy was down by the stern and in ten minutes had sunk. TUNA's deck force proceeded to pick up three prisoners, one of whom soon died from his wounds. While attempting to recover floating crates, Chief of the Boat John K. Huff, CTM lost his footing, sank and drowned. There is no mention in the patrol report of a memorial service being held.

HADDOCK (SS 231) was passing by en route back from patrol and prepared to join the attack, only to see the target blow up. Skipper John P. Roach then closed the wreckage and sent off his rubber boat under Lt. G. W. Kittridge, while Lt. Cdr. W. T. Germershausen and Lt. (j.g.) R. J. Williams jumped in and swam. Together they collared two more POWs and took aboard the pair from TUNA as well. The patrol report says the prisoners proved docile and helpful with information, and were turned over to the authorities at Midway. (The Japanese records identify the victim as the picket TAJIMA MARU of 89 tons and say eight crewmen were killed, which implies that the rest of the crew was picked up.)

An interesting sidelight is that the submarines had been ordered to capture the trawler and search it for new code books and other intelligence material, but TUNA sank it instead. Neither boat's patrol report nor their endorsements allude to this episode, and eleven pages have been redacted from the declassified copies of HADDOCK's report. Postwar revelations provided by W. J. *Jasper* Holmes in his book Double Edged Secrets explain the unusual exertions made by both subs to recover prisoners and material.

An unusual example of humanity occurred when SKATE (SS 305) on her fourth patrol, with William P. Gruner, Jr. in command, attacked a sampan on 19 May 1944. Making a battle surface, they left the craft in sinking condition after firing 67 rounds from the 4"/50 deck gun. Both 20 mm weapons jammed, but .50 cal. hits set the vessel afire. The sub picked up three survivors, including the Japanese captain and a Korean sailor. GRUNER gave eight others still alive a rubber boat and some food before going on his way. (The victim was the 31-ton MEISEI (or MEISHO) MARU, a fishing boat under naval control; the records do not specify the extent of damage.)

In June 1944 three pickets are listed as having been attacked by surfaced submarines. On the 3rd SHINKO MARU #10 of 72 tons was sunk with 20 killed along with the 102-ton SHOEI MARU #7 Go with 23 dead. Eight days later in the same general area KAIGYO (or KAIKATA or KAIKEI) MARU #8 of 173 tons fought with and depth charged a submarine with unspecified damage. No U.S. submarine reported any of these attacks, but they were all within the area assigned to GOLET (SS 361) on her second patrol in command of James S. Clark. The sub was never heard from after leaving Midway and is believed to have been sunk by Japanese anti-submarine forces on 14 June. GOLET has never been officially credited with a sinking on her only two patrols.

More engagements followed. On 4 August 1944 Orme C. Roberts on the first patrol of STERLET (SS 392) missed a patrol vessel with three stern torpedoes, was depth charged, missed again with his last torpedo, battle surfaced and destroyed the enemy with gunfire. About 30 survivors, all with close-cropped heads, refused to be picked up from the wreckage. (The victim was MIYAGI MARU , a 248-ton member of the picket force; Japanese records say only that the entire crew of 23 was lost.)

On 13 August ARCHERFISH (SS 311) under William H. Wright was returning from her fourth patrol when she encountered a picket with the typical configuration and armament 500 miles from land. Keeping well out of range of the enemy's guns, Wright methodically pounded it with his 4"/50 and smaller guns, ultimately expending his entire 120 rounds of 4" plus 1,200 rounds of 20 mm and 300 of .50 cal. ammunition. After the first five rounds the Japanese vessel ignited a smoke canister, jettisoned its depth charges, and charged the submarine. Additional hits left it splintered and dismasted; its fire slackened but never ceased. (It was the picket AJI (or AMIJI) MARU of 107 tons, which suffered six men killed but survived to fight again.)

APOGON (SS 308) under Arthur C. House on her fourth patrol was en route from Midway to her patrol area on 23 September 1944. House had already taken the precaution of firing his guns for practice when he sighted a modern-looking trawler, which he attacked and photographed. The 4" gun suffered three misfires, so House closed and opened fire with his 40 mm and 20 mm guns while bringing up fresh 4" rounds from below. The 20 mm weapon then jammed as the enemy returned fire from its own 20 mm and machine guns. "From here on in I don't know who was chasing who," House recorded. After 96 rounds of 4", of which 15 were misfires, 320 of 40 mm, 90 of 20 mm, and 2,500 of .30 cal. ammunition had been expended, the target started to burn, exploded and sank, leaving the sub with a few bullet holes in the superstructure and side plating. "This was APOGON's first gun action," House noted. "Target had plenty of guts and kept firing and trying to close the range until the end." (The opponent was the 91-ton picket CHOYO MARU #6, which reported fighting a surfaced submarine before sinking. Japanese records say there were 11 casualties.)

The new BESUGO (SS 321) under Thomas L. Wogan (previously in command of TARPON) came upon a small patrol vessel on 6 October 1944 soon after leaving Midway on her maiden patrol. The craft was stopped and drifting, an easy torpedo target. Wogan fired three fish, but all missed without alarming the Japanese ship. However, it quickly came to life when BESUGO made a battle surface and opened fire with all guns. The 5"/25 proved ineffective due to heavy swells and poor visibility, so Wogan closed and registered 20 mm hits until both guns jammed. The enemy continued charging in and swept the submarine's deck with its machine gun. One round hit the shears and its fragments wounded a lookout in a leg and the gunnery officer in a hand. The skipper decided the better part of valor was to break off and make haste to reach his assigned patrol area on time. "NOT an auspicious beginning for our fighting career," Wogan recorded in his report. (The victor was NANSHIN MARU #22 of 88 tons, which apparently suffered little damage and no casualties.)

On 13 October 1944 Donald A. Scherer was returning his boat, the veteran PERMIT (SS 178), from Brisbane to Pearl Harbor on her fourteenth and final patrol when he spotted a deep-sea tuna-type fishing vessel with a 3" gun forward and gear on the fantail that did not look like fishing equipment. He promptly sent it to the bottom with a salvo of two torpedoes, took some photos, and departed, leaving a few survivors in the wreckage. The division commander characterized the operation as "a fine attack and a real blow" to Japanese anti-submarine activities. (Japanese records are sketchy, but the victim was probably the 139-ton KINPO (or KINHO) MARU #1, a picket assigned to the 4th Fleet.)

BURT'S BROOMS AND THE FIRST PICKET SWEEP

When Operation Hotfoot, the first carrier strike on the Japanese homeland since the Doolittle raid, was being planned for November 1944, Admiral Lockwood proposed that his submarines could facilitate the mission by conducting a sweep in the area west and north of the Volcano and Bonin Islands to destroy any pickets or other ships that could provide the Japanese advance warning of the raid. Although the strike had to be cancelled, Lockwood decided to conduct the sweep anyway as a practice exercise. Seven submarines near the ends of their regular patrols were hastily summoned to Saipan to replenish and constitute Task Group 17.24, unofficially named Burt's Brooms, under the command of Thomas B. *Burt* Klakring, ComSubDiv 101.

The group was a heterogeneous collection of old and new boats armed with a variety of deck guns in various locations: SAURY (SS 189) under Richard A. Waugh on her eleventh patrol, TAMBOR (SS 198) under C.O. William J. Germershausen on her twelfth run, SILVERSIDES (SS 236) now under John S. Coye on her twelfth patrol, TRIGGER (SS 237) under Frederick J. Harlfinger II on her tenth patrol, BURRFISH (SS 312) under William B. Perkins, Jr. on her fourth patrol, STERLET (SS 392) and Orme Robbins on their second patrol, and RONQUIL (SS 396) under Henry S. Monroe, also on her second patrol. SAURY and TAMBOR were actually on their way to the States and retirement from combat. All had the usual assortments of defects accumulated during their patrols, and the crews would hardly have been enthusiastic about having their prospective refits or overhauls delayed. Few of the commanders had any previous experience fighting picket boats.

Klakring assembled the skippers on the tender FULTON on 9 November to plan the operation. The submarines would conduct the sweep for eight days in seven parallel lines at a seven-knot speed of advance, with the longer lines assigned to the newer boats. When a target was contacted the two nearest boats would concentrate on it and attempt to overwhelm it before it could get out a warning. The skippers would maintain contact with and receive orders from the group commander by VHF voice radio. Thus organized, the group set forth on the 10th. A harbinger of problems to come transpired two days later when surprise contact was made with a U.S. force of three heavy cruisers and six destroyers that had not been informed that the submarines were at sea. The weather in the area was normally bad enough but became even worse as a typhoon set in.

SILVERSIDES made the first enemy contact on 15 November when a mast was sighted. After summoning STERLET to the scene, Coye dove and started his approach for a torpedo attack only to have the target suddenly start taking evasive action. For STERLET had arrived and Robbins, unaware of Coye's intentions, was closing in on the target. It was a 120-foot trawler with a clipper bow, composite superstructure, high bridge, well-deck forward, and a high tripod mast or lookout platform aft, painted tan except for a black lower hull. Robbins thought it was circling and dropping depth charges on SILVERSIDES, so he charged the enemy and opened fire with his 4"/50 at 7,000 yards. The picket returned fire but its shells fell short until at 6,500 yards they started to straddle STERLET, which hastily turned away to get out of range of the cagey Japanese. With shells still falling all around him at 7,500 yards, Robbins pulled the plug. SILVERSIDES people thought he must have dived because of a plane contact and broke off their approach, then surfaced and tried to call in TRIGGER and TAMBOR.

When STERLETS surfaced again both SILVERSIDES and TRIGGER were in sight. The three subs formed a line and resumed the attack on the wily opponent, which maneuvered so radically that both STERLET and SILVERSIDES soon exhausted their supplies of 4" ammunition. TRIGGER too was straddled by the enemy while Harlfinger fired his entire load of 112 4" rounds with many near misses but no hits. "The 4" gun shooting was heartbreaking," he recorded, and asserted that the time wasted in VHF communications had allowed the target to escape. Only Coye of SILVERSIDES claimed hitting the enemy, noting rather defensively: "We presented a far larger and more vulnerable target than he did." (The evasive opponent was HACHIRYU (or NACHIRYU) MARU #12 Go of 97 tons, which not unreasonably reported fighting a 10-hour battle with six submarines! Its damage was described as medium.)

Later that day SAURY encountered another picket and Waugh chose to make a night surface attack, firing four torpedoes. All missed, whereupon the target retaliated with some depth charges and departed at high speed. At about midnight it was discovered by TAMBOR, which also missed hitting it with three *electric* torpedoes from the stern tubes followed by three *air* fish from forward. The Japanese responded with gunfire, so Germershausen decided to wait until dawn and surprise the enemy with a battle surface attack. The opponent proved to be a wooden-hulled diesel trawler, which was quickly riddled by hits from the 5"/51 and 20 mm guns. However, it returned fire with its own guns and hit the trainer of the five-incher, Robert E. Baggett, in the leg. TAMBOR closed the sinking craft and sprayed the wreckage with 20 mm and .50 cal. gunfire as well as 10 bazookas that missed. Two prisoners were picked up; there were no other survivors. In addition to the bazookas, TAMBOR expended 65 5" rounds and about 1,000 each from the smaller guns, but was then put out of further action by being ordered to deposit Baggett and the prisoners at Saipan before continuing on to Pearl Harbor. (The picket was KOJO (or TAKASHIRO) MARU of 91 tons, presumed by the Japanese as lost with all hands on 16 November 1944 after reporting both of its battles with submarines.)

Approaching noon on the 16th, RONQUIL came upon two small ships close together, with another submarine in sight in the distance, later identified as BURRFISH. Monroe ordered all guns manned, but the seas were so heavy that the 5"/25 gun crew was knee deep in water and several of the men were thrown against the lifelines. Nevertheless, at 1,600 yards they opened fire at the nearest target and were soon joined by the 40 mm, 20 mm, and .30 cal. guns. The enemy was slow to respond with his own gun of about 40 mm size, and after at least one 5" and many smaller caliber hits he slowed down and sheered away. As the second Japanese closed in to 800 yards, RONQUIL's 20 mm gun jammed, but the enemy was held off by 40 mm hits. Monroe then shifted back to the first target, which appeared to break in two after a direct 5" hit, still firing sporadically with its smaller machine guns. With the second target now at 600 yards and with all of his weapons except the .30 cal. temporarily out of action, Monroe cleared the main deck and turned away to reload. Once the bigger guns were back in operation, more hits were registered on the remaining target, which withdrew and seemed to be circling around the spot where the first one had apparently sunk. (This was probably the 95-ton picket OEBISU (or OJU or TAIKAI) MARU #3. It was obviously badly damaged here but may not have sunk at this time. The second target was FUSA MARU. Both pickets reported being in battle with a submarine at this time and FUSA MARU said it was unable to steer. The next day it reported being in another battle with two submarines, as described below).

BURRFISH now appeared on the scene and the two subs tracked the tough little opponent by radar through the pitch-black night. RONQUIL tried a surface torpedo attack but the two fish missed. At dawn the two submarines renewed the gun attack in heavy rain. Twice the first loader on RONQUIL's 5" gun, Thomas W. Connaughton, was swept off his feet and over the side, saving himself the second time only by catching onto the rail with one hand. With all guns in operation at ranges between 3,500 and 700 yards, one good 5" hit was registered and three bazookas were fired but missed. The Japanese vessel continued to spray RONQUIL with its guns and tried to ram, fortunately without causing any casualties or damage.

BURRFISH was not so lucky. Four rounds of 4" ammunition could not be removed from their containers and the after 20 mm gun had to be whacked repeatedly with a leather maul to get it to start firing. Perkins later explained that a high percentage of his shots "missed the target because of heavy seas and lack of firing experience." The enemy caught him off guard by making a quick turn across BURRFISH's stern at 700 yards and spraying the bridge and shears with its machine guns. Coxwain M. A. Foster was hit in the leg and Seaman R. D. Lopez in the side so badly that he needed to be gotten to the nearest medical facilities ashore. ComSubPac accordingly ordered Perkins to discontinue the operation and return to Saipan.

Just at this time RONQUIL was firing directly astern at the elusive target when a pillar of black smoke and debris shot up 50 feet above the deck and the after torpedo room watch reported that the hull had been holed. One of the sub's own rounds had exploded prematurely, producing two holes in the pressure hull so that it could not dive. The target was forgotten and two men, Lt. Cdr. Lincoln Marcy and CMoMM William S. Bellows, hastened aft on deck to see what could be done. Bellows was promptly swept overboard but was recovered and taken below while Marcy returned alone and drove plugs into the holes. No sooner was this done than a Nell appeared, forcing the boat to dive to 100 feet as a bomb fell close by. The makeshift patches held then and later as two more planes drove RONQUIL down again. Refusing to quit, Monroe remained on the sweep until 18 November, when ComSubPac ordered it terminated. (The plucky picket was the FUSA MARU of 176 tons, which had reported being damaged and unable to steer after the first RONQUIL engagement but recovered enough to claim sinking one of two submarines in combat the next day. The 111-ton HOSHO MARU #3 also reported being in battle with a surfaced submarine at this time and location, but was unhurt. Neither RONQUIL's nor BURRFISH's patrol report mentions a second enemy vessel being present, but it may simply have been overlooked in the confusion. Both pickets returned home safely; the records give no details of the damage actually suffered by FUSA MARU).

At the same time as the above carnage was taking place, about midnight on 16 November, a few miles away Robbins in STERLET made contact with another ship and conducted a night surface radar approach in "visibility like the inside of a suitcase." At the last minute he identified the target as a 100-ton SCS-1 type and fired four stern torpedoes. The first three missed but the fourth hit and broke the victim in two. A minute later a monumental explosion jolted the submarine upward as the enemy's depth charges detonated. (This vessel cannot be positively identified. It may have been the OEBISU MARU #3 or its remains, still afloat after being presumably sunk by RONQUIL earlier in the day.

TRIGGER had also been chasing around trying to locate two contacts reported by SAURY, and tracked one through the early hours of 17 November, intending to attack it in the morning. At 1115 Harlfinger spotted a converted tuna-type boat lying to and armed with a 3" gun. Making a submerged periscope approach, he fired three Mk 18-1 torpedoes in succession, all of which missed. Three hours later he surfaced with two targets in sight, both under way, and was closing in with all guns manned when a plane suddenly appeared, forcing him to dive leaving the guns unsecured and ammunition exposed on deck.

Thus the great picket sweep ended with a whimper rather than a bang. Clay Blair characterized it as a *complete disaster* while W. J. Holmes noted that intelligence showed that the Japanese had reacted by rushing in ships and aircraft so that "there were probably more pickets in the area after the sweep than there were when it started." Klakring summed up the problems in a post-mortem report: VHF radio range too short to maintain communications, poor circuit discipline, inadequate fire control equipment, need for more gun training and practice firing, etc. He called for the installation of 5"/25 guns both forward and aft and the provision of a simple gun director, and recommended that all shellmen be trained as first loaders in order to reduce ammunition handling. Not mentioned was the obvious observation that having an embarked group commander only complicated communications, dampened the individual skippers' initiatives, and delayed actions. Many of these rudimentary improvements were implemented on various boats before the end of the war, especially on a group destined to conduct another picket sweep about three months later.

NEW ANTI-ESCORT WEAPONS INTRODUCED

SENNET (SS 408) under George E. Porter, Jr. had a very unusual and short maiden patrol when she was sent out in January 1945 to test ten secret Mk 27 or CUTY homing torpedoes and some Mk 32 proximity-fuzed shells for the 5"/25 gun. The torpedoes were fired by sonar at depths of 150-170 feet, necessarily very close to the target. The results were reported in a top-secret supplement to the patrol report. The first was fired at a tanker on 21 January after SENNET*S*'s entire regular load of six Mk 18-1 torpedoes missed, and nine were fired between then and 26 January against patrol vessels or picket boats for a single hit. That hit was made on 23 January with the sub circling directly under a pair of the targets, which were almost certainly armed with depth charges. (According to Japanese records, the 85-ton picket KAINAN MARU *#7* was hit by two torpedoes and sunk with the loss of 11 killed. The survivors, including three wounded, were rescued by the HOSHO MARU *#3* of 111 tons.)

Later the same day the sub got into a gunfight with that very picket. Porter's report describes this encounter as "undoubtedly the worst exhibition of a gun action that I have ever observed." He had to keep the boat's stern within 20 degrees of the Force-4 seas in order for a deck gun to be manned at all, the SJ radar went out, the gun trainer's sight flooded as did replacement binoculars, and 50 percent of the Mk 32 shells prematured. To Porter, these were "more disconcerting than the gun fire returned by the enemy." Two hits were observed before contact was lost in the darkness. (Japanese records do not describe the damage, if any, to the HOSHO MARU #3.)

Adding insult to injury, task group commander G. E. Peterson's endorsement to the report said that 30 percent of VT fuzes would normally premature, but the increased failures were due to *bad shooting* because the shells were fired too close to the water. SENNET returned to Saipan to be rearmed, replenished, and sent right back to sea on another picket sweep.

THE SECOND PICKET SWEEP

This operation was more sophisticated and in some ways more successful than Burt's Brooms. It originated as part of the February 1945 assault on Iwo Jima, Operation Detachment, which was to be preceded by a carrier strike on Honshu targets. The initial sweep was planned as a two-pronged operation: the main thrust to clear a path for the carriers, and a diversionary feint to attract Japanese interest in the wrong direction. The submarines were all new or recently overhauled and specially armed with 5"/25 and 40mm guns mounted both forward and aft, plus additional smaller weapons and improved voice radios. This operation would occupy the first few days of their patrols, which were primarily intended to provide plane guard services for the many aircraft attacking Japanese targets.

The main group, TG 17.17 or Mac's Mops, was headed by PIPER (SS409) under Bernard F. McMahon on her first patrol, plus BOWFIN (SS 287) on her seventh patrol, with Alexander K. Tyree in command; POMFRET (SS 391) on her fourth patrol, under John B. Hess; STERLET (SS 392) under H. H. Lewis, on her third run; and TREPANG (SS 412), commanded by Allen R. Faust on her third patrol. These boats each carried a partial load of CUTY torpedoes to be used against the pickets or other targets.

The diversionary section, TG 17.13 or Latta's Lances, was led by Frank D. Latta in LAGARTO (SS 371) on her maiden patrol, with the veteran HADDOCK (SS231) on her eleventh patrol, and SENNET (SS 408) under George E. Porter, Jr., just returned from their short first patrol as described above. Latta was instructed to use only his group's guns and to give the targets enough time to radio their warnings and thereby induce the Japanese to draw forces away from the real clearance area. The subs had all gathered at Saipan for briefings and final topping-off of fuel and supplies in preparation for leaving the next day, when their plans were disrupted by a tragic accident. Five officers from LAGARTO and HADDOCK were seriously injured in a car crash while driving around the island on 6 February, including the skipper of the HADDOCK, John P. Roach, who died a few days later. Replacements for the junior officers were flown up from Guam, and command of HADDOCK was assumed by the division commander, William H. Brockman, who was undoubtedly delighted at the unexpected opportunity to go on patrol one more time but wisely left Latta in charge as the group commander. In spite of the disruption, the two sections got under way on schedule the next day.

To sum up the operation, neither Mac's Mops nor the carrier task force encountered any pickets, so in that sense the main sweep was a success, as was the diversionary action. Oddly enough, the boats were credited with 10 separate *special operations* characterized as picket sweeps between 25 January and 4 April 1945. STERLET, PIPER, and TREPANG each received two such awards and the others one each except for BOWFIN, which was inexplicably and unjustly omitted, as will be seen.

First blood was drawn by Latta's Lances. Despite their unsettling start, the three submarines worked well together, and on 13 February encountered their first pair of pickets. All three soon registered hits on both targets, then HADDOCK concentrated on the smaller ship, which was soon afire, but straddled its tormentor with automatic weapons without causing any damage. Having expended his entire load of 148 5" shells, Brockman closed in to finish off the opponent with 40 mm fire, but before he could get near enough, it sank with one Japanese sailor still firing a rifle as it went down. The larger picket was sunk by SENNET at point-blank range. All told, Porter had fired 214 5" and 384 40 mm rounds. There were no survivors from either target. (The victims were the 76-ton SHOWA MARU #3 GO and 109-ton KOTOSHIRO MARU #8.)

The next night HADDOCK detected two more pickets and was directed to hold contact until morning, then to make a submerged torpedo attack while the other Lances attacked on the surface. Brockman launched a single CUTY, but it failed to hit. LAGARTO and SENNET fired at the two pickets until both had exhausted their 5" ammunition and had to break off the action. In the process SENNET received two hits by .50 cal. bullets and an unnamed crewman was wounded in the back by shrapnel. (The pickets EIFUKU MARU and KANNO MARU #3, both of 98 tons, reported engaging in a battle with surfaced submarines, the latter suffering four men wounded.) The Lances then broke up and proceeded on their individual patrols.

The subs in Mac's Mops, however, stayed together and accounted for a few picket boats among other sinkings later during their patrols. On 17 February BOWFIN sighted two pickets. Letting the smaller one go, Tyree concentrated on the other, which turned out to be an abandoned sea truck type, masts fallen and still smoldering aft where four depth charges were visible. There was no sign of life and the seas were too rough to board the wreck, so Tyree blasted it with 40 and 20 mm shells, whereupon its depth charges exploded and it turned over and sank. McMahon in PIPER had come across this derelict the day before, judged it "well underway to Davy Jones," and passed it by. (Japanese records say several pickets were sunk or damaged by aircraft 16-18 February in that general area.) POMFRET encountered a similar gutted wreck two days later and picked up a Japanese sailor from a rowboat, further evidence of U.S. air competition with the submarines to sweep the ocean clean of Japanese shipping.

On 25 February PIPER fired three torpedoes at each of two small targets of unknown type, one of which blew up with a tremendous flash. (It was probably the picket HOSHO MARU *#3* of 111 tons, sunk with 25 killed; twelve survivors were rescued by the ISUZU MARU *#3*.) The next victim was a large sea truck type armed with four guns and having cargo stacked aft. This was sighted and avoided by POMFRET on 2 March but hit later that day by a CUTY torpedo from BOWFIN, which left it listing and dead in the water. The crew then jettisoned the cargo and abandoned the craft as it capsized and sank, leaving about 10 men in a lifeboat and a few still in the water. Tyree took photos of the scene and went on his way. (This was the picket CHOKAI MARU of 136 tons, reported sunk in a battle with a surfaced submarine on this date. The Japanese may have been using it more as a cargo carrier than a picket in an attempt to compensate for the huge shipping losses incurred to date.)

BOWFIN encountered another pair of pickets on 4 March and bored in, firing her 40 mm weapons and one of the five-inchers, even though the gun crew was nearly drowned by solid water and spray. Both enemy vessels returned fire and the gun trainer, TM2/c

R. E. Lee, was hit in both legs by shrapnel, with bones in the left limb shattered. Tyree broke off the attack and retired, having fired 12 5" shells and 64 rounds of 40 mm with at most only two 40mm hits on one of the targets. The Japanese were "too tough for us inside 5,000 yards," Tyree wrote. "We were humiliated and had suffered serious injury to one man as well. C.O. had underestimated the enemy." Lee was transferred the next day to SENNET for transportation back to Saipan. (According to Japanese records, the pickets FUKUKYU MARU #1 of 152 tons and FUKUYOSHI (or FUKUKICHI) MARU #2 Go of 98 tons reported battling surfaced submarines, but no damage or casualties were cited.)

On 9 March McMahon proposed that the Mops conduct another coordinated sweep when not tied down to plane guard stations. The others readily fell in line and carried out the impromptu sweep between 11 and 15 March, with negative results. In addition to the actions described above, the members of Mac's Mops had more adventures during their long patrols than can be mentioned here.

MORE NOTEWORTHY ATTACKS

In the meantime, individual submarines continued to challenge more pickets. Skippers often ran into unexpected opposition when they first ran into one. Charles M. Henderson in BLUEFISH (SS 222), returning to Guam at the end of the boat's seventh patrol, attacked one on 19 March 1945. Keeping at a safe distance of 8,000 yards, he thought a 5" hit had set the target's stern afire. However, at closer range it was seen to be a white smoke screen, from behind which the Japanese bracketed the sub with 40 mm fire. Henderson prudently broke off, having expended 70 rounds of 5" ammunition with one premature explosion. (The picket was the 96-ton MYOJIN MARU #7, which reported the engagement but made no mention of casualties or damage.)

On 28 March 1945 John J. Foote, skipper of THREADFIN (SS 410) returning from her second patrol, made what he described as *our first battle surface* on a group of two small trawlers and four large sampans or luggers. The 5" gun soon made hits, setting a lugger afire while the trawlers and a sampan sprayed the sub with 20 mm and machine gun fire. Confusion then resulted when the gun crew misinterpreted an order and started to return below deck. Once that was straightened out and all guns were back in action, a sampan was set on fire and hits were registered on both trawlers even though the SJ radar inconveniently went out of commission. After expending 31 rounds of 5", 89 of 40 mm, and 420 of 20 mm, the engagement was broken off when the APR detected an incoming aircraft. In his report, Foote noted that two men had suffered broken eardrums and admitted that poor fire discipline and communication problems had contributed to the less than satisfactory results. Back at Midway, inspectors found a small hole where the Japanese had hit the forward superstructure.

(Japanese records say that seven pickets had left Kagoshima on 24 March for their patrol areas. The FUJI MARU #2 Go of 225 tons discovered and attacked a surfaced submarine, receiving one hit. It was followed by the 76-ton DAI MARU #6 Go, which received six hits. The 128-ton MYOJIN MARU #2 Go moved in to cover the others and returned fire with the sub. As REIKO MAUR of 88 tons tried to get behind the enemy, the damaged FUJI MARU #2 Go managed to get close enough to rake the submarine with gunfire. Three of these pickets sent radio messages during the battle: one reporting fighting two submarines and another claiming the sub had been sunk. Although the extent of damage and casualties is not specified, DAI MARU #6 Go had to be escorted to Shimizu, where it was sunk by aircraft on 30 March.)

The veteran SILVERSIDES (SS 236), now on her thirteenth patrol, had already engaged in encounters with pickets under previous commanding officers, as noted above. Now it was John C. Nichols's turn to share those experiences. On the night of 11-12 April 1945 he made torpedo attacks on a small cargo ship and its escort, claiming one hit out of seven fish fired. The victim, which had two goal posts, a prominent forecastle and well deck, and a single stack, was seen to sink. (According to Japanese records, this was the 269-ton picket SHIRATORI MARU and its sinking with the loss of 16 men was confirmed by its fellow picket SUMIYOSHI MARU #7, which retaliated by depth charging the submarine.)

A week later on the 19th as he was returning to Midway Nichols came upon two more pickets, a converted trawler and one resembling a sub chaser, and launched a gun attack. Holding the range between 4,500 and 6,500 yards to avoid return fire, he fired 94 rounds of 4" and 200 of 50 cal. ammunition but registered only two hits on the trawler before breaking off because of repeated 4" misfires. (The damaged picket was the 180-ton KAIRYU MARU, which suffered two men killed and three badly wounded. Its undamaged consort was NANSHIN MARU #38 of 80 tons.)

PARCHE (SS 384) was on her fourth patrol with Woodrow W. McCarthy in command when on 13 April 1945 they encountered a wooden steam trawler with nets out. It had a clipper bow, two tall masts, and a high bridge amidships, and was armed with two machine guns. Repeated hits with 5", 40 mm, and 20 mm shells soon left it afire and sinking by the stern with masts down, superstructure a shambles, and two men in a lifeboat. Soon thereafter a sea truck was sighted with canvas up, a high forecastle, bridge aft, and two machine guns. It was holed repeatedly by 5" shells and set ablaze by 40 mm hits. McCarthy closed in to 600 yards when two Zeros appeared so suddenly that he had to dive and go deep with guns still loaded. (Japanese records identify the 133-ton picket KOSHO MARU #2 and the 101-ton army cargo carrier MIYOKAWA MARU #165 as sunk here. McCarthy's observation of nets and the picket's uncharacteristic weak response imply that it may have been returned to its original fishing duties, at least temporarily.)

A few days later Raymond Berthrong in CERO (SS 225) on her seventh patrol engaged some more typical opponents. On 19 April he sighted two pickets, stopped and apparently unaware of his submerged approach. A single torpedo demolished the first one, leaving only the bow afloat with five men still on the gun platform, one defiantly waving the Japanese ensign. As the second vessel approached, apparently to pick up survivors, Berthrong took photos and broke off contact. (Japanese records say the 75-ton ISUZU MARU #3 was sunk with 23 killed and four wounded, while FUKUKYU MARU #1 of 152 tons rescued seven survivors.)

On 22 April 1945 CERO made a gun attack on another pair of pickets, which headed for the sub and began firing when still 10,000 yards off. Berthrong opened fire on the first one with his 5" gun at 7,500 yards and at the second with the 40 mm weapon. The first picket, burning, turned away and both guns were concentrated on the second until all 5" ammunition was expended. The enemy slowed, settled by the stern and sank, leaving about 30 men in the water. Two prisoners were taken, but the rest refused to be picked up. The first target managed to extinguish its fire and escaped. (The picket AJI (or AMIJI) MARU of 107 tons was reported to have been sunk by its own depth charges after fighting a surfaced submarine. The second vessel was the 201-ton TAKAMIYA (or TAKAKU) MARU HO GO, which reported the engagement and probably picked up survivors. Its damage and casualties, if any, are not recorded.)

SMALL-CRAFT ATTACKS BECOME COMMONPLACE

As the war drew closer to its end and targets became increasingly scarce, submarines made many more gun attacks on fishing boats and small craft of all types, which the Japanese were forced to use as cargo carriers. In many cases the targets were unarmed native Indonesian, Malay, or Chinese vessels that were boarded and inspected to determine if they were carrying Japanese goods. If so, the crews were taken off or allowed to abandon ship in small boats before the craft were sunk by gunfire or demolition charges. On the other hand, bona-fide gun battles with picket boats and other well-armed small craft continued to the end of the war.

On 27 May 1945 Hiram Cassedy, in command of TIGRONE (SS 419) on her second patrol, had a memorable battle with an opponent that was not a regular picket boat, but which is an excellent example of the aggressiveness of armed Japanese small craft. This one was a sailing vessel, probably of the type known as a motor-sail. As Cassedy opened fire with his 5" and 40 mm guns, the enemy doused its sails and returned fire with a 25 mm weapon and machine guns, repeatedly raking TIGRONE despite taking several 40 mm hits. Cassedy pulled back to 2,500 yards as heavy seas caused injuries to three members of the 5" gun crew. Although hits set fires on the enemy vessel, a hard rain extinguished them. Finally a direct 5" hit disabled all of the Japanese weapons except a single machine gun, set the target afire again, and left it dead in the water. Moving in again, TIGRONE registered more hits until all 5" ammunition was exhausted and both 40 mm guns jammed, finally sweeping the target with 20 mm and .50 caliber fire. It was left burning with two gaping holes below the water line and depth charges visible on the stern. Cassedy summed up his evaluation of the fight in these words: "This action revised my ideas completely. I had been under the false impression that 40 MM would clear the topside of machine guns and in addition do far more damage than the 20 MM guns. That is a fallacy." The ideal armament, he concluded, was the 5" for its destructive value and small caliber machine guns for clearing the decks. He also noted that the submarine had sustained several 25 mm and machine gun hits, fortunately without damage. (The Japanese opponent was the navy cargo craft YAWATA MARU #3 of only 19 tons.)

TENCH (SS 417) on her second patrol, with Thomas S. Baskett in command, on 7 June 1945 engaged a picket with the number 113 on its hull. As the submarine approached, the enemy opened fire with its machine guns at 3,000 yards. Baskett withheld fire from his 5"/25 gun until the range was down to 2,300 yards, then sank the target with 30 hits out of 43 rounds fired, leaving no survivors in sight. "Target was remarkably tough," he noted in the patrol report. (The victim was the 92-ton picket HANSHIN MARU, sunk with the loss of 20 crewmen.)

DENTUDA (SS 335) under John S. McCain, Jr. was on her first patrol when she encountered a pair of pickets on 18 June 1945. DENTUDA carried the unusual armament of a 37 mm gun (a temporary substitute for the standard 40 mm weapon) as well as a regular 5"/25 deck gun. One picket dropped four or five depth charges and opened fire with machine guns and a larger weapon, which McCain countered at 3,900 yards. After firing 50 rounds for two hits that left the target smoking, the 5" gun failed to return to battery and the 37 mm went out of commission. With the 5" gun back in service, the crew registered a direct hit on the second picket, producing a cloud of black smoke. With only 25 rounds remaining in the magazine, McCain broke off and went on his way, leaving the two smoking pickets in his wake. (These were HEIWA MARU and *REIKO MARU*, both of 88 tons. Although some records are in conflict, the former probably sank here; the extent of damage to the other is not specified but does not appear to have been serious.)

One of the most aggressive attacks against Japanese small craft was made by skipper Charles F. *Chuck* Leigh during the fourth patrol of SEA POACHER (SS 406) late in the war. Leigh's preferred approach was to creep up undetected behind the victim after dark and blast it with all weapons at very short range. He claimed that this method produced practically 100% hits. Between 20 and 27 July 1945 he disposed of six Japanese sea trucks or other small craft until his ammunition supply was practically exhausted. At least one of the victims appears to have been a picket boat.

On the night of 22-23 July he encountered what he identified as a wooden sea truck. Closing stealthily to 350 yards, he poured seven rounds of 5", 86 of 40 mm, 270 of 20 mm, 300 of .50 caliber, and 350 of .30 caliber ammunition into the surprised Japanese vessel, setting it afire. Forty minutes later it blew up and sank. (According to Japanese records—which conflict in some details—this was probably the 70-ton KIRI MARU #2 Go. It is also the last picket known to have been sunk by a submarine during the war.)

SOME CONCLUSIONS

In the overall course of the war, Japanese small craft like the picket boats were of relatively little consequence. To the surface and air forces they were minor targets of opportunity. Only in the case of the Doolittle raid and the two organized sweeps were the picket boats enough of a nuisance to achieve formal notice. To submariners they were something of a conundrum, regarded by many as too small to waste a torpedo on, and by others as too dangerous to risk engaging in a gun battle. The leaders blew hot and cold, often at the same time, applauding the successes of aggressive skippers while warning them not to risk their boats or jeopardize their assigned missions. Not until the regular Japanese merchant marine had been largely swept from the seas were small craft generally considered worthwhile gun targets. As the foregoing examples indicate, the Submarine Force apparently never established a formal doctrine for employment of the guns, leaving it up to individual skippers to decide how to act on a case-by-case basis.

The 3"/50 caliber deck gun, with which most submarines went to war, was a dual-purpose weapon mainly intended as a last-ditch defense against enemy aircraft or surface ships that could not otherwise be evaded. Charles Lockwood was influential in rearming as many boats as possible with the few 5"/51 guns originally installed on the three old V-1 class subs or 4"/50s from S-class boats no longer in combat service, and championed the development of the 5"/25 as a specific submarine weapon. Skippers were also given the option of having their deck gun installed either forward or aft, or even in both locations if a boat's stability allowed it. Later some skippers were permitted to carry extra weapons, even bazookas and rockets, but many boats still carried 3-inchers when the war ended.

However, fire control of the deck-mounted guns was marginal even in the best weather, and in rough seas they were often more of a hazard to their own crews than to the enemy. Only at the end of the war were a few subs fitted with rudimentary fire-control systems, but these so-called *gunboats* never saw combat. Smaller rapid-fire weapons were steadily improved during the war, and the 40 mm Bofors in particular proved a valuable addition to submarine armament, but 20 mm, .50 cal., and .30 cal. machine guns remained useful until the end of the war.

For the most part, however, the focus of the Submarine Force was naturally on torpedoes. Encounters with pickets were few and sporadic, so skippers had little opportunity or incentive to develop real expertise in fighting them. Given the inherent unsuitability of the submarine as a gun platform, the pick-up nature of submarine gun crews, the dearth of formal gunnery training, and the lack of opportunities for gun practice, it is not surprising that too many rounds were fired for few hits, jams and misfires were prevalent, ammunition defects were common, and gunnery was generally poor.

On the other side, the Japanese guardboat force was well organized and equipped to perform the important function of early warning against enemy approaches to the main islands. Despite the inherent weakness of the individual vessels and their inferior armament of old-type guns and a few depth charges, they were surprisingly effective in repelling our submarines. Typically working in pairs for mutual support, they were able to call in aircraft that often arrived before a submarine could do much damage. Their gunfire was effective at unexpectedly long ranges, forcing subs to stand off where their own more-powerful guns had difficulty making hits. The Japanese skippers often maneuvered skillfully and aggressively to divide or distract enemy fire. When hit, their damage control was effective enough to save many vessels that submarine skippers were sure they had sunk. Even when overwhelmed, they went down fighting. The lowly pickets thus proved to be real warships, worthy opponents of our submarines.

- The material on specific U. S. submarine attacks has been taken directly from the original patrol reports; other general information is from standard reference works. Japanese information is mainly from several detailed reports and other archival sources. I am indebted to William G. Somerville of England and Erich Muehlthaler of Germany for translating these documents.

**In Japanese usage ship names that include numbers are written with the number preceding the name, e.g, #23 NITTO MARU, but this makes alphabetizing awkward, so most U.S. writers prefer to put the number last. Where alternative spellings for names are given, these generally result from different readings of the same Japanese kanji by different translators. The usage of suffixes such as Go etc. defies simple explanation.

EARLY EXPERIMENTS IN SUBMARINE WIRELESS

by Timothy S. Wolters, CAPT USNR, Ph.D.

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Three articles recently appearing in THE SUBMARINE REVIEW discuss the history of submarine radio communications in the United States Navy.[1] The first of these chronicles submarine radio developments through the 1920s, devoting a majority of space to the First World War (1914-18) and after. The article's authors point out that by 1910 several U.S. submarines had been equipped with transmitters and receivers; they also describe a *primitive* antenna system installed on OCTOPUS (C-1) around the same time.[2] Yet OCTOPUS appears not to have been one of the original test platforms for submarine radio communications. That honor belongs to several other boats, notably STINGRAY (C-2), NARWHAL (D-1), and GRAYLING (D-2), each of which conducted important wireless experiments in 1909-10.

This article examines those experiments, as well as another series of tests performed in 1915 that likely were the first in which American naval personnel used a floating-buoy antenna designed for a submarine. In aggregate, these experiments demonstrate that the individuals who worked with submarines a century ago were aggressively trying to get radio on boats and out to sea. Before exploring such efforts, however, a quick overview of the Navy's work with wireless prior to 1909 is necessary.

The first United States naval officer to communicate from a warship via electromagnetic radiation was Bradley A. Fiske, who in 1887 signaled between his ship and a nearby pier. Fiske accomplished this by passing current through copper plates suspended beneath his ship and the pier, but when he tried to implement this system on moving vessels it failed to work. Fiske went on to other endeavors, one of which involved inventing and developing the stadimeter, a device well known to later generations of submariners.[3]

While Fiske was perfecting his stadimeter, the U.S. Navy experimented with ways to extend the range at which signals could be sent and received. One interesting avenue of research involved messenger pigeons, but this work barely had begun when a new technology arrived on the scene.[4] That technology was wireless telegraphy, which Guglielmo Marconi first demonstrated to American naval officers in the fall of 1899. Marconi's demonstration showcased the potential of radio when during one trial two cruisers thirty-six nautical miles apart, communicated successfully.[5] But Marconi had not yet solved the problem of interference, and he insisted on annual royalty payments, something the Navy Department could not legally disburse. A few years passed before the Navy purchased its first radios, from a German company, in February 1903. The fleet utilized these several months later in an exercise conducted off the New England coast.[6]

The Battle of Tsushima (27-28 May 1905), during which the Japanese naval commander used wireless more judiciously than his Russian counterpart, seems to have created a new sense of urgency within the Navy Department over the adoption of radio. Yet exercises conducted in July 1905 and January 1906 revealed that interference was still a major problem.[7] Spark gap transmitters, the only reliable type during the first decade of the twentieth century, produced highly damped waves (i.e., their energy was dispersed over an extremely wide frequency band), and early receivers were temperamental, particularly under the harsh conditions of shipboard use. Fortunately, better equipment was on the way. Dependable arc transmitters would become available in time for World War I, but even before then Marconi and others introduced the *quenched* spark gap, a transmitter that minimized damping and thus helped overcome the interference problem. Receivers improved too, especially after Greenleaf W. Pickard patented his crystal detector near the end of 1906. Soon thereafter, Pickard founded a company that sold many of these devices to the U.S. Navy.[8]

By the end of the first decade of the twentieth century, then, wireless technology had advanced to the point where submarine radio was a realistic possibility. The Bureau of Equipment, which held responsibility for radio, was favorably inclined toward the idea but needed a few subs on which to conduct experiments. Fortuitously, in the spring of 1909 the Fore River Ship and Engine Company in Quincy, Massachusetts, had just launched and was completing work on three submarines: STINGRAY, TARPON, and NARWHAL.[9] STINGRAY and TARPON were C-class boats, designed by Lawrence Y. Spear and built in Quincy under a subcontract from the Electric Boat Company. Each had a single hull, contained internal ballast tanks, and displaced 275 tons submerged. NARWHAL, built under the same contractual arrangement, was nearly identical in design but larger, displacing 337 tons submerged. She was the lead ship of the U.S. Navy's D-class submarines.[10]

Testing commenced in June 1909 with a schedule that called for experiments on both STINGRAY and TARPON, but the latter had an unrelated material problem so STINGRAY became the sole test platform. She received a compressed air (i.e., quenched) spark gap transmitter designed by Canadian-American inventor Reginald Fessenden, but naval electricians quickly discovered a broken condenser on that device.[11] As such, no transmitting tests could be performed. STINGRAY succeeded in receiving messages from the nearby Boston Navy Yard, however, a feat that may have been a first for an American submarine.[12]

A few weeks later the Bureau of Equipment used another submarine, NARWHAL, for a wireless experiment designed to ascertain if underwater reception of radio was possible. Of course, this was similar to what Bradley Fiske had tried to accomplish more than twenty years earlier. This time around, the navy installed two brass plates below the waterlines of NARWHAL and a service vessel. Electricians ran insulated leads vertically up from these plates to each ship's deck. Initially the service vessel, then NARWHAL, succeeded in receiving signals from a nearby warship. When the leads were run from NARWHAL's deck down the hatch and into the pressure hull, though, the signals became very weak. This led George H. Clark, the radio expert observing the experiment, to report "that the presence of a metallically continuous screening around the leads from the under water plates to the receiver is very detrimental."[13]

Still needing to determine the feasibility of underwater wireless communications, in June 1910 the Bureau of Equipment conducted more tests on another D-class submarine, GRAYLING. These experiments initially mirrored those done on NARWHAL, with metal plates (this time copper, instead of brass) being submerged beneath the hull. The receiver on GRAYLING was almost certainly better than the one used the previous year, although electricians learned that one type of crystal detector "was very quickly put out of commission by the battery gas present within the boat."[14] After the initial configuration demonstrated reliable signal reception, sailors moved the copper plates topside and hung them on oars lashed to GRAYLING's diving masts (figure 1).

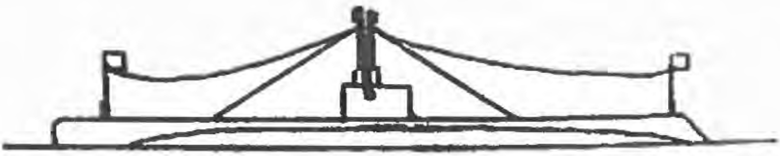

Figure 1. A sketch by George H. Clark showing an antenna arrangement during GRAYLING's wireless experiments in 1910. Courtesy of the National Museum of American History Archives Center (NMAH Archives). All four figures in this article are digital images taken by the author from documents in the George H. Clark Radioana Collection, series 100, box 293. See note 12 for citation information.

The submarine then submerged to various depths while moored to the pier. The copper plates touched water when GRAYLING submerged to ten feet, and were covered completely at twelve feet. Signals could be heard to a submerged depth of fifteen feet (i.e., the top of the plates were three feet beneath the water), but no deeper. According to George Clark, the GRAYLING experiments demonstrated conclusively "that there is some penetration of sea water by electro-magnetic waves, but that this is not sufficient to enable a method of wireless communication . . . to be employed in practice."[15]

Clark captured the essence of a problem that continues to plague submariners even today: how to communicate while submerged. Recently the Defense Advanced Research Projects Agency, as part of their TRITON program, awarded a $31.8 million contract for the construction of a blue-laser underwater communications system slated for trials in July 2012. Meanwhile, Lockheed Martin continues its work on buoys that potentially will allow for better two-way communications between submarines and shore stations, ships, and/or aircraft.[16] In the early twentieth century the Triton program would have represented science fiction, but the buoy concept was certainly comprehensible. And while today's engineers wrestle with issues of how to maintain radio connectivity at *both* depth and speed, naval personnel in the 1910s had their own idea about how to transmit from a submerged submarine. That idea centered on a floating-buoy antenna.

Cold War submariners undoubtedly will recall the BRA-8, a towed-communications buoy used by SSBNs to receive messages while on patrol. Its original forebear never had a name, but dates to 1915, when American naval personnel tested a floating-buoy transmitter. Known sources do not positively identify who first conceived of such a device, but many submariners surely would have liked the idea of being able to send messages without having to surface.[17] The experiments on GRAYLING in 1910 had demonstrated that a sub could receive messages while partially submerged, but transmitting through water was an altogether different matter. Likely prompted by someone familiar with submarines, the Bureau of Steam Engineering, which by then had assumed responsibility for naval radio, explored the potential of the floating-buoy transmitter in November 1915. The bureau's tests involved two different arrangements for exciting a *small* antenna mounted on a buoy that was to be "carried in a 'nest' in the submarine [and] so arranged that upon being released, it will float to the surface with its antenna."[18] The first arrangement proposed locating the entire transmitter inside the submarine, with an insulated cable running up to the antenna (figure 2).

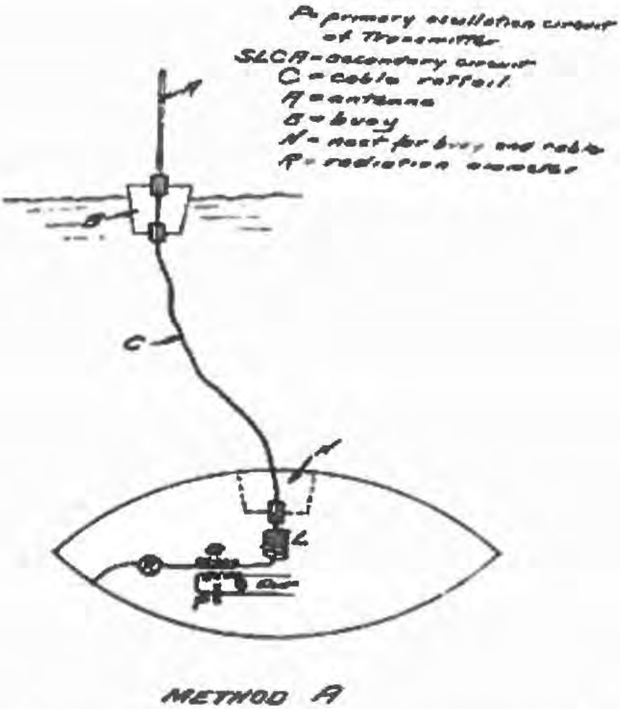

Figure 2. Schematic of a floating-buoy transmitter tethered to a submarine. In method A, shown here, the entire transmitter is inside the submarine. Courtesy of the NMAH Archives. See note 18 for citation information.

The second arrangement proposed placing a majority of the transmitting equipment on the buoy itself (figure 3).

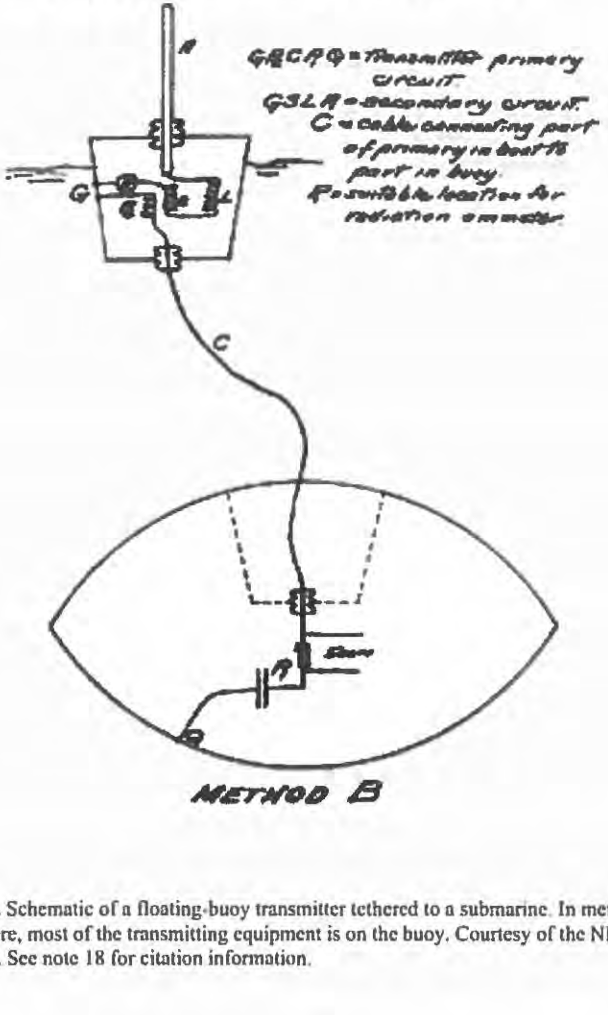

Figure 3. Schematic of a floating-buoy transmitter tethered to a submarine. In method B, shown here, most of the transmitting equipment is on the buoy. Courtesy of the NMAH Archives. See note 18 for citation information.

Standard shipboard antennas of the era were usually quite long, often 80 feet or more in length. Obviously this would not work for a buoy carried by a submarine, so the bureau tested three relatively compact antennas during the trials. The first was a 20-foot tall vertical pipe antenna with kite aerials; the second was simply a 10-foot tall pipe, apparently borrowed from the navy's stock of interior communications voice tubes; and the third was a spiral antenna made of looped copper wire (figure 4).

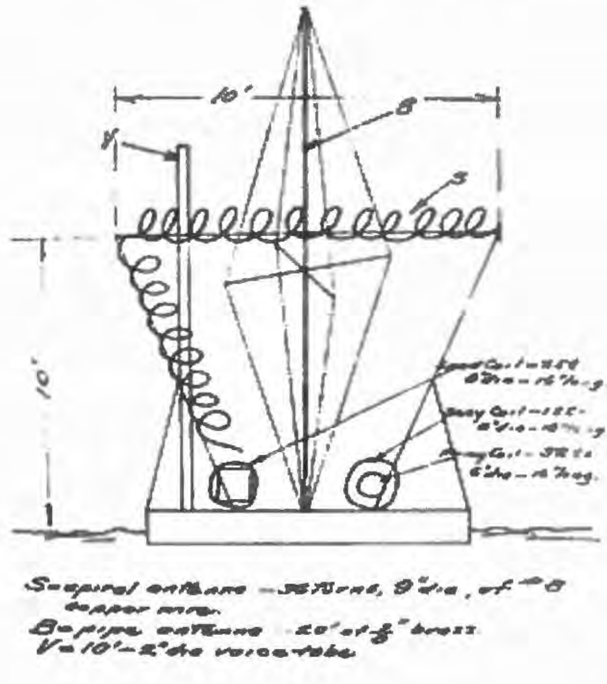

Figure 4. Sketch of the three antenna configurations tested during the U.S. Navy's floating-buoy transmitter experiments of November 1915. The kite aerial worked best (annotated "B"), although the 10-foot antenna (annotated "V") clearly would have been the easiest to store on a submarine. Courtesy of the NMAH Archives. See note 18 for citation information.

The recently launched destroyer CONYNGHAM (DD-58), moored in Philadelphia, simulated a submarine with a specially installed spark-gap transmitter equal in power to that which could easily be fitted on a sub. After a routine check of CONYNGHAM's own antennas, a 180-foot insulated lead was placed in the water and attached to the floating buoy. Each of the three antennas radiated at between 4.5 and 4.8 amperes, inclusive, with the tallest antenna giving the best results.[19] Yet the signals were not sufficiently strong to be heard by wireless operators just eight miles away. Would the results be better when electricians moved transmitting apparatus onto the buoy itself? Unfortunately, the answer was no. In fact, the results were significantly worse, with a maximum radiated signal of only 1.0 ampere. Although the first arrangement had proven superior, it was nevertheless inadequate, leading the officer who observed the tests to report "that it will probably be impossible to work the desired 30-50 miles with a 1/4 KW set, and the small antenna that can be used."[20] In short, the trials revealed that a promising idea was simply not practicable with the technology then in existence.

Indeed, the promise of a floating-buoy transmitter would not be realized until the advent of high-frequency radio, and routine use of such devices would have to await the Cold War, when the BRT-1 SLOT (Sub Launched One-way Transmitter) buoy became standard equipment on board U.S. submarines. While such developments lay well in the future, the experiments conducted on STINGRAY, NARWHAL, GRAYLIONG and CONYNGHAM in the early twentieth century made clear to American naval personnel the basic limitations of early submarine radio. They also marked a critical first step toward solving the inherent challenges of submarine communications.

ENDNOTES

1. Edward Monroe-Jones and Robert Baker, "A Summary History of Submarine Radio Communication: Part One," THE SUBMARINE REVIEW 28, no. 3 (July 2010): 37-49; idem, "A Brief History of Submarine Radio Communication: Part Two" THE SUBMARINE REVIEW 28, no. 4 (October 2010): 71-82; and idem, "A Brief History of Submarine Communication: Part Three," THE SUBMARINE REVIEW 29, no. 1 (January 2011): 106-111.

2. Submarines commissioned after USS HOLLAND were given fish names until 17 November 1911, at which point the Navy Department started assigning class letters and numerals (e.g., PLUNGER became A-1, ADDER became A-2, VIPER became B-1, etc., etc.).

3. Bradley A. Fiske, *From Midshipman to Rear Admiral* (New York: Century Company, 1919), 72-76, 99-101, 208-209; and Paola E. Coletta, *Admiral Bradley A. Fiske and the American Navy* (Lawrence: University Press of Kansas, 1979), 40-41.

4. Henri Marion, "Homing Pigeons for Sea Service," United States Naval Institute Proceedings 22, no. 1, (1896), 643-654.

5. John B. Blish, "Notes on the Marconi Telegraph," *United States Naval Institute Proceedings 25*, no. 4, (1899), 857-864.

6. Bureau of Equipment (BuEq) to Secretary of the Navy (SecNav), 1 October 1902, in *Report of the Secretary of the Navy, 1902* (Washington: U.S. Government Printing Office, 1902), 376; BuEq to Bureau of Supplies and Accounts, 28 February 1903, and BuEq to Commander-in-Chief, North Atlantic Fleet, 27 July 1903, in boxes 87 and 19, respectively, General Correspondence, 1899-1910, Records of the Bureau of Equipment, Records of the Bureau of Ships, Record Group 19, National Archives Building, Washington, D.C. (hereafter cited as RG19/BEQ).

7. Lieutenant Louis A. Kaiser, third endorsement to file no. 118, 540, 24 August 1905, box 36, RG19/BEQ; and SecNav to Commander-in-Chief, North Atlantic Fleet, 2 February 1906, summarized in Linwood S. Howeth, *History of Communications-Electronics in the United States Navy* (Washington: U.S. Government Printing Office, 1963), 111-112.

8. Greenleaf W. Pickard, "Means for Receiving Intelligence Communicated by Electric Waves," U.S. Letters Patent No. 836, 531, 20 November 1906; and Maurice L. Sievers, *Crystal Clear: Vintage American Crystal Sets, Crystal Detectors, and Crystals* (Chandler, Ariz.: Sonoran Publishing, 2008), 15-16.

9. BuEq to SecNav, 14 October 1909, in *Report of the Secretary of the Navy, 1909* (Washington: U.S. Government Printing Office, 1909), 264. The Navy later redesignated TARPON as C-3.

10. K. Jack Bauer and Stephen S. Roberts, *Register of Ships of the U.S. Navy, 1775-1990* (Westport, Conn.: Greenwood Press, 1991), 254-256.

11. On early radio transmitters the condenser was a system of conducting and insulating materials used to store electrical energy.

12. George H. Clark to Lieutenant Commander Cleland Davis, 12 June 1909, box 293, History of Naval Radio (Series 100), George H. Clark Radioana Collection, Archives Center, National Museum of American History, Smithsonian Institution, Washington, D.C. (hereafter cited as CC/100). Clark does not specify STINGRAY's location during the tests, but she likely received these messages while moored.

13. Ibid.

14. George H. Clark to BuEq, 13 June 1910, box 293, CC/100.

15. Ibid.

16. The acronym TRITON stands for Tactical Relay InformaTIOn Network. Assistant Secretary of Defense Press Release, 24 September 2010, http://www.defense.gov/contracts/contract.aspx?contractid=4374 (viewed 31 May 2011), and "Lockheed Martin Awarded $35.8 Million Navy Contract to Expand Submarine Communication Capabilities," 3 February 2009, http://www.yourdefencenews.com/news_item.php?newsID=22894 (viewed 31 May 2011).

17. Archival records show that a civilian inventor proposed a floating-buoy antenna to the Navy in 1912, but the service found it operationally impractical. Engineer Officer to Commandant [New York Navy Yard?], "Re-method of installing radio telegraph antenna on submarine torpedo boats for operation after submersion," 22 May 1912, box 292, CC/100.

18. D. Pratt Manney, "Report on Tests of Two Methods for Radio Communication from a Submerged Submarine," 30 November 1915, box 293, CC/100.

19. At the time of these tests antenna radiation generally was expressed in amperes rather than watts.

20. D. Pratt Manney, "Report on Tests of Two methods for Radio Communication from a Submerged Submarine," 30 November 1915, box 293, CC/100.

ETERNAL PATROL

CAPT Edward Clausner, USN(Ret)

CAPT Joseph G. DiGiacomo, USN(Ret)

CAPT Ralph L. Enos, USN(Ret)

CAPT James P. Forsyth, USN(Ret)

LCDR Phillip B. Kinnie, USN(Ret)

CDR John F. Kubovchik, USN(Ret)

Mrs. Sidney Elizabeth Donelson Meyer

RADM Maurice "Mike" H. Rindskopf, USN(Ret)

PERSPECTIVES OF SUBMARINE LEADERSHIP

By Dr. Edward Monroe-Jones, LCDR USN(Ret)

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Job competence has proven to be the one indispensible factor of submarine leadership. Whatever leadership qualities a submarine commissioned officer or petty officer may have possessed, they counted for little if the person lacked a level of competence, that by itself was worthy of admiration.

Leadership has been the subject of analysis by psychologists and executives in the military and private industry. The many-sided subject has often taken on the particular bias of the person claiming to have discovered the true nature of what makes a good leader. Most such pundits have spoken of personal charisma as an essential element of effective leadership. Charisma has defied real definition, but has been most often referred to in terms of a supervisor's charm which generates a positive feeling by subordinates toward the supervisor. One authority suggested that a profound belief in one's own power produced an irresistible charm and grace.[1] Robert House, Ph.D., stated that, "Charismatic leaders exhibit greater self-confidence, persistence, determination, passion and optimism than their run-of-the-mill counterparts."[2]

This description might have fit a Second World War German submarine commanding officer who displayed the quality of supreme self confidence, but who failed the test of competency and became a model of ineffective leadership which ultimately led to his death. Peter Zschech had served with the famous Jochen Mohr in U-124. He became commanding officer of U-505 and went aboard with high expectations of himself. Hans Goebeler, a crew member, described his new captain as follows, "Zschech also seemed very eager, perhaps a bit too eager, to get at the enemy. He actually had the cheek to criticize his mentor, Jochen Mohr for being too timid. This we took with a grain of salt since Mohr was universally regarded as one of our greatest U-boat commanders. We suspected Zschech had a bad case of *Halsschmerttzen*, or *sore throat*, a condition common to many young officers and one that could only be cured by wearing a Knight's Cross around the neck.[3] Later, Goebeler saw his captain going to pieces, "Our skipper seemed especially troubled by our situation. With each malfunction, Zschech's behavior became more erratic, alternating between morose introversion and sadistic outbursts of aggression.[4]

Equating charisma and real leadership is overly simplistic. Dr. House's prescription falls short of applicability to submarines. Practical-minded officers and petty officers who have been submarine crew members have tended to trust their own experience in identifying persons who were looked upon as, *good leaders* or *ineffective leaders*. The problem of such a practical approach has been the difficulty of pin-pointing those qualities or behaviors that have contributed to the person's reputation. Were they born leaders or were they what the Navy produced by training? The Navy has traditionally assumed that any competent submariner could learn the skills and attributes of a good leader. In effect, a submarine officer/petty officer who articulated with subordinates in a pre-defined manner would be regarded as having the qualities of good leadership.

The 2004 Secretary of the Navy, Gordon England, addressed this issue within the United States Naval Academy's Forrestal Lecture Series. He identified key leadership concepts which appeared in the Spring, 2004 issue of Undersea Warfare.[5] His speech continues to be applicable to submarine officers and is particularly poignant as changes in Submarine Force mission demand ever more command competency. The honorable Mr. England suggested 15 specifics that represented the framework of leadership in submarines. They are paraphrased as follows:

1. Provide an environment for every person to excel.
2. Treat every person with dignity and respect.

3. Be forthright, honest and direct.
4. Improve effectiveness to gain efficiency.
5. Respect the time of others.
6. Identify the critical problems that need solution for the organization to succeed.
7. Describe complex issues and problems simply.
8. Never stop learning.
9. Encourage constructive criticism.
10. Surround yourself with great people and delegate to them full authority and responsibility.
11. Make ethical standards more important than legal requirements.
12. Strive for team-based wins.
13. Emphasize capability, not organization.
14. Incorporate measures and metrics everywhere.
15. Concentrate on core functions and outsource all others.

The Secretary's comments were in answer to questions coming from submariners who looked for some behavioral-changing axioms; however, his constructs were open to variable interpretation in their application to the submarine environment.

In contrast to the Secretary's suggestions were those of a Second World War German submarine officer who advised his prospective commanders to look at leadership from the perspective of day-to-day problems peculiar to the lives of submariners. Wolfgang Lueth's (spelled Lueth, providing for the umlauted u) practical applications were of value at a time when submariners endured living conditions much more severe than modern American submarines. Never-the-less, his suggestions may have merit when looking at the historically illusive subject of leadership in submarines.[6]

While receiving the oak leaves, swords and diamonds to his Knight's Cross from Adolf Hitler, Lueth, the second highest scoring U-boat skipper, was asked the secret of his success. Lueth's reply was, "I care about my men." Lueth was a remarkable submarine commander, having sunk 47 Allied ships for a total of 225,756 tons had commanded U-13, U-9, U-138, U-43 and

U-181 before being assigned as commandant of the Marineschule-Muerwik in 1943. History would have been denied Lueth's insights, were it not for a lecture he gave on 17 December, 1943.[7]

The lecture to prospective commanding officers of U-boats was intended to illustrate the behaviors of effective submarine leadership. It dwelled on the two dimensions of submarine warfare; boredom and stamina to withstand the pressures of undersea combat. He described submarine warfare as a war of nerves, not only from depth charging, but the isolation from the outside world which demanded much of a man's sanity. Lueth's suggestions were essentially a check-list for submarine leadership taken from his experience as commanding officer of several type IX German submarines. Paraphrasing his lecture, he said,

"Life aboard a submarine on patrol lacks the natural rhythm of life on land. Sleep cycles are set by the submarine's routine and have no relation to day and night. These demands also produce dependency on caffeine in strong coffee for stamina in watch standing. Smoking's narcotic affect together with coffee are most adverse when fatigue from lack of sleep drains men's alertness. Lack of exercise in confined living, together with a limited diet produce long-lasting physical problems."

These ailments have subsequently been well-recognized by submarine physicians, but in Lueth's day every man was expected to deal with boredom, constipation, fatigue, skin problems and lack of hygiene as a part of being a stalwart submariner. In combating these conditions Lueth saw the importance of discipline, sense of mission, daily routine, officer attitudes, and spiritual leadership as key to a boat's success.

He continued his address, "Discipline and punishment for infractions or incompetence is a matter of the special conditions brought on by life in a submarine. For example, withholding leave or liberty is not appropriate since the time laps between the infraction and punishment is too great. A number of bunkless days where the steel plates of the torpedo room are most inhospitable brings home the point far better. The errant seaman may be assigned to sorting rotten potatoes, or cleaning bilges. The worst is to place a man "in Conventry" for a week or so and this peer pressure is far more severe than withholding pay or liberty.

Antithetical to today's views was his suggestion that a man's infraction and punishment should be known to the crew. This information was to be placed on the bulletin board and in the ship's paper. But, Lueth's over-riding concept to prospective commanding officers was to prevent a condition that might lead to incompetence, an error in judgment, a lack of alertness or other action or lack thereof which might place the submarine in jeopardy. Punishment was intended to educate. According to Lueth, when each crew member knows his responsibility to his fellow submariners, each man becomes a leader in his own right. To this end, he proposed the following tenets of a commanding officer's discretion: As he used his fingers to emphasize each concept:

1. "Insist that watches be relieved on time. It is a matter of personal honor."
2. "Respect includes recognition of the captain when he enters a compartment."
3. "Lookouts may be allowed to talk while surface cruising providing alertness is maintained."
4. "Let the crew share in the mission's success. Pass the word as to what's up tactically to every man in the crew."
5. When a job is well done, create a ceremony to recognize a man's or team contribution."
6. "Share the bridge with off-watch crew members not normally involved in the central operation of the boat."
7. "Keep a well regulated daily routine without too much regimentation. Leave a little slack for spontaneity."
8. "A man's bunk and sleep time are inviolable except in emergency."
9. "Evening half-hour of crew member-created entertainment is a morale booster."
10. "Holidays are occasions for special events and recognition. Preparation is the focus of the fun."
11. "Keep a clean ship. Saturday is devoted to clean sweep-downs."

12. "Daily CO conferences with key petty officers keep the CO aware of brewing problems."
13. "Keep a reign on poor taste, be it profanity, pornography or sense of humor."
14. "Insist on courtesy in the wardroom, crews mess and passageways."
15. "Give the officers access to the wardroom so they can grumble about the captain in private."
16. "Test diving officer and conning officers by asking "what-if" questions pertaining to emergency procedures."
17. "Keep calm under the most trying circumstances."
18. "Hold tournaments and competition—singing, chess, etc.—give prizes such as a day off without duty."
19. "Recognize birthdays in the crew's mess with first servings."
20. "Give lectures and classes on nautical issues that all seamen should know."

Elsewhere in the speech Lueth made more subtle suggestions

1. "Listen to the gripes of your crew and take action when necessary."
2. "Organization for its sake is of little value. Concentrate on performance improvement."
3. "Make every subordinate feel indispensible to the mission of the submarine."
4. "Never compromise your ethical standards. Expect your subordinates to live their lives ashore within the reasonable bounds of Naval tradition.
5. "Let your subordinates know where they stand in your judgment of their performance. A 'Well done' is all that is needed."

While much of Wolfgang Lueth's suggestions may have been vested in the peculiar demands of the German submarine service, his comments should not be ignored in an examination of submarine leadership history.

ENDNOTES

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5. The title of the lecture by the Honorable Gordon England was, Principles of Leadership for the U.S. Submarine Force.
6. Vause, Jordan, U-Boat Ace, the Story of Wolfgng Lueth, U.S. Naval Institute Press, Annapolis MD, 1990, p. 197-210.
7. www.uboatarchive.net/luethlecture.htm

SUBMARINE NEWS FROM AROUND THE WORLD

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<u>*From the May 2011 Issue*</u>

INDIA—Shishumar (Type 209/1500) Class Submarine: In early April 2011, AMI received information that the Indian Navy (IN) is considering further upgrades to the four Shishumar class submarines built in Germany and India from 1982 through 1992. This will be the second modernization effort for these submarines as the IN will need to retain this four-unit force in service as a result of the continuing delays of their replacements the Scorpene class that is currently being built in India.

Source indicates that the IN is in consultations with Germany (probably ThyssenKrupp Marine and Siemens) for the modernization effort that will probably take place in Germany and India's Mazagon Dock Limited (MDL). The IN is currently considering the following work package for all four units of the class:

- Addition of a Siemens Air Independent Propulsion System (AIP).
- Overhaul of diesel engines and generators.
- Hull maintenance.
- Replacement of batteries.
- Installation of a new or modernization of the existing periscope system.
- Complete the installation of the Thales TSM 2272 sonar.
- Installation of the Naval Physical and Oceanographic Laboratory (NPOL) active towed array sonar (ATAS).

If this program moves forward, and it probably will, the first unit could enter dry dock as early as 2013 with all four units being complete by 2017. The second modernization effort will extend the service life of the Shishumar class to around 2024 when the Scorpene class should be in service in appreciable numbers.

TURKEY—Ay Class Submarine: In mid-February 2011, AMI received information that Savunma Teknolojileri Muhendislik (STM) was selected as the prime contractor for the modernization of the two Ay class submarines, DOGANAY (S351) and DOLUNAY (S 352).

On 30 March, STM signed an agreement with Carl Zeiss Optronics for the delivery and installation of two SERO 250-A attack periscopes, two SERO 250-S search periscopes, an inertial navigation system (INS) and electronic support measures (ESM) system. The first unit could begin its overhaul by the end of 2011, followed by the second unit in 2012. The weapon control system will also be upgraded to work with the Mk48 ADCAP torpedoes as part of a separate contract.

STM's contract with the Turkish SSM also calls for the option for two additional submarines at a later date. However, the four remaining units of the class were commissioned from 1976 through 1981 and will be the first units replaced by the new construction Type 214s, indicating the options may not be exercised.

BRAZIL—Tupi (Type 209/1400)/Tikuna (Type 209/1450) Class Submarines: In March 2009, the Brazilian Navy (BN) signed a contract with Lockheed Martin (LMCO) for the modernization of the Tupi/Tikuna classes. The Foreign Military Sale (FMS) contract was for LMCO to upgrade the combat management, sonar, fire control and weapon launch systems.

A total of six Integrated Combat Systems will be delivered to cover the four Tupi class, one Tikuna class and one shore based trainer.

Major modifications will include:

- Hull, mechanical and electrical (HM&E) work
- Replacement of the batteries
- Upgrade to the Atlas Elektronik CSU-83/1 sonar
- Installation of a new communications system
- Installation of an indigenous fire control system
- Upgrade to the Thales DR 4000 electronic support measures (ESM) system

- Upgrade of the navigation system
- Replacement of the BAE Systems Tigerfish torpedoes with the Raytheon Mk 48 Mod 6 ADCAP Torpedo

Work began on the first unit, TAPAJO (S33), at Arsenal de Marinha Naval Shipyard in 2009 and is expected to be completed by the end of 2011 and followed by the remaining three units of the Tupi class and one Tikuna class through 2016.

From the June 2011 Issue

UNITED KINGDOM—Initial Gate Approval for Future Ballistic Missile Submarine (SSBN) Program

On 18 May 2011 the United Kingdom's Defense Secretary Dr. Liam Fox, formally announced Initial Gate Approval for the Successor Nuclear Deterrent Submarine Program (AMI Program Title: "Future Ballistic Missile Submarine—SSBN"). The approval included up to US$4.9B in authorized spending for further design development work for the future submarine.

Although additional design work has been approved the decision to build or not to build (Main Gate Approval) is not scheduled until 2016. It must be noted that the UK and the US are currently collaborating on the design of a Common Missile Compartment (CMC) for their respective Future SSBN Replacement Programs. Main Gate Approval would include approval for a more detailed design and as well as authorizing procurement of long lead construction items to enable the first hull to enter service by 2028.

Currently, the UK is planning for at least three new SSBNs to provide a Continuous-At-Sea Deterrence (CASD). An option for a fourth hull will be reviewed at the Main Gate decision in 2016. There appears to be current support for the 4th SSBN hull in most UK government departments concerned with the program.

In late February 2011, press reporting indicated that Fox supports a four-SSBN force, with a fall-back option of a three hull program depending on funding. A CASD will require at least one unit to be on continuous patrol with the others in varying stages of overhaul and training. If the hull count is reduced to three, it would probably be difficult over the long-term for the UK to maintain a CASD, suggesting a near continuous capability may be an acceptable posture for the UK SSBN force, especially in light of continued pressure to cut defense spending.

At any rate, Main Gate Approval in 2016 means that the final decision on the number of SSBN hulls to be built will be made on someone else's watch.

Regardless of the hull count, each of the successor SSBNs will have fewer missile tubes, probably 12, compared to the 16 on the current Vanguard class. The smaller missile bays envisioned for the future SSBN is also consistent with anticipated reduction of the total at-sea warhead count from 200 to 160—that reduction is already underway. The UK will continue using the Lockheed Trident II (D5) slated to remain in service until around 2042.

The UK's successor SSBN program schedule is dovetailed with that of the US Ohio class SSBN Replacement Program (AMI program title: "Future Nuclear Powered Ballistic Missile Submarine – SSBN-X"), which passed Milestone A on 04 February 2011. Milestone A approval enables the program to enter the Technology Development Phase (TDP). The TDP is expected to deliver a final design for lead ship construction beginning in 2019. The US version will replace the 14 Ohio class SSBNs with only 12 units and each unit have only 16 missiles vice 24 found in the Ohio class.

With Main Gate Approval in 2016, the UK (first of class (FOC) commissions 2028) and US SSBN (FOC 2025) replacement programs continue to share a common timeline that will enable both navies to execute acquisition strategies that will rely on a CMC developed for both sub designs. The CMC will house the Trident II (D5) as well as the follow-on submarine-launched ballistic missile that is scheduled to enter service after 2042.

BRAZIL – Submarine Force Requirements Growing

In late May 2011, AMI received information that the Brazilian Navy (BN) has established a long term Submarine Force structure goal of 20 total units in service by 2040. This goal is ambitious considering Brazil currently operates a sub force of only five units.

Within the 20-unit force, the BN has indicated a requirement for six nuclear powered attack submarines (SSN) and 14 conventionally powered submarines (SS). These force levels are based on the BN's vision of becoming the largest, most sophisticated and capable Submarine Force in South America by mid-century.

The Brazilian Navy's current in-service inventory, plus the programmed new subs in the PROSUB program through 2025 include the following:

- Five Tupi/Tikuna (based on the German Type 209) class in service. All five will be modernized in a program currently underway.
- Four PROSUB Scorpene design submarines projected to be in service by 2021.
- One PROSUB nuclear-powered submarine (SSN) based on a French/Brazilian design to be completed around 2025.

Considering the current BN sub force level and projected acquisitions under PROSUB, the BN will still need to build five additional SSNs and five conventional boats to meet its minimum 20-hull requirement by 2040. This is an ambitious, yet achievable goal if the original PROSUB program delivers its four Scorpene hulls and single SSN on schedule and budget.

The PROSUB units will be completed and operated from the new facility under construction at Itaquai (around 30 miles south of Rio de Janiero). The facility will be able to operate up to six nuclear-powered and four conventional submarines. The yard will be divided into the construction sector, where two submarines can be built simultaneously and a maintenance sector, which includes two dry docks.

Assuming the building schedule for the PROSUB Program remains on track, five additional SSNs could be ordered immediately following trials of unit one if funding is readily available. AMI estimates that the nuclear versions could cost between US$1B and US$1.3B per unit (Brazil claims follow-on units at US$500M) requiring US$5-6B from 2025 to 2038. In regards to the five additional conventional units, the BN could continue with the Scorpene design for a class of nine total units.

As an alternative, the sea service could modify the Scorpene hull or design a new conventional submarine as it will also have to begin replacing the Tupi/Tikuna classes immediately following the acquisition of the nine unit Scorpene (or alternative design) class by around 2035. The five additional units for the conventional hulls could cost an estimated US$600M per unit or around US$3B for the entire program.

It appears that the BN has set a lofty goal of building and maintaining a Submarine Force of six SSNs and 14 conventional boats. In a perfect world, the new facility being built at Itaquai appears to be capable of building and maintaining a large Submarine Force. In reality, an uninterrupted funding and construction flow lasting up to three decades, will be much harder to attain.

PHILIPPINES—Increasing Activity in Naval Procurement Programs

In light of the recent public disputes between the Philippines and China on Chinese maritime activities in areas of the South China Sea where sovereignty is in dispute, the Philippine government is giving greater emphasis to expanding its Navy. AMI continues to receive information from various sources indicating that the Philippine Navy (PN) is again working to advance a series of new and used naval procurement programs under the existing *Sail Plan 2020*.

PN sources indicate that these programs are to be funded under the Capability Upgrade Plans (CUP) 2011-2016 and 2017-2022. In early April 2011, President Aquino authorized US$220M for additional equipment purchases beyond the recent acquisition of the US Coast Guard cutter HAMILTON (WHEC-715). The US$220M funding is probably for 2011 and 2012 with additional funding annually for the rest of the current CUP (2016) and the next (2017-2022).

Programs currently being discussed by the PN are:

- Three new build platform landing docks (LPDs) in 2012.
- Two new construction 1,000-ton offshore patrol vessels (OPVs) beginning around 2014.
- Two diesel submarines (likely used), with the first delivering by 2020.
- Up to eight additional used US Coast Guard cutters, possibly Hamilton class High Endurance Cutters, coming available as Excess Defense Articles from 2012 through 2016.

In April and May 2011, senior officers of the PN indicated that the sea service would spend up to US$100M for the acquisition of three LPDs from Indonesia. PN officers have inspected the Indonesian Makassar class LPD built by Indonesia's PAL naval shipbuilding based on a Daesun/DSME design. However, Philippine officials indicated that the LPDs would need to be significantly different compared to those delivered to the Indonesian sea service. PAL Shipbuilding did develop a smaller LPD design that is similar to the Makassar and is probably the design being offered to the PN.

Assuming negotiations are completed in the near term, it appears the PN has the funding and high-level political support to move these programs forward. And for the LPDs, building space is available at PAL following the delivery this year of the last Makassar to the Indonesian Navy.

In regards to the new construction 1,000-ton OPVs, the PN is currently considering the procurement of these vessels through a US Foreign Military Sale (FMS) Program. The US Naval Sea Systems Command (USNAVSEA) released a Request for Information (RfI) in May 2011 in order to conduct market research for interested parties in building two new construction vessels in the Philippines. The complete RfI can be found on the Federal Business Opportunities Website at:

https://www.fbo.gov/index?s=opportunity&mode=form&tab=core&id=92b18bf0277f876bd0e92e06a771fc55&_cview1

Solicitation Number: N0002411R2217.

The OPV program is in the very early stages and could be several more years before details of design and construction are determined. It could be at the end of this CUP (2011-2016) before funding is available, although the PN could receive some of the OPV funding through US military assistance.

The PN is also interested in procuring up to eight Coast Guard Hamilton Class High Endurance Cutters through the FMS Excess Defense Articles (EDA) process. The PN took delivery of the first Hamilton (WHEC-715) on 01 June at a cost of US$24M for refurbishment. The sea service is also considering the USCGC DALLLAS (WHEC-716) and the USCGC GALLATIN (WHEC-721), both scheduled for decommissioning by the end of 2011 and probably available under the same terms.

AMI believes that the PN will attempt to go beyond the DALLAS and GALLATIN and procure as many Hamilton class WHEC as possible due to their low cost.

The submarine program for the PN will not occur until around 2020, although PN officials are calling submarine procurement sooner than that. The submarine acquisition is listed in Sail Plan 2020, but it will be difficult at best for the sea service to obtain new construction submarines. Like the Royal Thai Navy (RTN), the PN is likely to turn to the used submarine market for its initial capability. A Submarine Force will entail significant commitments for training and maintenance as the PN has never operated submarines and has no infrastructure to support them. A new build sub program would cost around US$1B (including infrastructure), putting it virtually out of reach for the Philippines.

AMI believes that these programs are again at the forefront due to continuing friction with China in the South China Sea, continuing battles with the Abu Sayef terrorist group in the country's southern islands and lack of preparedness for natural disasters that plague the archipelago. There now appears to be a commitment from President Aquino to move forward with new equipment for the PN, however, one must be reminded that the Armed Forces of the Philippines (AFP) began its overall modernization effort under the Armed Forces of the Philippines Modernization Program (AFPMP) that began in 1996. Since that time, procurement funds, more times than not, have shifted to other priorities to the detriment of the PN.

GREECE—Programs and Shipyard Update

Throughout May and June 0211, AMI sources in various European locations have provided the following information to update the ongoing naval shipbuilding situation in Greece as well as the prospective financial viability of Greek naval shipyards.

The sale of Hellenic Shipyard (HSY) to Abu Dhabi MAR (ADM) has not been completed; various disputes between the parties involved make any final conclusion of the arrangement unlikely in the short term.

Elefsis Shipyard has received temporary support from the Greek Government in order to prevent bankruptcy. However, if the Government intends to recoup its investment, it is possible that the shipyard will need to be sold at a later date and/or additional work will be needed to keep the yard solvent.

These developments have put every Hellenic Navy (HN) shipbuilding program in jeopardy. Below is a synopsis of the three major programs and their current status:

TYPE 214 Submarines: On 16 May 2011, the Greek Minister of National Defense, Prof. Dr. Evangelos Venizelos, announced that German shipbuilding group Howaldtswerke-Deutsche Werft (HDW) has pulled out of the program to build two follow-on units of the Type 214 class submarine at HSY.

Venizelos explained that HDW bowed out of the subcontractor deal due to *major disagreements* concerning broader project co-operation in Germany between ThyssenKrupp Marine Systems (TKMS) and ADM. The contract called for the construction of two new Type 214 diesel-electric submarines and the overhaul of an older Type 209 submarine at the Greek shipyard in Skaramagka, located a few kilometers west of Athens.

It is believed that there will be new discussions at some point and these deliberations will address payment and appropriate security clauses that are agreeable with all parties involved. Without TKMS involvement (German licenses and material packages) HSY and ADM will not be able to proceed with the construction of the Type 214s at the yard let alone coming up with a final solution for ADM's purchase of HSY.

VARIOUS DID YOU KNOW?

United States—On 20 May 2011, the keel for the USN 10^{th} Virginia class submarine, USS MINNESOTA (SSN 783), was laid at Huntington Ingalls Industries Newport News Shipyard in Virginia.

THE SUBMARINE COMMUNITY

REAR ADMIRAL MAURICE "MIKE" H. RINDSKOPF 27 SEPTEMBER 1917 – 27 JULY 2011

Navy Cross, Distinguished Service Medal, Silver Star, Legion of Merit, Bronze Star, Navy Commendation Medal

Today we pay our respects to a Submarine Force pioneer and hero. Rear Admiral Maurice "Mike" H. Rindskopf passed away on July 27, 2011. A World War II Commanding Officer, he helped to herald a new era of submarine warfare and forged many of the traditions the Submarine Force observes today. Born on September 27, 1917, in Brooklyn, New York, he entered the U.S. Naval Academy in 1934 at the age of 16. After receiving his commission in 1938 he reported to the battleship USS COLORADO (BB-45) for two years. In 1940, he completed submarine training and reported to the new fleet submarine, USS DRUM (SS-228). After nine war patrols, he assumed command of USS DRUM and, at the age of 26, completed two more patrols as the youngest Commanding Officer of a fleet submarine in the pacific. USS DRUM was credited with sinking 15 enemy ships and damaging another 11 for a total of 80,000 tons. After World War II, RADM Rindskopf assisted in the development of modern submarine fire control and tactics. During the Cold War he commanded two submarine flotillas and pioneered the concept of hydrofoil craft while directing harbor defense for the Navy and also served as Director of Naval Intelligence. RADM Rindskopf retired from active duty in 1972 and continued to lead an extremely active life serving the Naval Academy and the Annapolis Community. I have appended a very nice article from the ANNAPOLIS CAPITAL, as well as his obituary, below. I had the privilege of meeting RADM Rindskopf at the last two Submarine Birthday Balls at the Naval Academy. In 2009, he was invited to the podium to say a few remarks, and proceeded to give one of the most inspirational speeches I have heard - extemporaneously! He was a true officer and gentleman, and will be sorely missed from our ranks. Please take a moment to observe the passing of RADM Mike Rindskopf, a submarine legend and hero on eternal patrol. Our thoughts and prayers will be with his family as they navigate this challenging time.

Very respectfully, VADM John Richardson, USN

The following appeared in the ANNAPOLIS CAPITAL, 31 JUL 11 by Tina Reed.

'This Guy Was A Real Hero' Rear Adm. Rindskopf sank 15 enemy ships, served community.

Best known for being the youngest officer in history to command a submarine, Annapolis resident and retired Navy Rear Adm. Maurice Rindskopf died Wednesday after a short illness. He was 93. Rindskopf is remembered for his leadership and his contributions to the community long after he retired from the Navy. In 2007, he received the elite honor of being named a Naval Academy Alumni Association Distinguished Graduate, placing him among ranks that include a president, a Super Bowl champion quarterback and an astronaut. "This guy was a real hero," said Retired Adm. Leighton W. Smith Jr., who was honored as a distinguished graduate the same year Rindskopf received the honor. "You can't say enough about him as an officer, as a gentleman, as a businessman, as a friend, as a person who contributed and who had such a love for the Naval Academy." Rindskopf came to the Naval Academy as a 16-year-old in 1934. After being commissioned four years later, he soon was assigned to USS DRUM, a submarine stationed in the Pacific Ocean. He was soon at war.

And when the submarine's commanding officer suffered an attack of gallstones, Rindskopf found himself commander of the sub at age 26. He led patrols in the Pacific and was responsible for sinking 15 enemy ships and damaging 11 others. He later was a leader in antisubmarine warfare during the Cold War and eventually became the director of Naval Intelligence. After retiring in 1972, Rindskopf and his wife, Sylvia, moved to Severna Park and he began working as an international marketing manager for Westinghouse. He also became active on county and state library boards. He put so much preparation and dedication into activities such as the Anne Arundel County Public Library Board of Trustees that president Joan Beck said she had no idea how distinguished a background he had. Beck said she was floored when she learned what he'd accomplished during his Naval career. "I guess the troubles you'd face on the library budget committee are quite small compared to commanding a submarine," Beck said. Rindskopf was never one to boast about his record, but dedicated time trying to positively influence young people and give back to his community, Smith said. He was instrumental in creating a Class of 1938 endowment to support an annual forum to train midshipmen about being leaders in the military and the civilian world. "The way he lived his life, he was such a balanced individual that really made him a role model for others," Smith said. "We may never know how many lives he influenced. That's his legacy." Sylvia, his wife of 68 years, died last March. Together, they'd traveled throughout his career to duty stations in Washington, Long Beach, Calif., and New London, Conn., and overseas to Panama, Hawaii and Naples, Italy. Friends say Rindskopf was heartbroken by the loss of his wife. Rindskopf's only granddaughter, Amy Rindskopf, remembers well the stories she'd hear from her grandfather.

"I remember as a kid, he'd take me to the Naval Academy to skate there or to a basketball game," she said. He'd tell stories about commanding "the DRUM" and how it was the first submarine to reach Pearl Harbor after it was attacked by the Japanese in 1941, she said. Just this past winter, Amy Rindskopf said she was her grandfather's date to the annual Submarine Ball. He energetically introduced her to handfuls of people. "He just loved to be involved," she said. She was in Annapolis last week and said she was struck by a common theme about her grandfather as she went through what people wrote in some of his old yearbooks. "Everyone said he was well-liked, easy to get along with. It's a very special gift he had," she said. "He really believed if you are going to do something, you should do it right." A funeral service was held at 9 a.m. on 1 August at the Levy Chapel of the Naval Academy. Rindskopf's ashes will be scattered from a submarine in the Pacific Ocean.

RINDSKOPF, MAURICE HERBERT Rear Admiral Maurice H. Rindskopf USN (Ret.) passed away on July 27, 2011, at BayWoods of Annapolis after a short illness. He was predeceased by his wife of 69 years, Sylvia Lubow Rindskopf in 2010, and by his only son Peter Eric Rindskopf, Yale University (1964) and Yale Law School (1967) in 1971. He is survived by his granddaughter, Amy Kathryn Rindskopf, her husband James V. Schultz, and two great grandsons, Jasper and Ian Schultz of Winchester, MA, and by his daughter-in-law, Elizabeth Rindskopf Parker of Sacramento, CA. Memorial contributions may be made to the Poly Prep Country Day School, 9216 Seventh Avenue, Brooklyn, NY 11228.

ADMIRAL RICKOVER: THE FATHER OF NUCLEAR POWER

A Ninety-Minute Documentary Film for Public Television

Manifold Productions is producing a documentary film about Admiral Hyman G. Rickover for PBS national broadcast. This is the first and will be the definitive film biography of this important American. We have the active support of the Navy and especially the Nuclear Reactors Division.

Please help us find material to tell the story of Admiral Rickover's life, especially his personal side. We are looking for anything visual (or audio) such as home movies, snapshots, films, videotapes, audiotapes or photos—but not letters and documents. In addition to material featuring the admiral himself, we are seeking material on any of the projects he worked on or his co-workers. For example, we would love home movies or candid snapshots of office parties or life on board the submarines or surface ships he worked on, beginning with USS NAUTILUS, especially during sea trials or Admiral Rickover's visits.

Most readers probably know the outlines of Admiral Rickover's dramatic story: he harnessed the power of the atom to drive the first nuclear-powered submarine, USS NAUTILUS, whose trip under the polar ice pack was one of the great adventure stories of the 1950s. Later, Rickover built the world's first commercial nuclear power plant at Shippingport, PA.

Many questioned Rickover's goal of a nuclear Navy, however, few contested that he had transformed the Navy and much of U.S. industry, and changed the course of America's technological development.

Today, questions about nuclear power have risen again. To understand these issues, consider the story of the man who created the nuclear Navy as well as the civilian nuclear power industry, Hyman Rickover.

We have assembled a distinguished Board of Advisors including: Admiral Bruce DeMars, USN (Ret), Richard Hewlett, Richard Rhodes, and Admiral James D. Watkins, USN (Ret). Theodore Rockwell, who is also the executive producer, chairs our board. He served as Admiral Rickover's technical director in the 50s and 60s and is the author of *The Rickover Effect: How One Man Made a Difference* (Naval Institute Press, 1992). Michael Pack is the producer/director. He is the founder and president of Manifold Productions and has been producing award-winning documentaries since 1977.

Those who provide materials used in the film will be thanked in closing credits and all items will be returned to senders.

Please contact Nina Ing at 301.941.0445 or
ning@manifoldproductions.com

REUNION

USS STERLET (SS392)
November 9-13 2011 Tucson Arizona
Arizona Hotel contact Richard Jarenski YN1(SS) at
rjarenski@aol.com
or 520 850 1437

LETTER TO THE EDITOR

The SCORPION Story How She was Lost by CAPT C. McDonald conjectures SCORPION was lost because of the explosion of a torpedo battery. That conjecture is not supported by the following:

- Imagery of the wreckage that indicates the bow-section containing the torpedo room is relatively intact compared to the area of the operations compartment (above the main battery well) which was essentially destroyed (disintegrated).

- The conclusion by the Portsmouth, New Hampshire, Naval Shipyard investigative team that conducted microscopic examination and spectrographic and X-ray analysis of a recovered SCORPION main battery component to determine, as reported by the SCORPION Structural Analysis Group (SAG) in their official report of 29 January 1970 (Section 7.1.3, page 7.2), that "the general battery damage is violent. The high velocity intrusion of pieces of flash arrestors into both the inside and outside surfaces of the recovered plastisol cover attest to violence in the battery well".

Based on this conclusion by the Navy's leading authorities in the fields of submarine structures, submarine design and the effects of underwater explosions, respectively, Peter Palermo, CAPT Harry Jackson and Robert Price, the authors of the SAG Report, the conjecture that SCORPION was lost because of the explosion of a torpedo battery should be rejected.

Bruce Rule
Louisville, KY

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THE SUBMARINE REVIEW

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Articles for this magazine will be accepted on any subject closely related to submarine matters. Article length should be no longer than 2500 to 3000 words. Subjects requiring longer treatment should be prepared in parts for sequential publication. Electronic submission is preferred with MS Word as an acceptable system. If paper copy is submitted, an accompanying CD will be of significant assistance. Content, timing and originality of thought are of first importance in the selection of articles for the **REVIEW**.

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