THE SUBMARINE REVIEW

JULY 1991

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A Quarterly Publication of the Naval Submarine League

THE SUBMARINE REVIEW IS A PUBLICATION
OF
THE NAVAL SUBMARINE LEAGUE

NAVAL SUBMARINE LEAGUE • Box 1146 • Annandale, VA 22003 • (703) 256-0891

EDITOR'S COMMENTS:

For the April issue of **THE SUBMARINE REVIEW**, we identified **change** as the common highlight of the subjects presented. In many ways that condition of emphasis on general change will remain with us for the foreseeable future. That is the clear message of Admiral Jeremiah's remarks about the forces shaping the U.S. military and its tasks over the next quarter to half century. To a very real extent, however, the major theme for this edition of **THE SUBMARINE REVIEW** is concerned with the more specific subject of what is being done to face that change.

This theme is set by the reproduction here of the key addresses at the Annual Symposium. Those speeches treated the subject in general, and in one definite aspect, both explicitly and implicitly. It is quite clear that successful pursuit of the SEAWOLF building program is felt by Secretary Cann, Admiral DeMars and Vice Admiral Bacon to be essential to this nation's defense posture. It is equally apparent from the remarks of Admiral Jeremiah about both the required belt tightening and the necessity of being ready for the unpredictable future, that the Submarine Force needs the multi-mission flexibility, and the quick, efficient force response that the SEAWOLF class can offer to the National Command Authority in those uncertain times ahead. Our readers are urged to note Vice Admiral Bacon's request for help on this matter.

It was not the original editorial plan to present more than one of the Symposium addresses in this issue, but the uniquely complementary nature of those four main substantive presentations was felt to recommend to our readers an integrated consideration. Each of these speakers treats the problem of **Why Submarines, and Why the Best Submarines?** from his own vantage point -- and the points they make are those that we should be telling others about.

In addition to the Symposium addresses, two other articles address Submarine Force adaptability to change. Dr. Hogland's excellent piece on the relation of attack submarine requirements and capabilities was originally presented in May at the Submarine Technology Symposium, jointly sponsored by the League and Johns Hopkins University Applied Physics Laboratory. It was suggested that we reprint it in these pages because the

proceedings of that symposium will be classified and therefore not available to the many who can benefit from those insights. Captain Rad Plyler, in his piece about the strategic role in the future, describes the Navy's ongoing action to address the change coming in the strategic submarine force.

The emphasis, however, on the issues challenging the submarine community today, and for the near term future, is that they are very real problems and not just the subjects of learned discussion. Of the four main issues called out by Admiral DeMars -- the industrial base, force levels, the Soviet threat and the maintenance of U.S. maritime supremacy -- the first is very much in the national eye with the contract for the second SEAWOLF being contested in federal court. The force level issue is, of course, an underlying and perhaps a causative factor in what is really a dispute over how the nation shall handle the maintenance of critical forces. It is appropriate, therefore, that we devote more space than usual to the way in which the nation is perceiving both that issue and the submarine community in general. The In the News section is organized by issue and strives for two objectives: to give a clear picture of what is going on, and to demonstrate the wide interest being shown by the public in these important submarine matters.

Jim Hay

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FROM THE PRESIDENT

As this issue of THE SUBMARINE REVIEW goes to press, the glow of the very successful Ninth Annual Symposium is still very much with us. As a result of incremental adjustments over the years, and good old submarine feed-back of lessons learned, the Symposium has achieved a proper balance between the quality, diversity and significance of the formal presentations, and the pure enjoyment of reunion and socializing with old friends and shipmates. (Note: several attendees were heard to say, "If I just stand in one place, my whole life in submarines will pass before me.")

Our agenda read like a Who's Who in Submarines. We were privileged to hear directly from the movers and shakers of the submarine world their very frank and candid views and their assessments of the submarine future. There was good news and

there was bad news. We have published a sampling of those presentations in this issue. More will follow.

During the League business meeting, my Report To The Membership showed a sound financial condition, a healthy and growing chapter network, great support from our corporate benefactors, and clear evidence that the League, in a variety of ventures, is out delivering the "submarine message." As a challenge, I charged those present, and especially, the Chapter Representatives, with the task of increasing our membership. Like the mystical 3000 level of the Dow Jones Industrials, we need to break through and beyond the 4200 mark about which we have maintained a zero float for the past year. To that end, John Asher has accepted the Chairmanship of the Membership Committee. If you have ideas on this important subject, tell John.

The question has again been raised about the possible declassification of certain submarine special operations. Without exception, those operations remain classified and are not releasable to the public. You must assume that the personal security safeguards enacted for each operation remain legally (and morally) binding. I trust that message is clear.

On 5 June, 1991, the League hosted the "First Annual Great Submarine Debate" at our headquarters. We were privileged to have assembled in one room Admirals Bill Crowe and Carl Trost, Vice Admirals Chuck Griffiths, Al Baciocco, Ron Thunman, Al Burkhalter, and Dan Cooper, Rear Admirals Shap Shapiro and Jerry Holland, and several Captains of note. As moderator, I was tasked with keeping those *elephants* focussed on the theme of the meeting, "The Roles and Missions of the Submarine Force in the post-Cold War Era." The discussion was fascinating, and as you might imagine, if you get ten submariners in one room, you get eleven opinions. Jim Hay, who was our scribe for the event, is preparing a transcript which we will bring to you in future issues.

The Tenth Annual Submarine League Symposium will convene on 10 and 11 June, 1992. Please mark the dates on your calendar, and plan to join us.

Bud Kauderer

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ADDRESS TO THE NAVAL SUBMARINE LEAGUE NINTH ANNUAL SYMPOSIUM 13 June 1991

VADM Roger F. Bacon, USN
Assistant CNO, Undersea Warfare

Admiral Trost, Admiral Kauderer... ladies and gentlemen -- good morning -- it's a pleasure and an honor for me to address the Naval Submarine League Symposium, and I am pleased at the turnout. This symposium, which highlights the Submarine Force, has a solid reputation as an ideal forum for the exchange of ideas and information which will help support the Submarine Force as we approach the 21st century. I appreciate your support.

What a difference a year makes! Last year at this time, here at the Submarine League gathering, we were caught up in the events of the fall of 1989 and the end of the Cold War. The deficit was a fact of life, but the country's recession was just beginning. We had programs ongoing to build 28 submarines and no one had thought much about a tyrant called Saddam Hussein.

Since last June, our Navy has been a fundamental power for peace and freedom in the world -- in many ways that most of us could not have imagined just a year ago. Our Navy was the first to respond to the invasion of Kuwait on the 2nd of August last year. Navy air power was on scene and sea control was immediately established. I believe these factors were essential in deterring Iraq from continuing on into Saudi Arabia.

There were a number of Navy "firsts" in this conflict ... and to start our symposium, I wanted to review a few. A first that you should be aware of is the fact that for the first time since World War II, we had six carriers at war, at one time under one operational commander, and, at one point, four of the carriers operated within the Persian Gulf. During Desert Shield we had the quickest and the largest military sealift buildup since World War II -- an 8,000 mile, 250-ship shuttle from Atlantic ports to Saudi Arabia. The war saw the first F/A-18 combat use in both the fighter and bomber roles in one mission, and the first tandem deployment of two battleships since Korea ... with USS WISCONSIN and USS MISSOURI delivering tons of naval

gunfire on Iraqi targets. We saw a number of Navy firsts in high technology. We had the first combat launch of the TOMAHAWK cruise missile from surface and submarine platforms, and the first shots fired in anger from a U.S. submarine since World War II.

Yes, there were many new aspects of our modern Navy which were very successful in the rapid victory of Desert Storm. I think that we should be very proud of our military service men and women and I am pleased to see how the American public is supporting our sailors and troops by their victory celebrations and parades around the country.

We can be grateful for the successful conclusion of Desert Storm, but how many ocean storms or regional conflicts lie ahead?

The missions that submarines have traditionally been assigned -- ASW, ASUW, I&W -- are valid and will certainly remain so in the foreseeable future. However, today I want to provide some background on how and why we are evaluating continuing submarine missions and why there is increased emphasis on regional conflicts.

As we view the Submarine Force and its role within the Navy in support of the national objectives, there are several points I would like to make.

First, it is clear that the SSN-21 SEAWOLF class attack submarine is needed in the fleet as soon as we can get it to sea. SEAWOLF is the key, the blue chip, to maintain our undersea superiority over potential adversaries.

The margin of capability that we have enjoyed in the past has been significantly reduced by the quantity and quality of modern, quiet submarines being built by the Soviet Union. The Soviets have the world's largest submarine force, and they continue to modernize. Ten submarines were completed in 1990 alone. New Soviet submarine construction has continued unabated, and we expect new, more capable classes to be introduced in this decade.

SEAWOLF will be many times quieter than the improved 688, have improved combat systems, carry almost 40 percent more firepower, be deeper diving, more survivable and have significant margin for growth and improvements in the future.

SEAWOLF will maintain this nation's undersea superiority by regaining the margin we have lost and carry our Submarine

Force into the next century with a significant technological advantage. I need your help with this ship. Write or talk to your senators and congressmen. It is the only submarine program we have -- but due to the fiscal constraints, it is at a level of building only one per year. SEAWOLF is essential!

Next, as we contemplate future missions, it is evident that the role of our attack submarines, in a most uncertain world, is growing, not diminishing. For example, 13 submarines operated in support of Operation Desert Shield and Desert Storm. Some fired land attack TOMAHAWK missiles against targets in Iraq, while others conducted surveillance operations and provided valuable, real-time tactical intelligence for battle group commanders in support of the U.S. embargo against Iraq. Submarines have unique multi-mission capabilities that apply across a broad spectrum of possible conflict, and I believe that two principal advantages of nuclear powered submarines -- stealth and endurance -- will continue to be called upon as our nation addresses its role within the world community in the years ahead.

As we consider future missions, we must remember that a sufficient force of attack submarines is necessary to meet the challenges of the 21st century. Such a force cannot be sustained in the long-term by building only one SEAWOLF submarine a year. When LOS ANGELES Class attack submarines begin to retire in the next decade, we will be losing three ships a year and gaining only one -- ultimately, this will leave our maritime nation with a force of only thirty attack submarines by the year 2025.

To rectify this situation, in January the Chief of Naval Operations directed that we define options for a new, more affordable attack submarine. We are now a few months into a ten-year process, with personnel experienced in submarine operations and design evaluating key characteristics such as quieting, speed, depth, endurance, combat systems, weapons and launchers, connectivity, and special features. Once this phase of the characteristic study is completed, my office will evaluate ship parameters and direct R&D efforts.

As we evaluate the future of the Submarine Force, it is essential that we keep in mind that our strategic submarine nuclear deterrent force is also growing in importance. This fact is highlighted by the deployment of the TRIDENT II D-5

missile system in our Atlantic Fleet SSBNs. For over a year, these ships have been on deterrent patrol carrying the most advanced and accurate ballistic missile in the nation's arsenal. Combined with our survivability and connectivity, this system truly anchors the strategic TRIAD. This most formidable weapon will deter any potential adversary from engaging in nuclear aggression. The modernization of C-4 missile-capable TRIDENT submarines to D-5 capability has been delayed due to fiscal constraints. But we will continue to modernize the TRIDENT submarine force as we build the remaining ships to reach the goal of 18 TRIDENTs, 10 in Kings Bay and 8 in Bangor, Washington by 1998.

In his address at Aspen, Colorado last August, President Bush outlined a future defense policy which would be required to adapt to the significant changes in the world -- the end of the cold war. He said that our forces will be shaped by regional contingencies. The President's speech was significant in many areas. U.S. defense policy in the 1990s and beyond is based on four major elements: deterrence, forward presence, crisis response and force reconstitution.

The Submarine Force will continue to be a major force in each of these pillars of defense policy, building upon our present capability and adapting future technology to enhance our effectiveness and our versatility. Key to our deliberations on how best to prepare the Submarine Force for future challenges is aggressive pursuit of viable technological advances.

As President Bush said, "Time and again, we have seen technology revolutionize the battlefield. The U.S. has always relied on its technological edge to offset the need to match potential adversaries' strength in numbers."

That reliance has always been evident in submarine warfare -- outnumbered, independent operations, in waters controlled by the enemy, but always successful because we have the best people benefitting from the best technology.

As I mentioned earlier, Desert Storm was a conflict in which we saw the first shots fired in anger from a U.S. submarine since World War II. As we review the lessons of Desert Shield and Desert Storm, we can learn about the application of submarine technology and capability in future missions and assignments.

First, the inherent characteristics of my Submarine Force -- speed, mobility and flexibility, endurance, stealth and firepower are crucial and will be required in regional problems in the future. USS LOUISVILLE's overall transit speed was far greater than that which can be sustained by an entire battle group as she proceeded to her historic firing position in the Red Sea. USS PITTSBURGH demonstrated flexibility when her maintenance period at New London was cut in half and she sailed to the Med and remained on station for months waiting to strike. Operational flexibility and coordination involving water space management to support submarine operations was remarkable. And, of course, the firepower to strike key land targets portends the submarine role in future conflicts.

What we did NOT learn is the specific scenario for any future regional situation. I can't tell you where it might be, what political situation could generate the crisis, what Naval forces, if any, would be required or what submarine capability would be the best fit to support U.S. interests. I can tell you that the submarine or force of submarines will most likely be first on the scene of a problem and stay there throughout the crisis -- unknown to most.

I believe submarines will be called upon in the future to perform an increasing variety of missions. As the definition of the Naval battle space expands from hundreds of miles to thousands of miles, data transmission and connectivity will become even more important to the traditional roles of submarines, and open up additional areas where a submarine's stealth and mobility can enhance Naval power projection. We must shed the notion that a submarine is limited within its own acoustic, weapon, electronic and visual range of today's technology. Enormous efforts have been expended to increase the acoustic battle space of a submarine, much like the field of naval aviation's effort to get beyond visual range in tactical air combat. But, in a regional situation, off shore, a submarine should be able to improve and extend its capability to influence or impact events on land over that which exists today. Offboard devices, unmanned underwater vehicles will be key factors in improving our submarine battle space effectiveness in the years ahead.

As we look to the future, we must continue to improve our versatility and enhance our capability. We must keep an open

mind as we evaluate improved mission concepts to be able to employ special forces, off-board devices and weapons which can extend our battle space. The issues that we debate to address threats on the distant horizon -- the programs we push forward, or push aside -- will dictate what capability will reside in the future submarine force.

New developments -- as dramatic and unforeseen as those capturing the headlines and our imagination over the past year -- the kinds of world events I mentioned at the outset, surely lie ahead. Our Submarine Force readiness to tackle these challenges in the future will require continued support from the Submarine League.

The submarine force is in great shape today, thanks to the efforts of you in this audience. Our skippers have the best submarines in the world today and are operating them in many different missions, not just ASW and ASUW. I know from 31 years of experience, the submarine force will be able to forge ahead with new ideas and new technology to pace any possible threat in any situation. Our capability is extraordinary and will continue to improve. The future will no doubt hold many surprises, but one thing is certain: the submarine force -- submariners -- will be ready to meet the challenge.

Thank you and God bless.

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SUBMARINE ARTIFACTS

NSL Headquarters is willing to act as a broker between members who have submarine artifacts and organizations which would like to have such items to display to their visiting public. Museums, Ex-US Submarines open to the public, schools, libraries, etc. are the types of organizations which come to mind. Members who have artifacts which might be available for this purpose are asked to advise NSL Headquarters. The staff will keep a list of the items and the owners identified and, in response to requests, put the requester in touch with the owner to work out the details of the arrangements.

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ADDRESS TO THE NAVAL SUBMARINE LEAGUE NINTH ANNUAL SYMPOSIUM 13 June 1991

Admiral Bruce DeMars, USN
Director, Naval Nuclear Propulsion

The perception of a decreased Soviet threat has resulted in a dramatic decline in the defense budget. While this impacts the entire Navy, it is particularly serious for the submarine force due to the nuclear component industrial base.

Through the 1980's, the Navy bought at the rate of almost four submarine shipsets annually, plus four shipsets of aircraft carrier nuclear components. Now suppliers are looking at about one submarine shipset per year and one shipset of aircraft carrier components, sometime in the next decade.

Until recently there has been competition, with several sources for nearly all nuclear components; today there is only one manufacturer each for nuclear fuel, reactor cores, main coolant pumps, and an increasing variety of smaller but vital items.

Extensive quality organizations, cleanliness procedures, and management structures required for naval nuclear work leaves these suppliers ill-equipped to compete for less sophisticated work. Most have nothing to tide them through gaps in the shipbuilding program. For them a one-ship building rate translates to a workload less than 30 percent of 1980-1990 levels. FY 91 was the first year since the 1950's that the Navy could not procure at least one full shipset of nuclear components. Suppliers are in dire straits.

The second impact of the one SSN per year building rate is on force level. Today we have 87 SSNs. You hear general statements that through the six years of the Defense Department Plan the SSN number remains in the 80's. While this is not untrue, it is misleading. The ongoing retirement of the STURGEON class SSNs is offset through 1996 by the delivery of the last LOS ANGELES class SSNs. Then the slide starts.

While details of ship retirement schedules and future force levels are classified, applying the 30 year design life to ships in service and under construction provides some guide to the future.

- During the 1990's about 50 SSNs will be inactivated.
- From the approved 100 SSN force level of a few years ago, the number of attack submarines will decline about 20 percent by 1997 -- the last year of the Defense Department's Future Years Defense Plan (FYDP).
- Beyond the FYDP, the current submarine construction program indicates a 70 SSN force structure by the end of the century -- 9 years from now -- and lower thereafter.
- Even increasing the SSN building rate to three every two years in the latter years of the FYDP, will result in a force level of about 40 SSNs twenty-five years later.
- Continuing a one-SSN-per-year building rate leads inevitably to a 30 SSN force level.

Well, so what? If the threat has receded, why build forces we don't need just to sustain an industrial base? But has the threat diminished? Let me repeat some of the recent unclassified congressional testimony of RADM Tom Brooks, Director of Naval Intelligence.

- Despite current national difficulties the Soviet military continues to meet the needs of a global power. It is the only nation capable of threatening our existence.
- Any "new" Soviet Union will still likely have the world's largest military, the second most capable navy, and a formidable nuclear arsenal.
- Fewer cutbacks in the navy relative to other Soviet services suggest an expanding navy role relative to their other services.
- Although the Soviet fleet is getting smaller by scrapping many older ships, actual Soviet Navy capabilities have declined very little. Improvements in quality offset the reductions in quantity.
- The quality of Soviet third generation submarines is significantly better than their predecessors. The resulting submarine force will become noticeably more capable, especially in quality sensitive areas such as equipment radiated noise, propulsion plant operations, and sensors.
- In production today are six submarine classes -- DELTA IV SSBN, OSCAR II SSGN, AKULA SSN, SIERRA SSN, VICTOR III SSN, and KILO SS.
- The USSR launched 10 submarines in 1990.

This does not sound like a navy in decline or a submarine force that has conceded the undersea superiority race.

Aside from the Soviet threat there is a related reality. The United States of America is a maritime nation which requires a strong navy. Nuclear attack submarines are an important component of a strong navy -- perhaps the most critical when it comes to deterrence and actual war at sea. There are a number of lessons from Desert Storm -- some good, some bad and some indifferent. I would suggest one additional lesson topic. While it is well known that about 95 percent of the material went by sea -- uncontested -- there has been no discussion about what that implies. That is, we enjoy sea control -- virtually world wide. No nation has seen fit to challenge this for decades. We have had maritime supremacy for so long that we, as a nation, take it for granted. We are on a path that could jeopardize our maritime supremacy. We continue this at our peril.

Let me address three needs for these uncertain times.

- The need for attack submarines to concentrate on their strong suits -- continue to do what you do best.
- The need to stay the course with SEAWOLF, and
- The need to move out on a new SSN design.

SSNs, because of their stealth, mobility and endurance are best employed alone and unsupported in hostile waters with a terse op-order and little or no need to communicate. This means:

- Concentrate on forward area missions.
- Avoid deploying in lock step with the battle group -- meet up with them occasionally but stay off of pricomm and out of the outer screen, and
- Resist over concentration on Low Intensity Conflict and Contingency And Limited Objective Warfare (LIC/CALOW).

Nuclear attack submarines are a potent weapon and there is constant pressure by operational commanders to directly control them as they do other fleet units -- to the detriment of their effectiveness and support of battle groups. SSNs can coordinate with battle groups but at long ranges and in a loose tether. Diesel electric submarines did not come into their own until they left the scouting force and got into independent forward area operations. It took a world war to cause that to happen.

Don't get put back in the scouting force.

Resist the siren song of LIC/CALOW. Overemphasis can distort and confuse well developed and operationally validated submarine force doctrine. SSNs are overdesigned for most of these operations. If you want to land a raiding party or gain close-in intelligence or station a cruise missile shooter off a coast for an extended period the SSN can do it cost effectively. But this is a lesser basic rationale for the force as compared to countering the Soviet submarine fleet.

We need to stay the course with SEAWOLF.

The SEAWOLF R&D program has been successful. With 20 years since the inception of the 688 class program, much technology which could only be accommodated with a new design was potentially available. The challenge was focus and reach, commensurate with risk. Results to date from the most extensive submarine design testing program in our history clearly show we made the correct decisions. The stealth, propulsion power density, firepower, and weapon system flexibility will make this submarine the true top of the battle order and a principal naval force in the next century. SEAWOLF will be able to handle the best foreseeable Soviet SSNs well into the next century -- SSN 688s cannot. We must maintain a submarine force of sufficient capability to counter the Soviets. They have publicly stated they fear most the U.S. attack submarine force. SEAWOLF will ensure the longevity of that statement.

We need to move out on a new SSN design.

Technology growing out of SEAWOLF development opens the door for further improvements. The Navy is electing to focus this technology on simplification and economy rather than across-the-board enhancement of SSN-21 warfighting capabilities.

The process of determining ship characteristics and how to approach the various technological trade-offs is only in very preliminary stages.

There are five significant "don'ts" at this preliminary stage:

- Don't "assume away" Soviet capabilities.
- Don't demand predictions of savings, force levels, development and production schedules, etc. before credible information based on technical input and analysis can be developed.

- Don't saddle the project with cost saving bogeys to drive the work -- a completely unrealistic expectation considering dependence on an industrial base surviving at barely sustenance level.
- Don't assume funds will always be allocated among weapons platforms based on current percentages and appropriation structures when in fact decision makers, more than ever before, will need to adjust these percentages to meet different situations.
- Don't expect to translate savings into additional force structure; with only one or two units being produced a year, even a dramatic lowering of unit cost will not significantly enhance force structure.

The reason to go ahead with the new design rather than just standing pat derives from the need to maintain the technology base and to develop future force options.

- The nation can't allow the demise of the nuclear submarine technology base -- we should focus the technology to make future assets as affordable as possible.
- As the LOS ANGELES class starts to come off the line in the next century, we need an option to complement SEAWOLF. Whether all new design or a mixture will depend on the world situation at that time. No need to choose now and it is irresponsible not to take action now to allow future choice.
- Moreover, the simplification, cost reduction, and other technology growing out of this work will have a significant effect on all subsequent submarine designs -- and keep us from losing our edge in submarine technology.

On a more global basis several points are clear:

- The U.S. will continue to be more dependent on unrestricted use of the seas than the nations on the Euro/Asian land mass.
- As defense budgets contract, highly capable SSNs with ability to attack targets ashore, fleet units and maritime mobile missile launchers (SSBNs) -- as well as carry out intelligence collection and land special forces in hostile waters -- will be high on the list of assets to be used to protect U.S. interests.
- The cost effectiveness of weapons platforms must take into account the need for air-cover, escorts, ASW,

tankers, logistic supply trains -- not simply acquisition costs. On this basis, highly capable U.S. submarines continue to be one of the best bargains.

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NAVAL SUBMARINE LEAGUE 1991 FLEET AWARDS

The Chief of Naval Operations is pleased to announce the following winners of the Naval Submarine League Awards for 1991:

NSL Charles A. Lockwood Award for Submarine Professional Excellence:

LCDR James F. Caldwell, Jr., USN
USS ALABAMA (SSBN-731) (Gold)
MMCM(SS) James F. Lewis, USN
USS JOHN C. CALHOUN (SSBN-630) (Blue)
MM1(SS) Gary L. Masters, USN
USS OKLAHOMA CITY (SSN-723)

NSL Frederick B. Warder Award for Outstanding Achievement:

MM1(SS) Kevin J. Hoge, USN
SMMS Performance Monitoring Team

NSL Levering Smith Award for Submarine Support Achievement:

EMCM(SS) Steven F. Collier, USN
USS ORION (AS-18)

NSL Jack N. Darby Award for Inspirational Leadership and Excellence of Command:

CDR Joseph E. Enright, USN
USS HONOLULU (SSN-718)

Competition for the awards was tough. Congratulations to the winners!

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ADDRESS TO THE NAVAL SUBMARINE LEAGUE NINTH ANNUAL SYMPOSIUM 13 June 1991

The Honorable Gerald A. Cann
Assistant Secretary of the Navy
Research, Development and Acquisition

Good morning! It is, as always, a pleasure to be invited to speak in this forum. As you know, my association goes back a great many years with the Naval Submarine League and it is gratifying to be sharing the podium with such a distinguished group of speakers.

I believe that forums such as this are vital to the exchange of ideas to further the professionalism and to look to the future of the Submarine community. This morning I would like to give you my perspective, from the acquisition side of the house, on how we are doing and what we need to emphasize when defining the submarine mission in the nineties, and then talk about the new submarine in light of a shrinking defense budget.

I noticed that following my presentation, you will be hearing about the Capitol Hill perspective. I've been over to the Hill a dozen times this year... What I have learned is that there are 435 different perspectives in the House and 100 in the Senate... The last hearing I testified at was Senator Kennedy's subcommittee of the Senate Armed Services Committee. The topic was submarines and ASW programs.

The interest of the Committee centered on what changes the Navy has made in budget priorities in light of the new, post Cold War international environment. The standard response to that question seems to be a rehash of Soviet capabilities, especially in their submarine construction program, with a short discourse on the third world diesel threat.

Something that became apparent to me as the Senators listened to what Admiral Williams, Admiral Jones and I had to say, was that in so far as the Congress is concerned, the Cold War is over, the Soviet threat has already been dealt with, and the battle of the budget is in full swing.

Historically things have really not changed very much.

I suppose that the tone was set by the first Commander in Chief of the Continental Navy, Esek Hopkins of Rhode Island,

who was suspended from duty after cursing Congress and stating that he would not obey its orders. His outburst was the result of a Congressional investigation. Although things have improved somewhat since then, the Navy's relationship with Congress has never been as good as it could be.

During the days of the American Revolution, Congress authorized the construction of 13 frigates. Of these 13 frigates authorized in 1775, none were completed on time! Not a very auspicious start for Naval acquisition!

One problem was that the contracts were spread out over seven different cities in order to spread the work out among as many states as possible -- an early example of pork barrel influences on the military acquisition system.

None of the frigates originally scheduled to be completed by March 1776 were in service until the winter of 1777. By the end of winter, 8 of the 13 frigates were ready for sea. Unfortunately, an early attempt at standardizing what we now call their "combat systems suites" failed. Their cannons were to be made to the same specifications by four different Pennsylvania iron works, thus the ammunition and parts support would be common to all the ships. As it turned out, only 2 of the foundries produced any naval cannons and production was sufficient to arm only two of the frigates. The foundries were too busy building Army cannons, which no doubt were built to completely different specifications.

Fewer than half of these frigates were completed and put in service. In part due to the loss of the shipyards in New York and Philadelphia to the British.

Despite these early misadventures in Naval acquisition, the next year (1776) Congress authorized the construction of ten ships, three 74-gun ships of the line, five 36-gun frigates, a brig and a packet boat. These contracts were spread out among 5 states who had not received any of the 1775 contracts.

In 1778 all three ships in the 74-gun ship program were canceled due to affordability problems.

During this time frame the Navy shipbuilding program was run by a Congressional committee. Some might argue that it still is! This arrangement was replaced in 1779 by an executive committee consisting of 3 commissioners and two members of Congress. In 1781 Congress voted to replace this administrative body with a Secretary of Marine. Unfortunately no one could

be found who was willing to take this post, and believe me, after being in this job for over a year, I am beginning to understand why! In any case, the responsibility for Naval affairs was delegated to the Superintendent of Finance where it remained for the rest of the revolution, and under his fiscal management, the entire Navy had been sunk, lost or sold off by 1785.

It was not until January 1794 that Congress started discussion of a Naval construction bill to counter the depredations of the Barbary Pirates. A proposal to build six ships, four 44-gun frigates and two 24-gun ships for $800,000 was met with objections that "there would be no end to it, we would have to have a Secretary of the Navy and a swarm of other people in office at monstrous expense," and fears that the Government could not hope to build a fleet and pay off the national debt at the same time. Looking at our situation today, things really have not changed too much... I get the same argument when I go over to Congress to testify on the budget!

What really saved the ship building program was the proposal that one ship be built in each of 6 seaports: Portsmouth, NH, Boston, New York, Baltimore, Philadelphia and Norfolk, with the materials and supplies coming from nearly every state... Politics are not too different today.

Following the signature of a peace treaty with Algiers in 1795, three of the six ships in the program were canceled. The three others were completed in large part due to industrial base considerations, or in the words of President Washington "the loss which the public would incur might be considerable, from the dissipation of workmen, from certain works or operations suddenly being dropped or left unfinished, and from derangement of the whole system." He concluded that this might not "comport with the public interest." Some people might point out that a similar situation exists today with the recent cuts in the submarine construction program which is causing a "derangement of the whole system" and which also might not "comport with the public interest."

Half of the frigates initially envisioned, the UNITED STATES, the CONSTITUTION, and the CONSTELLATION were completed at a cost of $300,000 apiece. That totals $900,000. I guess that cost growth in shipbuilding programs is nothing new.

As the United States started flexing her maritime muscle, the Naval construction budget rose from $16,400 in 1794, to nearly $3 million in 1799. But budget cuts are nothing new to the Navy either -- by 1802 the Navy's budget had plummeted by two thirds to just over $900 thousand.

As you can see, things have not changed radically over the last 200 years.

If you look back at the period following every major war that the United States has participated in, the military has gone through a significant downsizing. It is only common sense to demobilize an Army, and a Navy and Air Force, once the battle is won. The end of the Cold War, especially when combined with the problem of a massive national debt is viewed by many as just such an occasion.

We are a maritime nation, virtually all of our allies, our trading partners, as well as our potential adversaries are on the other side of one ocean or another. For a maritime nation, there is no substitute for seapower. There is no more optimum force for third world contingencies and managing crises below and across the threshold of war, than the same Navy and Marine Corps team that has responded to over 50 crises since 1980. In addition to responding to crises, we need to maintain a credible and robust sea control capability. A highly credible submarine force is essential to this mission.

In fact, there is no more potent individual platform to protect or deny the use of the sea lines of communication than the attack submarine. Just as there is no more effective and survivable platform to maintain strategic deterrence than our SSBN force.

SEAWOLF must stand on its own as the premier submarine for the premier Navy in the world. Inherent in the ability to meet the front line Soviet threat, the multi-mission capability of the SEAWOLF allows it to go anywhere and meet all threats. With the advent of TOMAHAWK the SSN entered a new era. In addition to the traditional ASW, ASUW, intelligence, special forces insertion, and mining missions, the TOMAHAWK gives the SSN force a potent, stealthy strike capability. We should not forget that while there is a lot of activity in the aviation community on becoming stealthy, *stealth* is not a new concept. The Submarine Force has been doing it for years.

The SEAWOLF has set the benchmark in capability, but with the reduction in building schedule it is clear that we need to move on.

As you know, in an effort to seek a more affordable complement to the SEAWOLF, the Navy has begun the "Centurion" study to define a new class of attack submarine. Along with SEAWOLF, this submarine will carry the attack submarine force into the multi-mission environment of the next century, entering service around the time that the first 688 class submarines reach the end of their service lives.

There are a wide range of design characteristics under consideration to make the new submarine both cost effective and capable. A major goal is to reduce the submarine's cost to the point where more than one submarine could be funded each year. For the new submarine we must attack affordability with the same sense of mission that we have attacked the Soviet threat. Put simply, technology must be adapted and channeled into producing affordable capability.

I am firmly convinced that we are capable of designing value and quality into the new submarine without compromising essential mission capabilities. In order to do this we will have to leave our preconceptions at the door and find a way to refine our hardware to make it simpler and more affordable, both to build and maintain.

We need to exploit advances in technology in the areas of stealth, materials, new technologies and affordability. There are many promising development efforts underway in the Advanced Submarine Technology Program that have the potential to help keep costs down while enhancing the new submarine's capabilities. Some of this technology is currently being introduced to the SEAWOLF program, such as a non-penetrating periscope, and others -- magnetic bearings for example, are being tested on the R&D submarine, USS MEMPHIS. We have a lot of good technology in hand from the SEAWOLF program and expect to pick up quite a bit more before the submarine resulting from the "Centurion" study is built.

As we approach the turn of the century we are entering a new era. The same type of economies that are being called for in the current budget will continue for the foreseeable future. All of us, both Government and industry, must plan for further reductions. You have all heard that the fleet will downsize by

25 percent over the next five years. This is the new reality of the post Cold War world. As we plan for the Navy of the future we must factor in quality and value in order to offset reductions in numbers.

As the Navy Acquisition Executive, my goal is to ensure all programs are well run, technically achievable and adequately funded. To help achieve these goals I have a number of initiatives to strengthen and improve the acquisition process.

I am increasing my organization's focus on analysis, both technical and financial, to identify future problems early, before they become major problems...

One of my objectives for this increased analysis capability is to insert a new discipline into the contracting process. We need to make sure that contracts are appropriate to the type of risk involved. That they are realistic and fair to both Government and industry.

We have to know what is reasonable, know how far to stretch our technological advantage and remain within the limits of affordability. I am looking at building flexibility into some contracts to allow evolutionary tradeoffs in capability and cost in order to maximize producibility and affordability.

I am committed to competitively award contracts based on who can provide the "Best Value" to the Government. This includes considerations of proven past performance, management capability, life cycle costs, demonstrated technical competence and quality. These considerations, evaluated in concert with the degree of risk associated with the contract, determine the overall benefit associated with the offer. Unrealistically low offers increase this level of risk and recent events demonstrate that increased risk may be unacceptable.

Price is <u>not</u> the only criteria when considering "best value" to the Government ... And quality will become more and more important as the defense marketplace "downsizes" over the next FYDP.

This approach may not be applicable to all contracts, for some non-complex routine requirements that are clearly defined at the outset of the contract, it may be appropriate to award to the lowest price, technically acceptable offeror. But for major weapons systems, major service support, and requirements that dictate complex integration of people, equipment, hardware, innovation and software, a "Best Value" quality approach not

only makes sense, but is essential if we are to intelligently allocate increasingly scarce defense resources.

For major programs, I endorse the use of cost reimbursement contracts for development. However, this does not mean abandoning our use of options. What we are currently working on is something innovative -- a contract that will harness the competitive forces inherent in the fixed price contract while containing the risk to the industrial base and to the Government by mitigating the possibility of catastrophic losses, which no company, regardless of size, can absorb. This is how it works:

- The FSD or "Engineering and Manufacturing Development" (EMD) phase is covered under cost plus incentive or award fee contract.
- Initial production phase under "adjustable" options with an initial target cost, target profit and profit adjustments formula.
- Profit adjusted when firm target cost and ceiling established. This occurs at pre-defined milestone event.
- Firm target price and ceiling established after designs are substantially complete and risks are defined.
- Profits are adjusted depending on firm option price compared to target price. Catastrophic losses are avoided.

By using a more "common sense" approach to contracting we hope to avoid the type of problems that we are finding ourselves with today in administering large scale development programs. We are also attempting to make the acquisition simpler, and more "user friendly." Of course, trying to do this in the framework of current law and regulation is frustrating at times, but I assure you that I am committed to streamlining the system.

The common goal of both industry and Government must be to build systems that are within the limits of affordable technology. I am committed to accomplishing this. I firmly believe that American industry is ready and able to produce quality systems that meet fleet needs and provide the best value for the investment while remaining affordable. I look forward to working with the CNO, our research establishment, and industry to build a new submarine that meets all of these criteria.

■

ADDRESS TO THE NAVAL SUBMARINE LEAGUE NINTH ANNUAL SYMPOSIUM 13 June 1991

Admiral David E. Jeremiah, USN
Vice Chairman, Joint Chiefs of Staff

Thank you for that introduction. I'm delighted to be here today, and especially to have the opportunity to share my perspective on some of our future security challenges.

As I was preparing my remarks, I was reminded of a story that illustrates the problems that can arise from differing perspectives. A Texan was driving through Vermont and stopped by the side of the road to ask directions from a Vermont farmer. The Vermonter helpfully gave instructions directing the Texan back to the interstate. To be polite, the Texan then asked the Vermont farmer about his farm. "Well," said the Vermonter, "it's pretty good size. It runs from that stone fence you see over there, to that line of trees over there." Not a giant farm. This amused the Texan, who owned a huge cattle ranch in Texas. "I own land of my own in Texas," he told the farmer. "I can get up in the morning and it takes me all day to drive to the other end of my ranch." To this, the Vermont farmer replied, "Eyup, I used to own a car like that myself..."

With that caution in mind, let me try to share with you my perspective on how recent changes in the international environment are altering our national military strategy and force posture. I'm also going to sketch out for you some problems we will have to deal with over the next 30 to 35 years -- problems that, for the most part, are within our current technology planning horizons, and which will have an important effect upon the security and prosperity of the United States in the decades to come.

Let us turn first to the changes currently underway in the world, and our response to those changes.

The end of the Cold War is clearly the most dramatic change to have altered the international strategic environment. For over forty years, we were locked in a fierce struggle with the Soviet Union.

Today the Cold War is over, and we won. Last weekend we had a great victory parade here in Washington celebrating our

victory in the Persian Gulf War. It is ironic, perhaps, that there will never be a parade or a ceremony to commemorate our triumph in the Cold War. After all, the Cold War was the longest sustained military effort in our nation's history. In terms of dollars spent, it far outstripped even World War II as our most expensive military undertaking. The Cold War was expensive in terms of lives as well. It killed tens of thousands of Americans in Korea and Vietnam. And it claimed other Americans in hundreds of small... nearly-forgotten episodes -- people like Major Arthur Nicholson, gunned down without provocation by a Soviet sentry in East Germany; and Petty Officer Duane Hodges, killed by North Koreans aboard USS Pueblo in 1968.

When historians look back on the last decade of the 20th Century many years from now, they will see that our victory in the Cold War had a far more profound effect on the course of human events than did Desert Shield and Desert Storm.

Victor Hugo, the great French author, once wrote that "greater than the tread of mighty armies is an idea whose time has come." President Bush has suggested that, with the end of the Cold War, perhaps the time has come for a New World Order based on democracy, decency and human rights. And, on the other side of the coin, the time of communism is finally past, and one need only to talk to the Hungarians or the Czechs and Slovaks as I did last night to know this is so.

What does all this mean to us in terms of our national security?

One consequence is that the end of our polarizing conflict with the Soviets facilitates international cooperation. For example, during the recent Middle East crisis, we were able to take forces out of Europe without concern that the Soviets would turn this to their military or political advantage. Many nations, some unlikely, agreed to join the coalition against Iraq because, for the first time in recent memory, they could join such an undertaking without offending one of the superpowers. Similarly, the UN promises to become a more effective forum since it is no longer stymied by superpower rivalry.

But the greatest impact caused by the end of the Cold War is the changed basis of our own national security policy. In years past, we took it for granted that the Soviets were our adversaries, and planned our defense programs accordingly.

This is no longer the case. Let us be very clear about one thing: the Soviet Union has not gone away. They are still the strongest military power on the Eurasian landmass, and they are still the only nation on earth with the capability to destroy the United States. We certainly cannot ignore the Soviet Union completely. But neither can we use the Soviet "threat" as the sole yardstick against which our own strategy and force structure must be measured.

In short, we can no longer "steer by our wake," focusing our strategy and force structure solely on the Soviet Union. That is old thinking. It is unrealistic in the context of the changed international environment; it won't sell to the American people or on Capitol Hill; and it doesn't serve our other important security requirements.

But even though the Cold War has ended and we no longer view the Soviet Union as our adversary, the world still remains a dangerous place. And we still have important security interests around the globe that need tending.

We are still working to control the flow of illegal drugs into the United States, and to combat terrorism.

We remain committed to a forward presence in the Pacific, where our military forces play an important stabilizing role. The world's seven largest armies -- plus many of the world's most powerful navies -- operate in Asia. And nearly every nation in the region has some sort of geographic, ethnic, religious or political dispute with one or more of its neighbors. The end of the Cold War neither diminishes our interest in the Far East nor changes the strategic equation in the Pacific theater. Our continuing military presence there reminds everyone that we ourselves are a Pacific power, and that we will remain interested in the destiny of that region.

We have no intention of severing our military ties with Europe, even though the prospect of war against the Soviet Union now seems remote. NATO is the cornerstone upon which the future security of Europe rests, and we will remain a strong and willing partner in European security matters.

In a similar fashion, our longstanding commitment to support our friends and work for peace in the Middle East has not changed.

In this post-Cold-War world, I see our security problem as being like a gladiator entering the arena. In the past, our

adversary -- the Soviet Union -- was always waiting for us in the center of the arena, armed and dangerous. Today, the arena is temporarily empty. But around the outside of the arena is a series of doors, and behind each door is a new adversary. We do not know which door -- or combination of doors -- will open in the future. The only thing that is clear is that we will need capable, flexible and ready military forces to deal with whatever threat emerges.

Complicating this is the fact that our defense budget is shrinking, and our force structure is going to shrink with it. In light of the reduced threat from the Soviets, our nation simply cannot afford to keep military forces as large as we've had in the past. The economic health of our nation is a crucial element of our overall national strength, and we must nourish this in the years to come. The Soviet Union ignored this, and today has greatly declined as a superpower because its economy is in a shambles. Many inside and outside the United States worry that we will also stretch ourselves too thin and suffer a similar fate. We must not make that mistake.

We have already revised our national military strategy, and have sketched out to Congress the vision of our future force structure. The bottom line is that our forces are going to get much smaller. The Navy is going down to something on the order of 450 ships. We will have fewer carrier battle groups; fewer carrier air wings; fewer support and special-purpose ships; fewer VP squadrons; and, yes, fewer submarines. The other services will be cut as well. Still we want our future forces to be even more lethal and to have even more strategic mobility. But overall our forces will be less robust, and we will have less flexibility than we enjoy today. We will have less margin for error, and in some areas we will have to accept increased risk.

Our future force structure can be described in four force packages: an Atlantic force; a Pacific force; a contingency force based in the United States for rapid deployment to crisis areas; and a strategic force. (In fact, many of you may have seen the article in the April 1991 issue of THE SUBMARINE REVIEW explaining our new national security strategy and force structure.)

Within the strategic force, we intend to retain our nuclear triad. The TRIDENT submarine is a vital element of that triad, and will gain in relative importance as arms control negotiations

reduce our land-based missiles. We will continue to rely on the TRIDENT for a secure, effective, and powerful deterrent force.

But we will see changes not only to the size and complexion of our armed forces, but also to our procurement policies. The end of the Cold War and internal economic problems and problems in both countries will relax the force competition that has existed between ourselves and the Soviets. As a result, in the future we will be far more careful to make sure we are buying what we need, and that what we're buying actually works before we commit ourselves to a big production run. I think we can anticipate smaller numbers in each new ship class, for example, and each new class will serve as a "proven technology" stepping stone to future developments. The SSN-21 is a case in point. We are going ahead with production of SEAWOLF, but I anticipate the final class size may be small. Admiral Nimitz insisted on this sort of procurement strategy after World War II, and eventually saved the Navy a lot of money -- and embarrassment -- by making sure we got ships that could actually perform, rather than ones that just looked good on the drawing board.

Another consequence will be an increased emphasis on joint and combined operations. This was one of the major ingredients of our victory over Iraq. All our forces will have to develop improved communications procedures, tactics, and mission profiles so they can contribute in future military operations by the United States and its allies. And this includes submariners. The use of submarines in conjunction with other forces, and to provide stealthy, distributed firepower with TLAM-C -- such as we did against Iraq -- is more likely to be the rule in future conflicts than the exception.

Now, these may not be very comforting words. Some of you may feel threatened by these changes, and your instinctive response will be to batten down and try to ride out the storm. I think that's the wrong approach, and in fact the wrong way to look at our situation. We've just won a great victory in the Cold War. And whatever changes occur in the armed forces of the United States in the years to come, I think we can expect our nation to be more secure than at any time in the last 40 years. In 1776, many colonists complained about the upheaval the American Revolution was causing. John Adams, later to be our second President, wrote this to rally their spirits: "All great

changes are irksome to the human mind, especially those which are attended with great dangers and uncertain effects."

Those are wise words, and we should keep them in mind today. We are living in the midst of a great change, and we can expect the end of the Cold War will indeed be "irksome" in many respects. But instead of seeing only the discomfort, we should rejoice in the fact that overall our nation today is safer and more secure. And we should not begrudge that change simply because it dislocates our established ways of doing business.

Now, what I've told you so far is the good news! The bad news is that even more profound changes are just over the horizon, and these will bring even more formidable challenges to our nation. A few months ago, I had the Joint Staff undertake a series of studies to determine what the security environment will look like for us in the year 2025. These studies consulted renowned futurists around the country. Happily, not all of the opinions we received were in agreement across the board, but there were several disturbing trends that are worthy of our attention. Let me explain.

One ticking timebomb in international affairs is demographics. By the year 2025, the world's total population will be approaching ten billion people -- nearly double the current population. Right now, about 84% of the world's population lives in lesser developed countries. By the year 2025, that will increase to over 90% -- 90% of a doubled population. We cannot predict for certain what sort of a world it will then be in which 25% of the world's population is hungry every day. And can we expect a stable and secure planet in which 12% of the population controls over 80% of the world's wealth? Or in which there are mass migrations, not only across national boundaries but perhaps across entire continents? If this sounds farfetched to you, consider this: the countries of central and western Europe are already worrying about the potential for tens of millions of Russians to move westward in pursuit of better economic conditions in the not-too-distant future.

Population shifts will also cause problems here at home. Right now, the United States spends about 11% of its Gross National Product on health care. A decade from now, this may rise to as much as 16% and, as our baby boomers live into old age, perhaps to 25% of our GNP by the year 2025. What sort

of military forces will we be able to afford once so much of our national wealth is absorbed by health care costs?

We may be on the verge of profound changes in other areas as well. Consider technological change. Right now, we are still in the early stages of the "information revolution." DARPA tells me that last year, the world's transistor output was about one million transistors for every man, woman and child on the planet. (He really said 20 million for every man, woman and child in the civilized world, but we couldn't agree on what part of the world was civilized). Some futurists suggest this information revolution will eventually bring changes on a scale comparable to mankind's shift thousands of years ago from nomadic hunters to village farmers, or to the later industrial revolution which led to the rise of modern nation states. We already know that modern weaponry, whether it is chemical weapons, ballistic missiles, or even nuclear weapons can transform a third-rate power like Iraq into a major military threat. But technological change in the coming years could transform the entire basis for national power and economic wealth in ways we cannot yet foresee.

Several futurists suggest that change as a phenomenon will speed up in the future. In that future environment of constant change, an important quality differentiating rich nations from poor ones will be the ability to adapt, quickly and efficiently, to changes. To position ourselves for success in the future, we must begin now to develop the adaptability to make these changes successfully. (No one who is familiar with the adaptability of our current acquisition process would accuse us of being well-positioned for success in the future -- so there is an immediate challenge to resolve.)

The end of the Cold War is helping us to break out of habits that have been ingrained in our nation for the past forty years. But even when we've finished restructuring our forces over the next few years, we will not be able to settle into a new, static period. Rather... rapid change will very likely become a fact of life in the 21st Century, and the sooner we make the mental adjustments to cope with it the better for us all.

What I've tried to do today is give you some idea of the problems we're dealing with as we move into the post-Cold-War era. Changes are already underway, and these are going to disrupt familiar ways of doing business for us all. But this is a

healthy process for our nation, and we should not lose sight of that fact. I've also tried to point out that the changes we're facing today may be insignificant in comparison to the transformations that may be waiting for us just over the horizon -- and we need to develop ways of creating better understanding of that future so we have the hardware, strategy and force structure to deal with an indeterminate future.

There is an old Chinese blessing that says "May you live in interesting times." In this respect, we are all blessed -- we are certainly living in interesting times. And in the future, we will need all our ingenuity and imagination to take full advantage of this blessing.

Thank you for giving me this opportunity to speak to you. ■

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THE CHALLENGE IN ATTACK SUBMARINES

by Richard F. Hoglund

RETROSPECTION AND PROJECTION

In an attempt to depict where we have come with our attack submarine force, I enlisted the aid of two veteran submariners, Ken Cox and Tom Maloney, and asked them to rate the U.S. Submarine Force's capabilities to accomplish pertinent missions at five-year intervals starting with 1950. Capabilities in each of six mission areas (anti-submarine warfare, intelligence collection, special warfare, offensive mining, anti-surface warfare, and land attack or strike) were scored on a scale of 0 to 10 for each mission area versus the global threat that existed at each time. The result, admittedly subjective, is shown in Figure 1, where some of the major factors and systems that influenced the capabilities are noted.

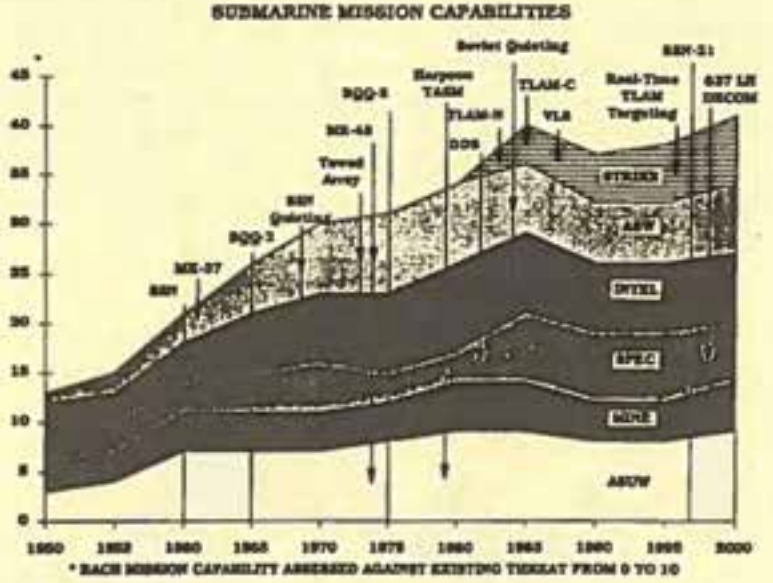

Figure 1.

The introduction of nuclear propulsion over the 1955 to 1965 period resulted in a major increase in capabilities for all missions, while both sensor system (e.g., BQQ-2; towed arrays; BQQ-5) and weapon system (e.g., MK-48 Torpedo; anti-ship

cruise missiles) introductions provided selective improvements. We show a capability reduction due to the Soviet quieting efforts of the 1980's along with the emergence of strike as a viable mission with the introduction of submarine-launched TOMAHAWK cruise missiles. Our projection for the decade ahead shows continued increase of capabilities due to the introduction of the SSN-21, but a decrease in special warfare capabilities with the expected decommissioning of the SSN-637 long hulls.

The point of this is not to quibble about the validity of our specific ratings, but to illustrate the overall trends. What we see is a dramatic increase in capabilities (about three-fold from 1950 to 1990) despite the evolution of a formidable Soviet threat during that period. (We have not attempted to rate the Soviet capabilities in the same fashion, but estimate that their overall score on the same basis went from 5 or less in 1950 to about 25 in 1990).

At what cost? Using Ship Construction, Navy (SCN) funding as a surrogate for overall costs, we find, in constant dollars (Figure 2), that (at least for the period for which data were readily available), the attack submarine part of the budget is fairly constant at about $2B a year. The message is that our capabilities, versus a steadily growing threat, increased nearly three-fold with an essentially constant expenditure rate. That's a remarkable achievement.

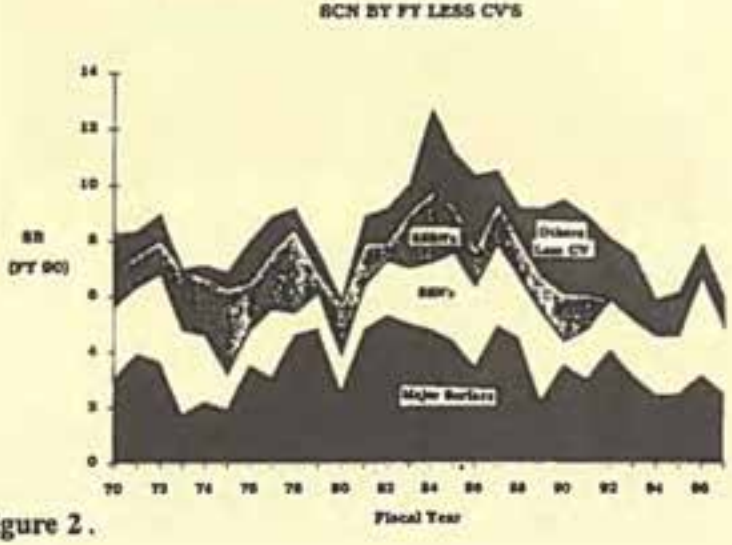

Figure 2.

What you *can do* with the attack submarine is only part of the story. The other part is what you *need to do* with it. The *need to do* is driven by world events, the political situation, and the threat at any given time. Again, in each five-year snapshot, we estimated the relative emphasis on each mission of the U.S. attack submarine force (Figure 3). For example, in 1950, we said that 55% of the emphasis was ASUW and only about 15% ASW. Things changed. The Soviets started developing a blue-water navy including a large and capable submarine force of SSs, SSGs, and SSBs followed shortly by SSNs, SSGNs, and SSBNs. This resulted in ASW rising in importance. It's not that ASUW decreased in importance in absolute terms, but when ASW rose in importance (as it did over the 70's and 80's), something had to give within a 100% total. A new trend developed in the 1980's with the emergence of Strike as a major submarine mission. In fact, our projection says that Strike and ASW will be equal in importance somewhere around the year 2000.

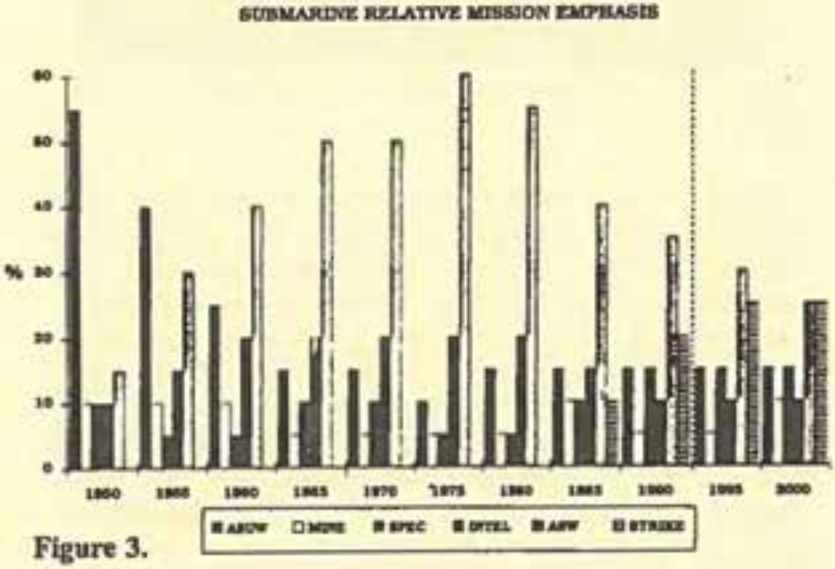

Figure 3.

The total story is the combination of these two things: what you *can* do and what you *need to do* with the attack submarine. To illustrate this, I have arbitrarily defined a quantity called *dominance*, which is simply the product of *capability* (on a 0 to 10 scale) from Figure 1, and *emphasis* (in percent) from Figure

3. The idea is to see what *was driving* the submarine force and what *will be driving* it. If you designed a submarine in the 70's, according to this analysis, it was driven very much by ASW along with intelligence gathering and ASUW considerations. Importantly, however, it still had to be capable of the other missions.

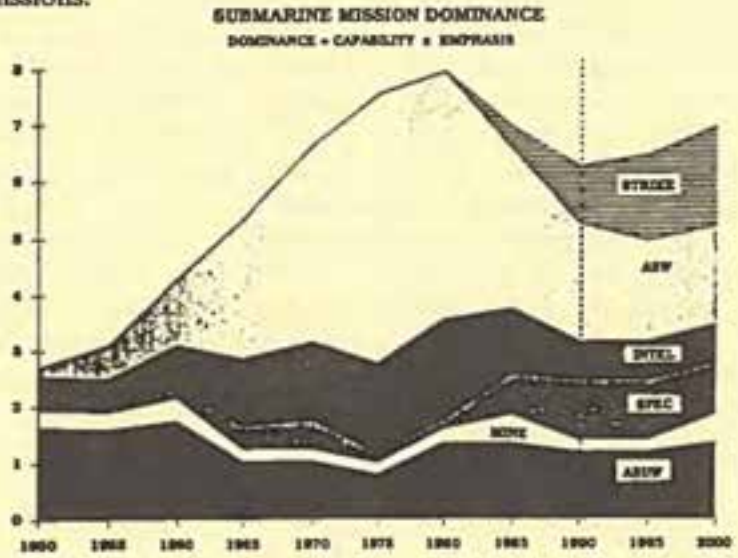

Figure 4.

But if you look beyond the 1990's, in the year 2000, we find much more equal importance attached to the various missions than ever before. Thus, the attack submarine force of the future **will need more, not less, multi-mission capability.**

Accompanying these multi-mission needs is a whole new strategic environment. As laid out by President Bush, our new national military strategy rests on the four pillars of deterrence, forward presence, crisis response, and force reconstitution. The military forces to implement that strategy must be flexible, capable of precise attack, and have assured survivability and global reach (range, endurance, mobility). Any objective analysis of this strategy calls for an increased naval role and a crucial role for submarines, which have exactly the above characteristics.

The relative importance of the ballistic missile submarine fleet will increase both for us and for the Soviets. This makes our counter-strategic force, principally an SSN function, of

increasing national importance. The strategy of maintaining a forward presence and being able to respond to distant crises calls for control of the sea lanes -- the submarine force is vital.

Indications and trends are that regional conflicts that would involve U.S. military participation are increasingly likely in the future. While many nations can buy or build rather effective AAW and ASUW systems, at this point and hopefully for the foreseeable future, the nations of likely concern cannot field effective ASW systems except for mining of their local waters.

The emergence of regional conflict scenarios suggests that we need new measures of effectiveness for attack submarines. The frequently used exchange ratios are meaningless in most, if not all, regional conflict scenarios. The numbers of units involved in plausible conflicts do not support meaningful exchange ratios. More importantly, in foreseeable scenarios, the U.S. cannot afford to lose any submarines. Similarly, the concepts of loose trail and fractional holding times lose pertinence.

THE CHALLENGE

So the challenge facing the submarine community is to provide multi-mission capabilities, where all of the missions are vitally important, while maintaining effective ASW capabilities against a still-improving Soviet threat, while adding new roles associated with regional conflicts all within the constraints of decreasing resources. Now that's a challenge!

MEETING THE CHALLENGE

Plausible ingredients of a strategy to meet the challenge are affordability, risk minimization, and inter-operability. Adfordability dominates the defense procurement scene these days, not just in submarines. Everyone's hope is that technology advances will result in lower costs, either through lower acquisition costs, greater reliability or more automation. So far, however, any loser costs due to technologically improved submarine designs, components, and production processes have been overshadowed by the demands in increased performance and associated complexity, particularly in combat systems. Can this be turned around? Also, we lack a credible life cycle cost model for submarines to be able to demonstrate that technology introductions that result, for example, in reduced maintenance costs, really are cost-effective in the long run. The submarine

community's efforts in this area appear to be inferior to what the aircraft community has accomplished.

Other approaches to affordability that have been proposed are single purpose submarines for either strike or regional conflicts and reconfigurable submarines. The problem with the former concept is a classical one for Navies or for that matter, for any forces that have long lead, construction, and service times. Designing a submarine for specific missions far in the future generally demands a degree of prescience that is not achievable, and in any event runs orthogonal to the conclusion reached earlier in this note regarding the need for multi-mission capability. The concept of configurability, wherein the submarine has a core ASW/ASUW capability augmented by mission-specific modules, is borrowed from aircraft. Whether the obvious differences in sizes, weights, accessibility, sensor requirements, reconfiguration time-lines, and world-wide logistics chains permit application of the concept to submarines remains to be demonstrated. It appears to this author that affordability will have to be addressed as a classical trade-off between numbers of units and cost/capability of each unit, all within a multi-mission framework.

Risk minimization is driven simultaneously by the likelihood that regional conflicts will arise wherein a submarine role is called for, while politics and populace preclude losses, as well as by the sheer cost and manning level of the platform itself. Fruitful areas for research and development include mine avoidance, longer-reach sensors (e.g., bistatic low frequency active acoustics), stand-off weapons to go with the longer reach sensors, and off-loading of high-risk functions onto unmanned vehicles, either tethered or autonomous.

Finally, increased submarine interoperability with both surface and air assets is in the offing, especially in regional conflict scenarios. Enhancements in the submarine's value and roles are on the horizon in ASW, anti-ship and land strike missions. Two developments that would accelerate progress in this area are improved covert two-way communications and improved near-real-time targeting for land strike.

CLOSING

The challenge now facing the U.S. attack submarine community is unique and as stressing as any faced within the second half of the twentieth century. A still-improving Soviet capability

that must be countered, preparation for plausible assignments to regional conflicts including a need for assured survivability, along with more emphasis on a full spectrum of multi-mission capabilities all come at a time of unprecedented pressure to reduce expenditures. Tough choices need to be made while opportunities need to be pursued in affordability, risk minimization, and interoperability. Thankfully, the effectiveness of the accomplishments of the past forty years bodes well for the community's ability to meet and beat the challenge.

[Note: The opinions expressed herein are solely those of the author and do not represent positions of General Dynamics Corporation.

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LOW-FREQUENCY COMMUNICATIONS - A DEVELOPMENT OF PHYSICAL PRINCIPLES FROM SONAR

by Woodrow R. Shields

Submariners possess a basic understanding of sound propagation in water and its utility for sound navigation and ranging (SONAR). Underwater acoustics is the environment in which the submariner lives and excels. The submariner also lives in an electromagnetic environment which provides information just as important and valuable as that provided by acoustics.

Some submariners view low-frequency communications, that is, extremely low frequency (ELF), very low frequency (VLF), and low frequency (LF), as akin to black magic, which, on the basis of operating experience, appears to randomly succeed or fail. A basic understanding of the physical principles of low-frequency communications can provide the submariner with the knowledge to retain both reliable low-frequency communications and maximum operational flexibility.

Sound propagation in water and low-frequency electromagnetic propagation in air are based on similar physical principles. In both cases energy is transmitted from a source to a receiver, but, the submarine's use of each is very different. SONAR is used to detect, localize, track, and classify contacts within the submarine's ocean area of interest, whereas low-frequency communications are used to transfer information to the submarine.

One approach to developing a basic understanding of the physical principles of low-frequency communications is to build upon the submariner's existing knowledge of acoustics and SONAR. The purpose of this article is to examine the similarities and unique properties of sound propagation in water and low-frequency radio-wave propagation to provide a basic understanding of low-frequency communications.

General

Sound propagates in water via an acoustic pressure wave bounded by the ocean's floor and surface. Acoustic frequencies of interest are detectable in the hertz (Hz) to kilohertz (kHz) frequency ranges. Acoustic paths are characterized by spherical spreading at short ranges, and cylindrical spreading at long ranges.

In comparison, low-frequency electromagnetic waves propagate at the speed of light bounded by the earth's surface and the bottom of the ionosphere (i.e., 70 to 90 km). Low-frequency signals are also specified in Hz and kHz. Short-range low-frequency electromagnetic paths are also characterized by spherical spreading and long-range electromagnetic paths by cylindrical spreading. Excellent signal stability at long ranges and seawater depth penetration ability (Note: The earth's surface is not a perfect boundary) are the primary reasons low-frequency electromagnetic signals are used for submarine communications.

Passive SONAR Equation

A good place to start a comparison between SONAR and low-frequency communications is with the well-known Passive SONAR equation

$$SNR = (L_s - N_w) - (L_n - N_{di}),$$

where

SNR = signal-to-noise power ratio in dB;

L_s = source radiated sound level in dB referenced to 1 micropascal in a 1-Hz bandwidth at 1 meter from the source. (A pascal is a unit of pressure defined as one newton per square meter);

N_w = propagation loss in dB;

L_n = total background noise in dB (ambient and self) referenced to 1 micropascal in a 1-Hz bandwidth measured at the submarine sensor; and

N_{di} = directivity index gain in dB.

The low-frequency communications equation in equivalent form is

$$SNR = (S - L) - (I - G),$$

where

SNR = signal-to-noise power ratio in dB;

S = transmitter vertical electric field strength in dB referenced to one microvolt per meter in a 1000-Hz bandwidth at one kilometer from the transmitter;

L = propagation loss in dB;

I = total interference vertical electric field strength (atmospheric noise, EMI, external man-made interference, receiver thermal noise, etc.) in dB referenced to one microvolt per meter in a 1000-Hz bandwidth measured at the submarine receiver;

and

G = receive antenna directive gain in dB.

The above equation can be called the "Passive Communications Equation". The same SONAR terms calculated from the Passive SONAR Equation can also be developed for the Passive Communications Equation.

Recognition Differential

A very useful term is the SONAR recognition differential (N_{RD}) defined as the SNR required to detect a contact with the desired probability. As an example, the SONAR operator will detect the contact 50% of the time when the SNR is equal to the $N_{RD50\%}$. In low-frequency communications, the equivalent term is SNR_{PCMR} defined as the SNR required to provide the desired probability of correct message receipt (PCMR), for example, $SNR_{PCMR50\%}$ provides a 50% PCMR.

Figure Of Merit Range

Another useful term is the SONAR Figure of Merit(N_{FM}). N_{FM} is the allowable propagation loss to achieve the desired N_{RD}. N_{FM} is converted to the Figure of Merit Range (i.e., the range where N_{RD} occurs) with the appropriate acoustic propagation loss curves. Likewise, a low-frequency Figure of Merit Range (i.e., the range where SNR_{PCMR} occurs) can be calculated from the appropriate electromagnetic propagation loss curves. The low-frequency Figure of Merit Range is usually displayed in the form of coverage contours from a transmitter. The respective Figure of Merit equations are

SONAR:

$$N_{FM} = (L_s - N_{RD}) - (L_n - N_{di})$$

Low-frequency communications:

$$N_{FM} = (S - SNR_{PCMR}) - (I - G)$$

Signal Processing Gain

The ability to distinguish the desired signal in the presence of background noise or interference is related to the length of time the desired signal is averaged prior to a discrete measurement. The N_{RD} or SNR_{PCMR} decreases as the time allocated for signal processing (or averaging) increases. For passive SONAR detection, the signal processing time is called integration time, e.g., short time average (STA), intermediate time average (ITA), and long time average (LTA). For low-frequency communications, the time allocated for signal processing is called the bit duration. Note: Communications engineers attempt to confuse the lay person by defining the binary one's and zero's (which are usually referred to as a bit) as a chip. Multiple chips are algebraically combined (averaged) to provide a bit decision, that is, an overall one or zero in a communications code. The process of averaging multiple chips for each bit decision is called spreading (i.e., the bit decision is spread over time). The simple equation to calculate the theoretical signal processing gain of a low-frequency communications mode is: Theoretical signal processing gain (in dB) = 10 log(# chips per bit).

For example, a communications mode with a 1000 chips per bit has a theoretical signal processing gain of 30 dB (i.e., SNR_{PCMR} improves by 30 dB - a factor of 1000).

In the same manner as the signal processing gain of the ITA and LTA displays provide the ability to detect a contact below the SNR where a sonarman can hear a contact. The signal processing gain of the special low-data-rate Minimum Essential Emergency Communications Network (MEECN) modes used for Emergency Action Message (EAM) transmission provide successful message reception below the SNR where a radioman can hear a signal.

The signal processing gain for low-frequency communications can also be improved by using error detection and correction (EDAC), which consists of transmitting extra bits of information (i.e., parity check bits inserted by the transmit system) to improve reception performance. There are numerous EDAC encoding techniques used to improve signal processing gain. The most efficient techniques provide several dB of additional gain. In other words, correct message copy can be achieved with up to 10% of the received bits in error.

The gain from SONAR and low frequency communications signal processing can be used either to

1. Improve the recognition differential (or PCMR) while maintaining the same range, or
2. Increase the range from the source (or transmitter) while maintaining the same recognition differential (or PCMR).

Attenuation

The useful range of an acoustic or low-frequency electromagnetic system is also a function of the attenuation rate (or propagation loss rate) of the desired signal. The desired signal can be detected until the received signal level falls below the sensitivity threshold of the receive system. Typical attenuation rates for acoustic and low-frequency electromagnetic signals are

	Sea Water	Air
Acoustic		
60 Hz	0.001 dB/km	-
25 kHz	3 dB/km	-
50 kHz	9 dB/km	-
Electromagnetic		
60 Hz (ELF)	0.3 dB/m	1 dB/Mm (night) 1.25 dB/Mm (day)
25 kHz (VLF)	7 dB/m	1.5 dB/Mm (night) 2.5 dB/Mm (day)
50 kHz (LF)	9 dB/m	2 dB/Mm (night) 3 dB/Mm (day)

One megameter (Mm) is 540 nautical miles (nm); one kilometer (km) is 0.540 nm.

Acoustic systems are limited to useful ranges (in sea water) of tens or hundreds of nautical miles; whereas, low-frequency communications systems may provide useful ranges (in air) of thousands of nautical miles. The low frequency electromagnetic signal propagates in air from the transmitter to the ocean surface above the submarine. Then it propagates in sea water to the submarine's submerged communications antenna which may be tens of feet below the ocean surface for VLF/LF reception or hundreds of feet below the ocean surface for ELF reception.

Background Noise/Interference

The sources of acoustic noise which compete with the desired acoustic signal originate from a variety of ambient and shipboard sources (e.g., biologics, shipping, weather, flow noise, rotating equipment, etc.). Likewise, the sources of low-frequency electromagnetic noise which compete with the desired electromagnetic signal originate from both ambient and shipboard sources.

The total electromagnetic noise (or interference) power at the submarine receiver is the sum of the powers of all sources of electromagnetic interference. The possible sources of low-frequency electromagnetic interference are

1. Atmospheric noise
2. Electromagnetic Interference (EMI)
3. External man-made interference
4. Receiver thermal noise

Atmospheric noise - Low-frequency electromagnetic radiation from lightning bolts during thunderstorms is the major source of low-frequency atmospheric noise. The level of atmospheric noise at a submarine's radio antenna is the power sum of all thunderstorm-generated low-frequency radiation which propagates to the submarine's location.

The daily and seasonal variations in thunderstorm activity are the major sources of low-frequency atmospheric noise level variations. Nighttime atmospheric noise levels are usually higher than daytime atmospheric noise levels because nighttime attenuation is lower. In the northern hemisphere, winter atmospheric noise levels are less than summer atmospheric noise levels because thunderstorm activity occurs farther south resulting in greater propagation distances (and more attenuation) to northern areas.

Electromagnetic interference - The primary source of low-frequency EMI on submarines is electromagnetic noise generated by rotating equipment (e.g., power generators, propeller shaft, etc.) and other electrical loads (fire control, SONAR, navigation, etc.). In the same manner as the submarine's acoustic self-noise is controlled to maximize the acoustic SNR, EMI must be controlled to avoid degrading the submarine's ability to receive low-frequency communications. A high EMI level on the desired signal's frequency may prevent message reception in much the same way as a sound short may mask

detection of a SONAR contact. EMI can be identified and minimized by conducting periodic EMI surveys. The generation of new sources of EMI can be minimized by using proper installation, maintenance, and repair procedures on all shipboard electrical and electronic systems.

External man-made interference - The presence of undesirable signals within the bandwidth of the communications receiver is a possible source of interference. External man-made interference may originate from unintentional sources (i.e., existing transmitters) and/or intentional sources (i.e., hostile jamming). The large bandwidth requirements of a low frequency communications system relative to the usable frequency band and the world-wide distribution of VLF/LF transmitters increase the possibility of external man-made interference. As an example, a VLF receiver with a 1-kHz bandwidth monitors over 5% of the usable VLF band (14 to 30 kHz). With over two dozen VLF transmitters in operation world-wide, the possibility of external man-made interference exists. The effects of external man-made interference may be reduced by minimizing the bandwidth of the communications receiver, that is, the bandwidth of the communications receiver must be centered and matched to the bandwidth of the transmitted signal.

Receiver thermal noise - Electromagnetic noise is generated within the communications receive system from the residual movement of charged particles in electrical components. The kinetic energy of the charged particles is proportional to the temperature of the electrical component. Any electrical component connected to (e.g., antennas, multicouplers and amplifiers) or within the communications receiver may be a source of thermal noise. Low-frequency communications receive systems are designed with high-quality components (with low thermal noise characteristics) to minimize receiver thermal noise levels. Thermal noise can be minimized by ensuring that proper maintenance and repair procedures are used to maintain all communications receive system components at design specifications.

Sensors/Antennas

The purpose of a sensor is to convert acoustic or electromagnetic energy into an electrical signal capable of being processed by a receive system to extract meaningful information. Acoustic pressure waves and electromagnetic waves are received

by hull/sail mounted and tethered sensors.

There are two basic types of sensors used for the reception of low-frequency communications (i.e., loop antennas and wire antennas). A loop antenna receives the magnetic component of the electromagnetic field. The loop antennas used for submarine VLF/LF reception are the towed buoy antenna and various mast mounted VLF/LF magnetic antennas. Loop antennas are not used for ELF reception on submarines. The sensitivity of a loop antenna is proportional to its magnetic cross-sectional area. The effective cross-sectional area of a loop antenna increases with additional wound turns of conductor. A single-loop antenna has a figure-eight reception pattern with maximum reception in the direction of the plane of the loop. The output of two-loop antennas at right angles to each other (i.e., crossed loops) can be combined to provide an omni-directional reception pattern. The loop antenna is normally operated several meters below the surface. The electromagnetic field available to the loop antenna may be reduced by the high VLF/LF attenuation of sea water directly above the loop antenna.

In comparison, a wire antenna receives the electric component of the electromagnetic field. The wire antennas used for submarine low-frequency reception are the floating wire antenna (FWA) and the auxiliary wire (i.e., pigtail) of the towed buoy antenna.

Terminators/Thermal Layers

The location of the ionospheric terminator (day-night interface) with respect to a low-frequency propagation path is one of the most important factors affecting the daily and seasonal variability of low-frequency electromagnetic signal propagation. The location of the terminator determines the ionospheric condition (day, night, day-night transition, night-day transition) through which a low-frequency electromagnetic signal must propagate. Propagation through a terminator may result in destructive interference (i.e., reduced signal levels) of low-frequency electromagnetic signals. Figure 1 is a plot of signal strength over a 24-hour period from the VLF transmitter at Lualualei, Hawaii to a ground-based receiver at Laurel, Maryland.

The effect of a terminator in a low-frequency propagation path is similar to cross-layer detection of a SONAR contact on

the other side of a thermal layer. Low-frequency communications reception (or SONAR detection) for cross terminator reception (or cross-layer detection) is more difficult because of the lower received signal level. Unlike thermal layers where the submarine can control which side of the thermal layer to operate, the submarine cannot control the ionospheric conditions affecting low-frequency communications. However, the presence of terminators is very predictable based on the solar zenith angle at the transmitter and submarine locations.

Summary

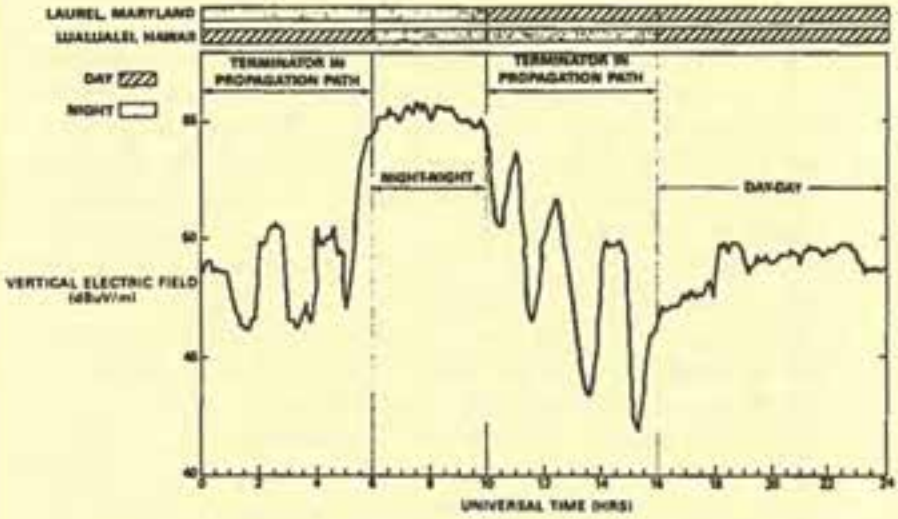
In the same manner as the submariner knows and controls his submarine's acoustic environment, he must also know and control the electromagnetic environment. He should be aware of the actual received SNR at his communications receivers and the dominant source of interference, and should understand his ability to control these signal levels. When the received SNR is large, the depth of the communications antenna may be increased while successful low-frequency communications are maintained. The resulting, less stringent communications posture provides additional operational flexibility and may also reduce the submarine's vulnerability.

There are, however, several factors beyond the submariner's control which may affect his ability to successfully copy low-frequency communications from a particular transmitter. These factors are

1. Transmitter power and frequency,
2. Atmospheric noise and external interference levels on the transmitter's frequency,
3. Signal propagation loss based on the geographical distance from the transmitter,
4. Ionospheric conditions of the propagation path between the submarine and the transmitter, and
5. Signal processing gain of the transmitted communications mode.

In conclusion, the propagation of low-frequency electromagnetic signals is based on predictable physical principles. A basic knowledge of these principles provides the submariner with the ability to maintain reliable low-frequency communications while also retaining maximum operational flexibility.

SIGNAL LEVEL OF LUALUALEI (23.4 KHz) AS MEASURED AT LAUREL, MARYLAND DURING AUGUST, 1987



OBSERVATIONS ON WOODS HOLE, OCEANOGRAPHY, AND SUBMARINES

by Dr. Gary E. Weir
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The birth of ASW during the First World War inaugurated a scientific commitment to underwater sound research which has persisted to the present day. The work of the Navy and the Woods Hole Oceanographic Institution (WHOI) with the bathythermograph (BT) and underwater sound transmission before and during World War Two demonstrated the remarkable results achieved on behalf of the Submarine Force through the proper combination of pure and applied science.

The BT was first developed in 1934 at Woods Hole by Carl-Gustav Rossby of MIT and refined over the next three years by his colleague, the South African, Athelstan Spilhaus. This instrument provided the scientist with data on water temperature variation as depth increased and allowed a better analysis of the all-important course of echo-ranging signals through the water.

Given its awkward construction and tolerance only for slow surface speeds, the Rossby-Spilhaus version of the BT required further refinements before the Navy could place it in service. In October of 1940, Maurice Ewing, a WHOI associate and Professor of Physics at Lehigh University, along with his students Allyn Vine and J. Lamar Worzel, began working on a more refined and durable version of the BT for use in both ASW surface ships and submarines. Their goal was to give the Navy a way of determining sound velocity through seawater. Since water temperature was the most important factor in this calculation, the BT proved the perfect instrument. Allyn Vine recently recalled that "our problem was not to make it necessarily more accurate but to make it so that it was ten times more usable."

During 1941 the WHOI team developed a BT model which could endure depths of over 400 feet and provide accurate data at speeds of between 15 and 20 knots. By 1942 most research vessels and convoy escorts carried BTs. Under Allyn Vine's

supervision, Woods Hole manufactured two hundred of these instruments before the Bristol Company of Waterbury, Connecticut, signed a contract to assume this responsibility in cooperation with WHOI.

In estimating the BT's wartime value, Columbus Iselin, director of the Institution from 1940 through 1950, commented that in "the first four years of its use, over 60,000 records were accumulated and processed. From data collected by these, and later by the submarine bathythermographs, new fields of sound transmission phenomena were opened."

Ewing and Vine created a submarine BT in 1942, and added isoballast lines to the standard 3 x 5 inch graph on which the submarine BTs recorded their temperature data. This graph allowed the submarine diving officer to determine quickly the location of density layers caused by dramatic temperature change. This data would provide the probable locations of *shadow zones* in which a vessel could escape detection because of the effect of radical temperature change on the speed and direction of the active ASW sonar signal. The isoballast lines provided further insurance by actually giving the submarine diving officer the number of tons of ballast water he would have to take in or pump out in order to maneuver the submarine quietly into the shadow zone and maintain trim without further machinery noise.

In one typical example, the submarine USS HERRING (SS-233) recorded, in its submarine patrol report for the period 11 to 17 June 1943, that the submarine BT allowed the diving officer to determine increasing water density as the temperature decreased with depth near Palau. As a consequence, the information from the submarine BT "enabled him to adjust his trim so that during the search following each attack while we were deep he never had to pump, blow or increase speed to maintain depth."

With the aid of WHOI and other centers of oceanographic research, the Navy acquired a greater understanding of the factors common to both ASW and submarine warfare. Very often the research which helped the ASW forces to find and kill a submarine with greater frequency during World War Two also permitted the submarine to hide or take countermeasures. For oceanography, ASW and pro-submarine research were two sides of the same coin.

Consequently a close professional and personal relationship developed between the submarine community and those scientists, like Allyn Vine and William Schevill of Woods Hole, who taught officers how to apply scientific developments to their craft. These scientists managed to convince operational officers that instruments such as the submarine BT could truly protect their boats in post attack searches and enhance their chances of survival.

At a 1972 Navy ceremony honoring Allyn Vine for his work on the BT and submarine BT, a former engineering officer on the USS GUITARRO (SS-363) recalled a time twenty-eight years before when his vessel barely survived a Japanese search. The GUITARRO managed to hide under a layer of dramatic temperature change at 240 feet detected by the submarine BT. He concluded his comments by saying, "We on the 363 have always believed in the BT but this attack made salesmen for the BT out of us." As a result of experiences like this, many veteran officers became great friends and apostles of oceanography when they occupied billets of considerable influence in the pentagon in the postwar era.

In addition to their research and instrument development, the WHOI faculty instructed naval officers both in the field and at Woods Hole in the operational application of naval oceanography. The faculty wrote manuals, held classes, rode the submarines giving lessons on the use of instruments, and acted as advisors to the commanders of American Submarine Forces in the Atlantic and Pacific. Woods Hole, in conjunction with Scripps Institute of Oceanography and the Naval Hydrographic Office also inaugurated the Submarine Supplements to Sailing Directions, a series of classified Navy publications which provided submarine officers with additional information regarding the most critical characteristics of the ocean in various war zones.

Some of WHOI's water temperature research also led to developments which proved significant after the war. In one case Maurice Ewing and J. Lamar Worzel discovered the remarkable sound transmission characteristics of the ocean's natural deep water channels and their possible importance for naval warfare. In the North Atlantic the deep sound channel usually occurred at approximately 4,000 feet. Ewing and Worzel determined that sound traveled at a minimum speed at this

depth. But, as Columbus Iselin recalled, because of sound refraction, or bending, "signals emitted in this layer can travel very long distances without having to undergo bottom or surface reflection. Thus sound transmission in this layer is relatively efficient and a receiver located at similar depth can record signals originating several thousand miles away."

By 1943, Ewing and Worzel developed their knowledge of underwater sound channels into the SOFAR system for locating downed airmen. The unfortunate pilot would drop a small bomb set to explode in the SOFAR sound channel. With the extraordinary transmission properties of this layer, the Navy could detect the submerged explosion at three carefully situated listening stations. The time the sound took to reach each station would provide sufficient data for rescue personnel to calculate the location of the pilot.

Using this same principle, but reversing the process, if the three stations broadcast a signal into the sound channel, a submarine equipped to receive the transmissions could easily determine its location. This alternate use of the SOFAR system, called RAFOS, formed the basis for postwar submarine navigation systems and the underwater Sound Surveillance System (SOSUS).

Wartime work demonstrated to scientists that applied research could produce great rewards, as well as new frontiers for exploration. For the submarine community, these conflicts identified the practical application of science as one of the most potent weapons in the submarine's arsenal.

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ILS - ESSENTIAL TO SUBMARINE WARFIGHTING

by CAPT James E. Collins, USN(Ret.)

"ILS - What is it and what value is it to the submarine skipper?" These are questions I asked when I found that I was to be assigned as ILS Director for the SEAWOLF SSN-21 Project. The reply was that ILS was the area in which I had voiced the greatest concern when I was a Squadron Commander, and from which I benefitted the most when I was in submarine command.

ILS - Integrated Logistic Support - provides through every element of this developing science the foundation for submarine support. ILS quantifies in minute detail every facet of manning and material support for submarines, including areas not generally recognized as falling under the *logistics umbrella*.

One of the primary reasons for the United States Submarine Force's continued demonstration of readiness and availability is the successful execution of ILS planning, although for a long time this support function wasn't known by this name. We have always relied on ILS, but generally didn't recognize it as such.

Submarine operations planners use three factors in formulating operating plans and determining numbers of submarines required to meet commitments:

(1) Force Availability -- that percentage of submarines available for deployment. This number is reduced by overhauls, restricted availabilities, or reduced status imposed by any of several deficiencies (e.g., training, manning, equipment failures);

(2) Mission Sustainability -- a measure of the submarine's ability to remain on station, and is enhanced by equipment redundancy, repair capability, repair parts on board, provisioning, and crew endurance;

(3) Submarine operating and maintenance (Life Cycle) costs -- always a major consideration for any weapons system program.

Thus, a submarine's readiness requires redundancy and maintainability designed into the submarine, adequate manning and continuous training, and a well planned maintenance support organization and system. It is also highly dependent upon having the right logistics support available at the right place at

the right time. As submarine operators we all know this, but most of us never fully appreciate the depth of the ILS science and its direct value to our submarines. For example, a lack of adequate repair parts and support equipments, trained operating and maintenance personnel, accurate technical documentation, or proper provisioning would greatly hinder submarine operations. ILS is thus a necessary function of submarine force planning as well as an integral part of new submarine development.

ILS covers all aspects of submarine support planning. The classic elements of ILS speak for themselves: Maintenance Planning; Manpower, Personnel, and Training (MPT); Support and Test Equipment; Logistics Technical Data (LTD); Computer Resources; Supply Support; Packaging, Handling, Storage, and Transportation (PHS&T); Facilities Planning and Support; Configuration Management; Standardization; and Reliability, Maintainability, and Availability (RM&A).

The goals of ILS are to:

(1) identify and develop support requirements that relate to and support system readiness objectives,

(2) design logistics support functions into the system, and

(3) provide the required support for minimum cost.

Integrated Logistic Support has been a factor from the beginning of the SEAWOLF design and acquisition process. One can gain an appreciation for the relation of ILS to current submarine operations through a discussion of support designed into this ship class.

The SSN-21 Project is under the direction of the SEAWOLF Program Manager, who reports to the Assistant Secretary of the Navy for Research, Development, and Acquisition. This project, the premier submarine acquisition program in the Navy, has clear goals: **Take advantage of developing technology to design and build a submarine for the 21st Century which will assure for decades to come our submarine advantage, yet be affordable in the near term and cost effective over the life of the ship.** In an October 1989 American Society of Naval Engineers Submarine Symposium in Portsmouth, New Hampshire, Mr. Frank C. Ambrose, current ILS director for the SEAWOLF Program, stated that "Prudent investments in submarine design and logistic support planning will lead to less depot-level maintenance and reduced operating and support

costs, while improving the availability to the fleet of safe and reliable submarines." This concept has been always been at the forefront throughout SEAWOLF development.

How will this concept be carried out in the SEAWOLF ILS planning process? One can answer this question by analyzing each of the above ILS elements as factored into SEAWOLF planning.

The first element is Maintenance Planning. This element, central to ILS planning and indeed to the overall design of the ship, is the crux of meeting SEAWOLF's operating goals: Control (read *decrease)* life cycle costs, enhance ship's reliability and safety, sustain material readiness, maximize availability (both in the short term as well as for the life of the ship), and facilitate the crew's ability to operate and maintain the ship. Maintenance planning as incorporated in the SEAWOLF design meets the goals of Reliability Centered Maintenance (RCM) concepts, and reflects the innovative character of SEAWOLF Program Manager's total ship planning:

(1) Operating cycle coinciding with refueling which is expected to occur at about the 15-year point (i.e., no interim overhauls);

(2) one restricted availability (SRA) of about 60-days duration occurring mid-cycle, primarily for combat system upgrade;

(3) system and equipment performance and vibration monitoring by ship's crew and site teams using both onboard and squadron based monitoring systems;

(4) a rotatable pool of components with use based upon SMMSO (Submarine Monitoring, Maintenance, and Support Office) analysis;

(5) accessibility enhanced by engineered access, controlled rigging paths, and a logistics escape trunk through which most major equipments can be removed without hull cuts;

(6) reliability designed into systems so that planned maintenance (PM) can be scheduled as much as possible into in-port availabilities to lessen at-sea PM requirements on the crew; and

(7) material condition feedback to assist crew, repair facility, squadron, and type commander planners.

Thus, limited crew size and optimum ship availability remain forefront in SEAWOLF's total maintenance planning. As a result, it is estimated that overhaul and SRA costs will decrease by a factor of six from current extended operating cycle (EOC) costs, and by a factor greater than twelve from pre-EOC submarines.

MPT, the next ILS element, takes in all aspects of submarine and support repair facility manning, onboard and shore based training, training device development, and pipeline training for all skills, including operating and maintenance training for submarine and repair facility personnel. A complicating factor in new submarine design is that systems become more complex, yet there is a need to limit the size of the operating crew. Thus, correlation of manning in the various rates with systems design is an iterative process.

Support and Test Equipment planning is vital to ship's operations and maintenance. This element includes not only the selection of each piece of support and test equipment, but its availability, supply support, maintainability, ruggedness, and diversity of use. Only so much equipment can be carried on board, and it has to be operational throughout a submerged deployment.

The Logistics Technical Data (LTD) ILS element covers all aspects of technical manuals and technical drawings. Proper documentation is essential to all other ILS elements, and to the operation and maintenance of the ship. In SEAWOLF, this element leads directly to the Computer Resources element.

Computer Resources planning is integral to SEAWOLF operations. Besides the myriad of onboard computers for operations and war-fighting, including the combat and navigational systems, SEAWOLF will employ the latest in computer technology for administrative support and training. The plethora of technical manuals, supply documentation, drawings, and training booklets has overloaded the storage capability of most submarines. SEAWOLF crews will be able to call up COSAL and repair parts storage data on their terminals, use data banks of technical information and drawings for maintaining ship's systems, and conduct interactive qualification and training. The *paperless ship* concept has been the subject of much publicity -- if any ship presently in the planning state can approach this concept, SEAWOLF comes closest. Further in

the future, decision support systems will assist crews in operational decision making - a task becoming increasingly difficult because of the sheer amount of rapidly changing tactical data available to the Commanding Officer and his Fire Control Party.

The elements of Supply Support and PHS&T are interrelated. Supply support for SEAWOLF incorporates the concept of Timely Spares Provisioning. This means that Navy supply support for all ship's systems will be in effect at the time of delivery. Interim support directly from manufacturers and later transition to Navy supply support will be a thing of the past. New ADP programs are available for supply support planning, and are in use now. Parts have to be packaged, transported, and stored safely - free from corrosion, breakage, and in many cases electrostatic discharge. Systems have to be in place to have parts available to submarines in their home ports as well as during port visits.

Proper Facilities planning is paramount to SEAWOLF operability. The ship has to be able to transit to, moor, and be supported in our established submarine homeports. This requires considerations such as dredging, pier status, hull protection from tug boats and adjacent ships, resident and available drydocks without the need to depend on shipyard support, deperming facility availability, SMMSO team and warehouse space, and explosive arcs to accommodate the increased SEAWOLF weapons load support needs. These considerations resulted in the undertaking of a homeporting study, to formulate SSN homeporting plans into the next century.

Configuration Management (CM) drives system and equipment ILS planning. The ultimate goal of CM is to result in each ship of the class being an exact copy of the first. Since this is rarely attainable, configuration management functions to maintain detailed records over the life of the ship of differences from original design, and differences that develop between ships of the class. Thus when maintenance or overhaul is required, planning, parts, and procedures will match the systems as installed in that particular ship.

Standardization is a key to effective Configuration Management and Supply Support. The benefits of using standard or like components throughout the ship are obvious. The result are simpler supply and storage requirements for standard

components, and easier configuration management.

RM&A reviews all aspects of reliability, maintainability, and availability of the ship and each of its systems. The goal of RM&A is "Reliability by design, not by chance." Calculations of RM&A sum up the results of total ship and ILS planning, and must achieve a designated readiness, called Operational Availability, A_o. Although calculation of A_o requires an extensive computer program, operational availability is best described as a function of the relationships among hardware, personnel, and procedures:

$$A_o = \text{(Up Time)} / \text{(Up Time + Down Time)}$$

An A_o of 0.98 would mean that the system is calculated to be available 98% of the time. The program is run with different mission profiles; for example, an Arctic Ocean or an Indian Ocean deployment. While a satisfactory A_o is necessary for DoD approval to continue program development, RM&A analyses assist ship's planners in analyzing all facets of operations and maintenance toward a target of meeting all system's goals.

By way of concluding this description of Integrated Logistic Support, the value of proper planning and execution of ILS should be apparent to the operators of today's submarines. We have well trained people coming to our ships; complete and detailed maintenance planning has resulted in successful implementation of the extended operating cycle; very few missions have had to be aborted for material or training reasons; SSBN patrols continue an unparalleled record of success; the list goes on and on. The result of proper ILS planning for today's operators is simply the means for making their difficult and challenging job far easier and their goals attainable.

■

TARGET MOTION ANALYSIS INNOVATIONS BY NAVAL OFFICERS

by Daniel H. Wagner
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Target motion analysis (TMA) has received enormous attention since ASW became the primary mission of attack submarines in the early 1950's. Many, perhaps most, of the fundamentals of TMA based on three or four bearings have been innovations by naval officers, predominantly submariners, working outside their normally assigned duties. In fact, from my 38 years of experience with naval tactical analysis (as a civilian operations analyst and mathematician, not specialized in TMA), I can think of no topic that has attracted as much officer analysis work as TMA. This article reports the most successful officer TMA innovations of which I am aware. It undoubtedly has gaps, which I hope readers will fill.

The more advanced statistical processing methods, by civilian scientists, are not addressed, nor are the important and extensive officer management roles in TMA development and testing, largely by COMSUBDEVRON TWELVE (CSDS-12) and its predecessor, COMSUBDEVGRU TWO (CSDG-2). To keep the focus on officers, credit lines to civilians are suppressed. I have attempted a more comprehensive TMA history in *Naval Tactical Decision Aids, Military Operations Research Lecture Notes, NPSOR-1,* by Daniel H. Wagner, Naval Postgraduate School, September 1989. Contemporary expositions of TMA substance are also in *Theory of Ranging and Target Motion Analysis*, Draft NWP 71-1-4, in preparation, 1991, COMSUBDEVRON TWELVE, and *Naval Operations Analysis (Third Edition)*, in preparation at USNA for Naval Institute Press, 1991.

TMA is estimation of a target's position, course, and speed. Here we stick to **linear** target motion (constant course and speed).

We begin with the Lynch Plot, devised in early WWII by LT (later CAPT) Frank Lynch. He was serving on the recommissioned WWI submarine R-1. Her first sonar had been installed, and Lynch was assigned to find a method to make sound-only approaches on a surface ship, for sea trials a few days hence.

Through intense pre-sail effort and excellent geometric insight, Lynch found a pivotal relationship among bearings, bearing rate, and target relative motion. In ensuing weeks, he perfected the Lynch Plot working evenings plotting geometries. He used this method throughout the war as XO HARDER under Medal of Honor winner CDR S. D. Dealey and as CO HADDO. Post-war it entered the Submarine School curriculum, remaining in use into the 1960's.

For this account of the Lynch Plot, I am indebted primarily to David Ghen of Analysis & Technology, based on his conversations with Lynch and later his widow, and also to retired CAPT Frank Andrews. Andrews also made the interesting observation that, while it wasn't an innovation, his Chief Engineering Officer on the K-1, LT Jimmy Carter, wrote a creditable command thesis on the bearing rate slide rule. I am unable to unearth documentation of the Lynch Plot method -- perhaps readers can provide this. I also invite information on the vintage and originator(s) of the strip plot.

A landmark innovation occurred with the development in 1953 of the Spiess Plot by CDR (later CAPT) Fred Spiess, USNR, in *Complete Solution of the Bearings Only Approach Problem*, Scripps Institution of Oceanography, 15 December, 1953. He was at the time a civilian oceanographer with the Marine Physical Laboratory (which he directed for 22 years), Scripps Institution of Oceanography. I include this work because it was inspired by his extensive combat submarine experience and a three-month West Pac SS tour in 1953, and because it is so important. Spiess showed that given bearings at three times, the locus of target position at a chosen fourth time is a computable straight line, now called a **Spiess line**. By intersecting the Spiess line with the bearing at the fourth time, position is found, *unless* the two coincide (now called a *singularity*). His solution also yields course and speed, which can also be done by, e.g., reversing the time sequence to find a second position. This was the first complete TMA method by bearings only. Graphic methods of solution were developed jointly by Spiess and LT (later CDR) William Liesk and introduced by Leisk to submarine officers' classes at Fleet ASW School, San Diego.

Spiess gave an algebraic condition necessary for a singularity to occur. If own track is linear, Spiess lines are bearings lines and a singularity is inevitable. Being close to a singularity is

bad, and difficulties with Spiess Plots are probably attributable to inadequate understanding of this hazard. Recently, Midshipman 2/C Frederic Nauck at the Naval Academy, who is probably a future submariner, performed an interesting investigation (see *Singularities in Spiess Target Motion Analysis* by Frederick E. Nauck, U.S. Naval Academy Mathematics Honors Report, May 1991), of loci of singularity situations, in which he developed a PC tacaid to provide guidance for avoidance of singularities.

A very interesting innovation in TMA theory was observed in 1953 by LT John Kettelle, USNR, now CEO of Ketron, Inc.. If own track is linear, then three distinct bearings determine a parabola tangent to bearings at all times and to all possible target tracks consistent with the three bearings. At the time Kettelle's active duty on GUITARRO interrupted his graduate work in mathematics. This observation was published by Kettelle in *Parabolic Envelope of Bearings-Only Tracks*, Journal of Underwater Acoustics, 11 October 1961, and independently by a NEWRES civilian in 1960. The first documented proof was by the latter in 1970. It can be shown in *Naval Operations Analysis (Third Edition)* that even if own track is not linear, three bearings determine a parabola tangent to the Spiess lines and the tracks. Also, the axis of the parabola is parallel to the direction of relative motion.

In 1954 LT (later CAPT) John F. Fagan, in his Command Theses, *A Mathematical Method for Solving the Sonar Fire Control Problem*, derived a four-bearing TMA solution from a system of three transcendental equations. To make this computable by slide rule, he assumed own motion during three bearings was approximately zero, which was probably satisfactory for diesel operations.

Probably the most famous TMA method is Ekelund ranging, devised in 1958 by LT (later RADM) John J. Ekelund, as an instructor at the Submarine School. The Ekelund range estimate is the difference between own speeds across line of sight, before and after own turn, divided by the bearing rate difference in reverse order. After deriving this theoretically, Ekelund tested it in lunch hours on the attack trainer, assisted by fellow instructor LT (later CAPT) Roy Goldman. Ekelund's report through channels was bounced for revision multiple times, so he submitted it directly for publication in the COMSUBLANT Quarterly Information Bulletin in the summer of

1958. From that dissemination it was picked up in the Fleet and eventually gained widespread use in several navies. I believe it would be very difficult for contemporary dissemination of this nature to gain attention amid the pressures on Fleet personnel to absorb existing technology.

Ekelund ranging is convenient and can be quite useful. It does assume idealizations that can introduce serious errors. Ekelund gave attention to maneuvers to reduce such errors, and investigation of this issue was carried much further by CAPT Fagan. The powerful method of **time correction** can greatly reduce such errors by finding **best range times** at which range estimation is insensitive to target speed in line of sight. Also, the Spiess line at a best range time is perpendicular to a particular bearing used to find the best range time. Fagan's work is credited as being an important precursor to time correction.

The important classified innovation called FLIT was developed by ENS Lyle Anderson in 1970. Much of the fundamentals had been given independently by an Electric Boat (EB) civilian in 1969. Anderson was a surface officer assigned to CSDG-2 awaiting nuclear power school. His work was quickly taken up by CSDG-2, and with supplementary implementation work by EB it was tried successfully at sea in a few months. He drew high praise from CSDS-2 management and civilian mathematicians and was awarded the Navy Commendation Medal. CSDG-2 held him over and steered him into submarine duty.

The final innovation I'll mention is the following observation of LT Jerry Gullick at CSDS-12 in 1980: If own and target tracks are linear and L is the bearing line between them at some time, then the intersection of the other bearing lines with L moves at a constant rate. This came to be known as "Gullick's theorem" and is not hard to prove. Gullick used it as a basis for a four-bearing TMA method -- W. J. Browning of Applied Mathematics, Inc. supplied me with informal documentation. Of more interest is the fact that Gullick's theorem can be used as a step in a proof of the parabola theorem.

That naval officers have provided abundant TMA innovations should not be surprising. What has been surprising to me is that after four decades of extensive investigations in TMA by large amounts of expertise, very interesting and useful innovations, which I am not trying to report here, based on a few

bearings, are still being obtained. Future officer initiative and success in this area are to be expected.

■

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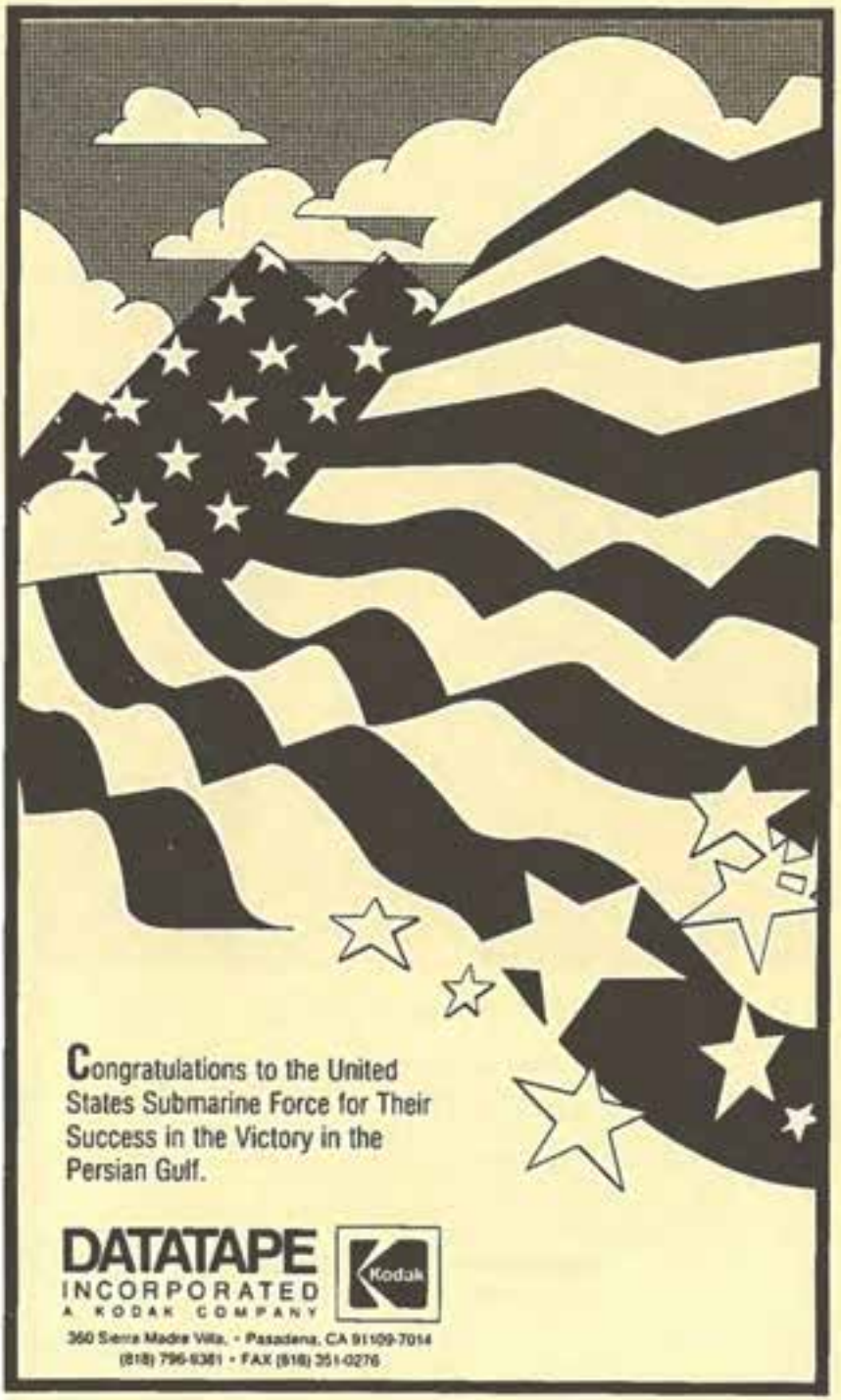
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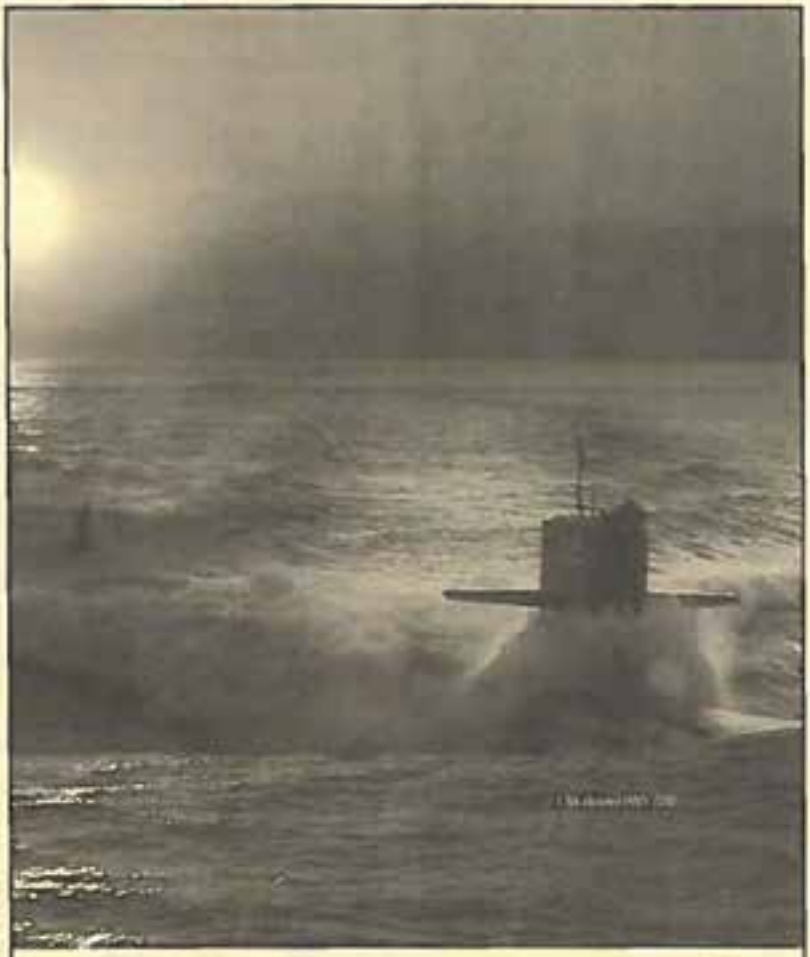

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SUBMARINER PURPLE HEARTS

by CAPT Stan Sirmans, USN

On the morning of Dec. 7, 1941, the Pacific fleet's call to colors was interrupted by the roar of aircraft and at 0757, World War II's first bomb aimed at America exploded on the seaplane ramp of Patrol Squadron 22 at Ford Island, slightly wounding three sailors. By 0800, several ships, including USS DOLPHIN (SS-169), USS NARWHAL (SS-167) and USS TAUTOG (SS-199), had opened fire at the attacking Japanese aircraft. USS CACHALOT (SS-170) crewmen were a little behind. Moored in the Pearl Harbor Naval Shipyard just behind dry docked USS PENNSYLVANIA (BB-38), CACHALOT was covered with scaffolding and part of her deck and periscope shears had been removed. Her crewmen had an awkward time getting guns rigged, but by 0803, a .30 cal. and a .50 cal. machine gun were firing. Soon after opening fire, a Zero made a strafing run against the ships in CACHALOT's area and several bullets hit her superstructure, flinging bits of metal through the air. S1C Charles Arthur Meyer, who had been sent topside to help replace ballast tank covers, was struck in the chest by several fragments. He was the first submariner to be wounded in World War II.

When the last submarine patrol ended in 1945, submariners had become one of the most decorated groups of fighting men in the war. Well known are the feats of Medal of Honor winners Cromwell, Dealey, Gilmore, Fluckey, O'Kane, Ramage and Street. The most Navy Crosses ever awarded -- five -- were won by submariner CDR Roy Davenport. Six more submarine Commanding Officers received four each. Five enlisted submariners also were awarded Navy Crosses, and over four thousand other awards of the Silver Star, Legion of Merit, Navy and Marine Corps Medal, Bronze Star and Secretary of the Navy Letter of Commendation were made to enlisted dolphin wearers. But almost nothing is known of the Purple Hearts awarded to World War II submariners. Yet, this medal was awarded to over 2000, and not just those who went down with their boats. Purple Hearts also were awarded to a number of submariners for wounds received in surface actions, and for mistreatment while prisoners of war of the Japanese.

When World War II began, the Purple Heart was an Army medal. Modeled on the Badge of Military Merit given to three enlisted men by GEN George Washington in the Revolutionary War, it was created by Army Chief of Staff GEN Douglas MacArthur. It was made official during the Washington birthday bicentennial celebration Feb. 22, 1932. It actually had come about through a long struggle within the Army which started soon after World War I, to establish a medal to reward junior officers and enlisted men for meritorious service. GEN John J. Pershing only had three medals available for World War I soldiers: the Medal of Honor, Distinguished Service Cross and Distinguished Service Medal. The first two were for heroism and the latter was to recognize "exceptionally meritorious service to the government in a position of great responsibility" -- usually colonels and generals. There were no medals for the thousands of junior men and women who had performed meritoriously.

After 13 years of bureaucratic infighting by successive Army Chiefs of Staff, MacArthur got the Purple Heart -- primarily by an end around Congress to President Herbert Hoover who signed an executive order authorizing the medal. It was to be called the Badge of Military Merit like Washington's medal, but MacArthur struck through that name in a Dec. 7, 1931 memorandum and changed it to the "Purple Heart." With another stroke of the pen, he changed the criterion from meritorious service to that of having been wounded, concluding that anyone who had been wounded in war had performed meritoriously. It should be noted that MacArthur himself had been wounded twice by gas in World War I. He would receive Purple Heart serial #1 with an oak leaf cluster.

A final quirk of the new medal was that anyone who had been in or assigned to the Army, had been wounded in action, was still living and could provide a medical certificate proving wounds, could receive the Purple Heart. At least ten Civil War veterans, a number of veterans of the Spanish American War, and some from the Indian Wars, the Boxer Rebellion and the *Banana Wars* received Purple Hearts. However, in setting the parameters of the medal, MacArthur directed that it not be made a posthumous award.

Members of the Navy, Marine Corps and Coast Guard not serving with the Army weren't eligible for the Purple Heart

until President Roosevelt signed Executive Order No. 9277 on Dec. 3, 1942. Besides making the award an all-service one, it provided for posthumous awards to next of kin. It also allowed the delegation of authority to Fleet Commanders or designated subordinate commands for awarding the medal. The actual administration of the Purple Heart in the Navy was placed in the hands of the Bureau of Naval Personnel (BUPERS) Medals and Awards Section, with instructions to refer doubtful cases to the Secretary of the Navy's Board of Decorations and Medals. BUPERS retained the authority to award posthumous medals in the name of the Secretary. This was never delegated.

Fleet Commanders began awarding the Purple Heart in December 1942, but only ribbons were initially available. Actual Purple Heart medals were not presented within the Navy until May 1943, when BUPERS began mailing out medals to the next of kin of those killed at Pearl Harbor, in the Philippines and in the battles of the Coral Sea and Midway. This mailout included the first awards to submariners. A Purple Heart was sent to the parents of LTJG Samuel H. Hunter, Jr. of USS SEADRAGON (SS-194), killed by fragments of the bombs which destroyed USS SEALION (SS-195) in Cavite Navy Yard, P.I. on Dec. 10, 1941. He was the first officer of the submarine force killed in World War II. Medals also went out to the next of kin of SEALION's dead, the first enlisted submariners killed in the war. They were: CEM Sterling C. Foster, CEM Melvin D. O'Connell, MOMM1 Ernest E. Ogilvie and EM3 Valentyne L. Paul.

Also mailed in May 1943 were Purple Hearts to the next of kin of CDR Howard W. Gilmore, ENS William W. Williams and F3c Wilbert F. Kelley, killed during the USS GROWLER (SS-215) engagement with the Japanese provision ship HAYASAKI Feb. 7 1943. The first living submariner to be presented a Purple Heart was TM3 John A. Baxley, one of the surviving GROWLER lookouts. He received his Purple Heart from the Commanding Officer of the Oak Knoll Naval Hospital July 6, 1943. The other wounded GROWLER lookout who survived, GM3 George Wade, didn't get his Purple Heart until Sept. 29, 1943, while recuperating at the U.S. Naval Hospital, Treasure Island.

There was another man wounded in the GROWLER engagement. He was LCDR Arnold F. Schade, the Executive Officer

who took command of the boat when Gilmore was lost. Though severely bruised in a fall from the conning tower to the control room when HAYASAKE and GROWLER collided, he didn't consider himself wounded and his name was not included in the casualty message. As now retired VADM Schade says, he was "battered and bruised several times, but no Purple Heart -- for which I thank the Lord." This philosophy was fairly typical of submariners at least early in the war. If a bullet or shrapnel didn't hit you, you weren't wounded. So while surface force personnel collected Purple Hearts from a variety of injuries due to enemy action, including smoke inhalation, hearing loss, exposure, sunburn, sprains and contusions like Schade's, submariners sustaining similar injuries while firing deck guns or being depth charged often received no Purple Hearts. As an example, though a number of submarine personnel were injured from flying glass and the like during depth charge attacks, only two received Purple Hearts. One, former TM1 Howard E. McCune of USS SNOOK (SS-279), didn't get his until 1989. As VADM John A. Tyree, Jr., former CO of USS FINBACK (SS-230), put it in a letter to the author, "We often joked that as submariners, we did not aspire to be awarded the Purple Heart. We looked upon it as a posthumous award for the boys in the *overdue* boats."

And what of the *boys in the overdue boats*? The submarines lost due to enemy action in World War II were initially listed as *presumed lost* and the men aboard them were carried as *missing*. Since the crewmen weren't declared dead, no Purple Hearts could be awarded. However, the ever resourceful VADM Charles A. Lockwood, Jr., COMSUBPAC, had his staff send Submarine Combat Patrol Pins to the next of kin of missing submariners. Each pin had the correct number of stars indicating successful war patrols and each was accompanied by a special letter from Lockwood praising the contributions of the families and their missing kin.

On Feb. 16, 1943, the men of USS SHARK (SS-174), missing since Mar. 7, 1942, were declared dead, the result of information received from various intelligence sources. BUPERS mailed SHARK crewmen's Purple Hearts to their next of kin July 31 of that year. These were the first posthumous Purple Heart awards to submariners of a boat lost with all hands due to enemy action. They were followed by Purple Hearts to next

of kin of USS ARGONAUT (SS-166) and USS AMBERJACK (SS-219) also sunk in 1942, and to those of USS GRAMPUS (SS-207) and USS TRITON (SS-201), lost in early 1943. The TRITON medals were the last posthumous Purple Hearts awarded to submariners until after the war.

As the war continued, more Purple Hearts were awarded to living submariners, usually for being wounded during surface action against Japanese aircraft and ships. Most notable were six including the XO aboard USS PLUNGER (SS-179), wounded by a Japanese Zero while picking up a downed pilot, and ten aboard USS TROUT (SS-202) wounded by machine gun fire while battling on the surface with a damaged Japanese merchant ship. In fact, as the number of submariners wounded in surface engagements increased, disagreement developed in the submarine community as to whether the results of surface battles with Japanese ships were worth the increased danger to crews and boats. Although patrol instructions directed skippers to sink enemy shipping with all means available, some were reluctant to use their guns. Even Chief of Naval Operations, ADM Ernest J. King, expressed his displeasure at a duel between USS GATO (SS-212) and a Japanese aircraft in Dec. 1943. Finally, VADM Lockwood directed that submarine COs would not engage enemy vessels on the surface within the range of small arms fire.

Though conservative in awarding Purple Hearts, the submarine force did have some unusual ones. RM3 Kenneth H. Williams of USS SKIPJACK (SS-184) received a Purple Heart for frostbite to both hands while serving as trainer on the 4" gun during a surface engagement. LT Robert C. Giffen, Jr., USS GURNARD (SS-254), was wounded when he attempted to stop a runaway bow planes wheel caused by a bomb attack from a Japanese aircraft. He received severe contusions and lacerations when thrown across the control room. Several submariners received Purple Hearts from being injured by their own guns when shells exploded in the breech. TM3 Caleb L. Cochran, USS ROCK (SS-274), almost lost a finger while loading a round in the 4" gun during the shelling of a Japanese installation in the Philippines. Coincidentally, the ROCK CO, CDR Robert A. Keating, on the bridge during the engagement, received flash burns and was temporarily blinded by the same 4" gun. His XO had to take over for several days. VADM

Lockwood awarded them both Purple Hearts.

When the war was over, there was a flurry of activity in the BUPERS Medals and Awards Section to mail posthumous awards of the Purple Heart and other medals to the next of kin of submariners who were finally declared dead. The preparation of posthumous Purple Hearts was different from those awarded living individuals. BUPERS had each one hand engraved with the name and rank/rate/rating of the recipient. This caused some management difficulties. The medals and a list of what had to be engraved on each one was picked up by the Navy's contract engraver who worked in his home in Washington, D.C. When the medals were ready, they were delivered back to BUPERS, matched with the appropriate certificates and mailed to the next of kin. In spite of these arrangements, surviving records indicate few mistakes.

Another category of Purple Heart recipients required a great deal of effort on the part of the Medals and Awards Section at the end of the war - returning prisoners of war who had been mistreated by their captors. The Navy Board of Decorations and Medals declared soon after the war was over that mistreatment to POWs such as beatings by their captors merited the award of the Purple Heart. However, mistreatment had to be substantiated in some manner. Since there usually were no medical records from the POW camps, substantiation usually took the form of lengthy affidavits from officers who had been POWs. Full names often were not known and this required research. Among those Navy men returning from Japanese POW camps were 164 submariners from seven boats. Although all had been mistreated, due to administrative errors, only 95 received Purple Hearts. Twenty-four other submarine POWs were awarded Purple Hearts for being killed while prisoners. Those who died from starvation or disease, although beaten before they died, were not awarded Purple Hearts. BUPERS determined that their deaths were "were not as a direct result of a wound received in action with an enemy."

A number of the submariners returning from prisoner of war camps passed through Camp Dealey, the submariner rest camp at Guam, and through Pearl Harbor. Once again, *Uncle Charlie* Lockwood wasn't satisfied to wait for the bureaucracy to take care of *his people*. He met the arriving POWs and awarded them Purple Hearts. BUPERS refused to accept the followup

paperwork from the COMSUBPAC Awards Board and directed that the men be instructed to make application for Purple Hearts "with substantiating papers" to the Chief of Naval Personnel. By this time the men had been sent to hospitals throughout the United States and these instructions apparently didn't reach them. Consequently, few of the submariners awarded Purple Hearts by Lockwood had the medals entered in their service records.

Today, the Navy's Awards and Special Projects Branch of CNO's office in Washington, D.C. and the Navy Liaison at the National Personnel Records Center in St. Louis are still receiving requests from World War II submariners for Purple Hearts. Medical and service records are checked to substantiate a wound. Often there is no mention of one. That's as far as the Navy will go in helping a man receive a Purple Heart. Copies of deck logs or war patrol reports documenting the wound must be provided by the submariner. But these sometimes don't list men slightly injured who were treated by the boat's corpsman. In that case, two affidavits from eye witnesses to the wounding usually will suffice for awarding of the Purple Heart.

And what about the first submariner wounded in World War II -S1C Meyer? His wounds weren't very serious and in the rush to get CACHALOT buttoned up and out to sea, it didn't seem important. Most on board, including the boat's gunnery officer, LTJG Otis R. Cole, and newly reporting ENS Albert J. Beede, didn't even know he had been wounded. Meyer was taken to the Pearl Harbor Naval Hospital in a pickup truck driven by a shipyard worker. Later that day, he was moved to Aiea Naval Hospital where the shrapnel was removed from his chest. He checked himself out that evening and hitchhiked back to CACHALOT. He made the boat's first war patrol and was awarded a Secretary of the Navy Commendation for the patrol. His Purple Heart was finally awarded in June 1946, while he was serving in USS TUNA (SS-203).

[Editor's note: This article is condensed from a chapter of Hearts: A History of the Purple Heart, currently being researched and written by Stan Sirmans.] ■

STRATPLAN 2010 - A LONG-RANGE PROCESS PLANNING THE NAVY'S FUTURE IN STRATEGIC DETERRENCE

by Captain Conrad A. Plyler, Jr.
Head, Analysis and Evaluation Branch
Strategic and Theater Nuclear Warfare Div. (OP-65)

The TRIDENT D-5 weapon system is the **modernized** leg of the strategic systems triad. It is an invulnerable, flexible, and supremely capable system for today's rapidly changing world and will be durable throughout its service life. But as confident as we are in the capability of TRIDENT to continue to deter global nuclear warfare, we must accept two principal points. First, weapon systems don't last forever. They are overcome by the advance of technology, or they simply become less capable because of age. Our museums are full of systems and weapons of war which, although ideally suited to their missions at the time, are now well obsolete and useful only to document the past. And so, despite its nonpareil position among other legs of today's triad, TRIDENT, too, will reach the end of its practical service life. Second, the world is changing much faster than even the most prescient of our oracles could have predicted. As this is being written, the war in the Persian Gulf is over, but stability in the region is uncertain. And other regional conflicts, absent the global power oversight of the USSR, are increasingly likely.

These two points lead to an inescapable conclusion: if the Navy is to continue in its role as this nation's preeminent strategic deterrent force, there must be a plan for the future. It would be folly to put together any plan in a rigid fashion, hoping that all of its facets would be played out, or even that the destination would be the same as intended at the beginning. Plans are made to be changed. There is no better example of this than a plan to predict the Navy's role in strategic defense twenty to fifty years in the future. Imagine planning, at the end of World War II, to send men to the moon in 1969, knowing little about the advance of the technology required. Yet this is something like the magnitude of the task we face when planning TRIDENT's successor, whose service life will begin as early as about 2010 and stretch out until around 2040 to 2060.

There are other issues which make planning now for the future necessary. In these days of tight DOD budgets, we cannot afford to produce as many big-ticket items, and so force levels measured in numbers of weapons must decline. But investment in research and development for new systems must continue. As unknowable as the future is, estimation of the direction of future policy and potential Navy roles is required to ensure our R&D effort is structured to minimize regret. The industrial base of the nation requires support continuously if it is to be ready to respond to production requirements of the future. We cannot afford to allow the creative scientific and engineering power of this country to atrophy.

But a problem confronts us when we try to make these points. There are few customers for change. A few years ago, the CNO, Admiral C. A. H. Trost, as the Navy's chief long-range planner, sought to remedy the situation. Questions about the Navy's future role in strategic deterrence prompted a study to determine the Navy's contribution to the nation's strategic defense after the year 2010. This date was picked to be near the first TRIDENT submarine's end of service life (based on a 30 year estimate). In the terms of reference for the study, CNO spelled out guidelines which would allow ample room for innovative thought as the study progressed. He foresaw that the course of arms control and technological development were not clearly defined and that other considerations were even more blurred. The very definition of the word "strategic" was opened to debate, certainly not automatically to be equated to the term nuclear when applied to the armament of future forces. The notion that a future Navy strategic force could be based in platforms other than, or in addition to, submarines was suggested. Treatment of Sea-Launched Cruise Missiles (SLCM) as strategic weapons was recognized as an option. Finally, Admiral Trost suggested that the Navy's future strategic role might encompass missions in SDI, Anti-Satellite, Satellite Reconstitution, and Theater Offense and Defense. It was not assumed that the Navy would cover all roles; there are many reasons why other services might take the lead, but Admiral Trost wanted R&D directed to give the Navy the options to participate.

The study team had to invent an organizing principle from scratch. It turned out to be amazingly simple, but nevertheless

unique, because the process finally decided upon was different from traditional methods of advance planning for system acquisition. STRATPLAN 2010, as the study became known, was rooted in an assessment of the course of national strategic policy, instead of reaction to a threat or the development of a technology which could be easily weaponized. Sensitive to allegations that some new weapons are developed before a mission is clearly defined, the team decided that future systems should be developed to accomplish predetermined missions stemming from National Policy, and not the other way around. So, from policy direction, roles and missions were developed. Using these roles and missions, and considering threats to platforms and weapons and the capabilities of the technology spectrum for the first time, operational requirements and desires for force characteristics were drawn up. Only then were concepts for system designs formulated. System design concepts ultimately were decided upon only after orderly consideration of national policy and the factors which flow from it. As it progressed, the study became a process for advance planning which could continue beyond the decision on the next system.

Phase I

The end of the first year of STRATPLAN 2010 saw the development of the planning process completed, with separate panels working to address National Policy, Operational Requirements and Force Characteristics, Advanced Technology, and Concept Development for the traditional strategic deterrent roles of Offensive Strike and Secure Reserve. Several key insights and findings from this Phase I surfaced. First, future force structure is likely to be driven by national policy, arms control, and the fiscal and political situation, instead of by threat and the input of advanced technology. Of course, new threats and the development of new technology will influence the final character of future forces, but their inputs come only after missions are defined by national policy. Second, force characteristics of survivability, lethality, flexibility, and reliability exemplified by the SSBN/SLBM combination continue to be the answer for traditional strategic deterrent roles. No other platform and weapon combination was convincingly strong enough in all of the characteristics, despite the development of over one hundred concept options, many of which centered around other platform and weapon types. Third, the

TRIDENT weapon system was found to be a durable concept throughout its service life, within the predicted spectrum of national strategic policy. And fourth, based on the nominal time required to design a new system, including research and development of the required technologies, now is the time to begin looking at the technologies and missions of the next generation SSBN.

The Phase I finding that the submarine and ballistic missile were the most desirable naval platform and weapon system for traditional strategic deterrent roles narrowed the focus to just a few tradeoffs. These center on cost and survivability as the primary factors affecting decision-making. Fiscal pressure to build less expensive platforms begs a look at submarines of different sizes. In additiion, because arms control development of a new submarine-launched ballistic missile with fewer warheads than the D-5, and because a lower ceiling on total missile numbers may lead to fewer missiles per SSBN, the next generation system might be made up of a smaller SSBN carrying smaller missiles. It remains to be seen whether a new concept of this type will be more affordable, but intuitively it seems so.

Phase II

Three other primary roles not addressed in Phase I have become the focus of the second phase of work: Theater Support, Strategic Defense and Space Control. Theater Support, comprised of Theater Offense and Defense, is defined as the use of naval assets in regional theaters of operations for coastal and deep strike, and for defense against Tactical/Theater Ballistic Missiles (T/TBM). The Navy's role in Strategic Defense could be as an adjunct to SDIO space-based and land-based systems for defense of the U.S. against Soviet attack, as well as part of a national strategy of Global Protection Against Limited Strike (GPALS). Space Control roles of anti-satellite (ASAT) and C^3I reconstitution finish off the effort.

Even though Phase II is only about one-third complete, some key findings are becoming obvious. First, instead of just one platform type and delivery vehicle, a mix of platforms and systems may be required. Surface ships and air platforms could become important. And conventional and exotic weapon types appear to have some usefulness. Second, application of naval forces to these new missions is no more than the extension of traditional naval missions into the future, albeit with new names

assigned. Finally, if these future missions become national imperatives, maintaining this country's technological superiority will be essential. Careful planning for the future and investing in research and development now is the first step in keeping the edge.

Summary

STRATPLAN 2010 is a process in place for planning the Navy's strategic weapon system future. It is well on the way toward recommending design concepts for a successor to TRIDENT. New missions in space, strategic defense, and theater support may require new platforms and weapon systems. Evaluation is just beginning in this area. Integration of efforts dealing with traditional strategic deterrence and these new missions will lead to a strategy for R&D investment applicable to the period beginning with POM-94. Implementation of this strategy, based on national strategic policy, will lead to an affordable reinforcement of the nation's technological base and industrial capacity.

■

IN REMEMBRANCE

Captain E. M. Archer, USN(Ret.)

Rear Admiral Wreford G. Chapple, USN(Ret.)

CDR Richard G. Colquhoun, USN(Ret.)

Rear Admiral Edward M. Peebles, USN(Ret.)

Rear Admiral Donald Whitmire, USN(Ret.)

ATTACKING SOVIET ARCTIC COMMERCE

by Richard Thompson

In deciding how to deploy U.S. SSN's in a future war with the Soviet Union, commerce destruction has taken a back seat to higher priority missions such as interdicting Soviet SSN's, destruction of land targets, and threatening Red fleet SSBN's in their bastions. Yet commerce destruction, particularly in the Soviet Arctic, remains, for American SSN's, a viable mission which has tactical and strategic importance much greater than the resources necessary to accomplish it.

We generally think of the Soviet Union as the prototypical *land power*: a nation little of whose trade is seagoing and for whom the effects of a campaign of commerce destruction at sea would be negligible. Is this really so? For instance, the Soviet Union's merchant fleet is the most numerous in the world (apart from those flying flags of convenience), comprising over 2,000 ships. A large fraction of these ships carry commodities mined, pumped, or harvested from the Soviet Union, which provide much of her hard currency earnings. Many manufactured goods, like bulk commodities such as timber and ores, can only be transported cost-effectively on ships, or are destined for overseas customers. It is difficult to overestimate the importance of hard currency earned abroad to the Soviet Union, and in war her need for foreign exchange would be greater, particularly with the disintegration of the Warsaw Pact. While the Soviet Union is not as vulnerable is this regard as Japan or Great Britain, a campaign of blockade and commerce destruction might exert useful pressure in the event of war.

A significant fraction of Soviet shipping (80% of coastal traffic) is within the Soviet Arctic. From our perspective, this shipping has some interesting features. First, owing to the poor road and railroad system in Siberia, much of what is produced there must be moved down rivers for trans-shipment from ports on the Arctic coast. Similarly, shipping along the Soviet Arctic coast provides most of the supplies for many settlements in Siberia, particularly those along the Lena, Ob, and Yenisey rivers. Apart from the Trans-Siberian Railway and air routes, the Arctic sea lanes represent the main connection between Europe and Siberia and the Soviet Far East. Blocking these

routes would tend to isolate the Soviet Far East from supplies of fuel and other bulk commodities. One is reminded of the Germans having to re-base their U-boats in Norway after the Normandy invasion in 1944 cut off supplies of fuel to the Biscay ports. Consider the environment and character of Arctic shipping. The Arctic coast east of the White Sea is typically icebound eight months of the year, and the Soviets maintain a fleet of more than fifty icebreakers to permit shipping operations. In 1983, a difficult year, the summer lasted only three weeks. It is the extreme character of the conditions which give commerce along the Arctic coast its unique character, and additionally make it so easy to interdict.

Let us consider these merchant vessels from a targeting standpoint. In the presence of ice, vessels travel in line ahead following icebreakers at an average rate of advance of less than five knots. In general the most southerly practicable route is taken, as the ice makes any other route difficult or impossible. Thus such vessels are easier targets than surface vessels on the open ocean, since they travel a predictable course at a slow speed, and have essentially no freedom to maneuver or change course. Moreover, most vessels must travel during the short Arctic summer or run the risk of being immobilized in the ice pack or frozen in harbor. Even minor disruptions and delays thus are magnified, and a blockade need only be active for a short period to shut down shipping for eight months. Targeting by satellite overhead imagery should be possible with even SPOT-level resolution (10 meters or so), since as they break through the ice the ships leave a wake of more or less open water. Also, the ships' slow rate of advance and predictable course makes even low frequency coverage (one pass per day) adequate.

This theater of operations would appear to offer several advantages for submarine warfare. The ice pack renders useless ASW sensors such as radar, air-laid sonobuoys and dipping sonar, and degrades the effectiveness of all acoustic detection near the marginal ice zone. For surface vessels, operating a towed array might prove difficult in the ice, and a bow-mounted sonar would quickly become a casualty. Even emplaced hydrophone systems like our SOSUS are at risk from grounding ice keels, and are difficult to install and maintain. Similarly, air- and surface-launched antisubmarine weapons might be stymied

by the lack of open water. Of great importance is the extended length of the coastline, being three times the length of our own East Coast. This is a lot of territory to patrol, and as mentioned above, patrolling by aircraft would be ineffective. Minelaying against the surface targets might be a very effective tactic due to the circumscribed routes shipping must take, and the extreme difficulty of mine hunting and sweeping amidst the ice. Since the first vessel in line is typically an icebreaker, crippling or sinking her quickly immobilizes the whole group of ships. Indeed, sinking the icebreakers would pretty much stop the music for the entire Arctic coast. Mines also have the virtue that they were the first fire-and-forget weapons, and enable an attacking submarine to be two places at once. Mines could be laid piecemeal over a period of months in several places, but would only become apparent during the summer when shipping passed by. Torpedoes might have to be reprogrammed to attack vessels amidst the ice due to the presence of ice keels. However, the facts that the targets are moving slowly and cannot evade suggest the use of torpedoes at long ranges with slow speeds, to conceal the bearing of the attacking submarine. Missiles such as HARPOON might be less effective since they may not cause a hull penetration below the waterline, and an ice ridge may provide a radar return that confuses the seeker. Note that towing a disabled ship through the ice is difficult, and that the ice is likely to finish off any abandoned ship.

There is a downside to such a submarine campaign. The minimal effectiveness of air and surface ASW assets is perfectly apparent to the Soviets, and they will respond with their own SSN's to hunt our SSN's. While from a tactical standpoint this is undesirable, it is certainly acceptable from a strategic standpoint. In particular, having several Soviet SSN's tied down defending an extended coastline against a few attacking American SSN's who can pick the time and place of their attack is good strategy. Every Soviet SSN along the Arctic coast chasing U.S. SSN's is one less attacking our own shipping or protecting their SSBN's. While the shallow water along the Soviet Arctic coast makes submerged navigation very demanding, it also provides poor acoustics which limit detection ranges. These circumstances favor us, since a shorter detection range implies the use of many more platforms to find our subs. By

comparison, we need not find their subs, nor even detect our targets acoustically to complete our mission. Moreover, the Soviet subs must be SSN's to operate in the Arctic, not diesel-electric SSK's; therefore our convoy escorts elsewhere will face proportionately more Kilos, Tangos and Foxtrots, and fewer submarines altogether.

In summary then, it is proposed that it would be strategically very favorable to attack Soviet Arctic shipping in any general war with the Soviets. The reasons for doing this are to prevent the output of the eastern Soviet Union from coming to market and earning foreign exchange; to isolate Siberia and the Soviet Far East from the rest of the Soviet Union; and to compel the redeployment of Soviet SSN's from other theaters.

■

MEMBERSHIP STATUS

	Current	Last Review	Year Ago
Active Duty	992	988	987
Others	2841	2853	2979
Life	225	211	179
Student	28	26	32
Foreign	70	73	64
Honorary	24	25	25
Total	4180	4176	4266

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STRATEGIC THOUGHT FOR SUBMARINES

by LT David C. McDonnell

The Navy's *Maritime Strategy*, published during the mid 1980's, tasked the U.S. Navy to use an early, forceful, global, forward deployment of maritime power both to deter war with the Soviet Union and to achieve U.S. war aims should deterrence fail. Secretary of the Navy Lehman proposed that a *600 ship Navy* was required to fulfill the Navy's mission as prescribed in the *Maritime Strategy*. With this well defined strategic mission, the Navy was highly successful in obtaining funding from Congress to purchase ships, planes and submarines. The threat of a global war with the Soviet Union has diminished, and the funding for a 600 ship Navy has deteriorated. Thus, the Navy has abandoned the *Maritime Strategy* of the Reagan era and a new naval strategy must be defined.

A shift in strategic planning focus from a global war to a *low intensity conflict* has occurred within the Navy. Along with this shift in naval strategy, the strategic missions of the U.S. submarine force have also changed. This essay addresses some of these changes and raises some questions about the use of submarines in the future.

The U.S. ballistic missile submarine's (SSBNs) mission in the *Maritime Strategy* was to conduct strategic deterrent patrols while remaining undetected and, in the event of a global nuclear war, accurately launch its nuclear missiles. While the Soviet Union retains the ability to launch a nuclear strike at the United States, the role of the SSBNs must remain the same. The TRIDENT class submarines are capable of performing this mission for the foreseeable future. While the TRIDENT's major defense lies in its ability to remain quiet and undetected, it must retain its ability for self defense if it is detected and attacked. Officers serving on these SSBNs must continuously enhance their tactical capabilities to effectively fight any opponent.

U.S. fast attack classes of submarines (SSNs), under the *Maritime Strategy*, were tasked with the mission of destroying

the Soviet submarine fleet, including both SSNs and SSBNs, in Soviet home waters. The main reason behind destroying the Soviet SSNs was to protect the U.S. sea lines of communication (SLOCs) across the Atlantic. The Soviets still possess more submarines than the United States and they are continuing to build more. The United States must retain the ability to effectively combat the Soviet submarine force in case of a resurgent Soviet intention to globally employ its submarine fleet. The Navy is currently projecting a 25% reduction in the SSN force to about 80 submarines by 1995. The ability to perform an offensive campaign to destroy the Soviet submarines will be hindered and if cuts in funding continue this ability will be lost. Some say that a defensive strategy would protect our SLOCs and that fewer submarines would subsequently be needed. It appears that as the number of U.S. SSNs decrease the Navy **must** adopt a defensive maritime strategy to protect its SLOCs. **But**, as the number of U.S. SSNs decreases, the ability to keep the Soviet SSNs in their own waters, away from our SLOCs, declines. The Navy must maintain a powerful SSN force not only to protect our SLOCs, but also to deter the Soviet SSNs from leaving their home waters. The likelihood of a global war is minimal, but it is wise to keep enough SSNs on hand to deter the Soviets from any malicious activities.

The Navy must decide on the strategy of the '90s with regard to the mission of the U.S. SSN force. With a well defined mission, the Navy can direct its funding and training programs to better meet the requirements of the mission. The U.S. SSN force is presently capable of fulfilling numerous missions including anti-submarine and anti-surface warfare, intelligence gathering, convoy escort, carrier task force escort, cruise missile launching, harbor penetration, mine placement and more. The U.S. SSN force will continue to be capable of performing these missions, but without a well defined strategic mission it may be hindered in its ability to carry out some of them due to lack of training or lack of funding in particular areas. A well defined mission can assist in the proper allocation of funds and training in the areas needed to carry out that mission.

The emphasis in maritime strategy has shifted toward a low intensity conflict in a local area of the world with a minimum likelihood of an open ocean fleet battle. With this in mind, there are still many questions that must be answered. What will

the mission of submarines be in the next conflict? How many and of which type of submarines does the U.S. need to fulfill this mission? Should the U.S. build smaller, cheaper diesel submarines? Should the U.S. sonarmen and sonar systems be geared toward the detection of quiet diesel submarines or nuclear submarines? What should submarine commanders emphasize in their training programs? There are many more questions which need to be answered to effectively plan the submarine strategy of the future.

The next submarine engagement could very well occur in shallow waters close to enemy land. There are many countries throughout the world which possess capable navies, some of which contain SSNs. The threat of modern diesel submarines, which many of these countries possess, is lethal. I propose that U.S. SSN training programs should concentrate on seeking out and destroying these navies in a shallow water environment. U.S. SSNs must be able to enter enemy waters, perhaps penetrating through minefields, then detect and destroy the enemy Navy without being counter-detected along the way.

It is clear that the U.S. must maintain the technological advantage in sound silencing and underwater acoustics over all potential enemies because the dominant advantage of a submarine is in its stealth. Without proper funding from Congress, the technological advantage will deteriorate and the submarine will become a less potent weapon.

For most officers aboard submarines, the responsibility for strategic thought belongs to the Admirals in Washington, D.C., but it is these officers aboard present submarines who have the first hand knowledge of the capabilities and limitations of their own submarine. These are the men who should be thinking about how the U.S. can best use submarines in future conflicts. The wardrooms aboard U.S. submarines should allocate time on a regular basis to discuss the strategic use of submarines in future conflicts and answer the questions raised here.

With the current projected cuts in funding for all branches of the military, the Submarine Force must have a well defined strategy so that it may receive its fair share of the funding. It is up to the officers who wear dolphins to establish this submarine strategy so that the U.S. submarine force may remain the most lethal weapon in the U.S. military.

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HTGR GAS TURBINE POWER PLANT FOR SUBMARINE PROPULSION IN THE 21st CENTURY

by Michael J. Gouge
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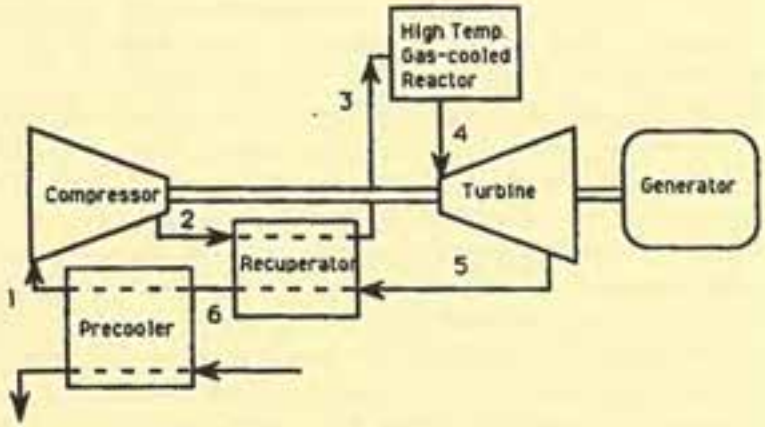
Pressurized light water reactor plants have provided an effective, safe and reliable submarine propulsion system for over three decades. The next generation of nuclear submarines will continue to employ this successful and mature propulsion technology. High temperature gas-cooled reactors (HTGR) using a steam turbine (Rankine cycle) secondary loop have been developed and employed for electric power generation in this country and abroad. HTGR technology, when integrated in a *closed* gas turbine (Brayton) cycle offers an innovative option for small modular electric power plants and compact propulsion systems. Such a compact propulsion system integrated with electric drive could provide a highly effective submarine propulsion system in the 21st century. The compact single-process-loop of the high efficiency, closed Brayton cycle offers substantial promise for a smaller propulsion plant volume and attendant overall plant power density increases relative to light water reactor plants with steam turbine-based propulsion. This is possible even with the lower core power density of gas-cooled reactors relative to light water reactors because the reactor core volume is a small fraction of the overall nuclear propulsion plant volume. A simple schematic of the closed Brayton cycle is shown in the figure. Hot helium gas leaves the gas-cooled nuclear reactor and enters the closed gas turbine which is driving both a high efficiency, AC electrical generator and the compressor (there may be more than one turbine, one driving the compressor and the other the electric generator). The low pressure exhaust gas from the turbine enters a compact, high heat transfer recuperator where it heats cooler helium flowing on the other side of the heat transfer surface and is itself cooled. The helium leaving the recuperator goes to another heat exchanger called a precooler where it is further cooled before entering the compressor. The compressor raises the helium pressure to its highest value in the cycle and heats it somewhat. From the compressor the high pressure helium goes

through the recuperator as discussed above where it is pre-heated before it enters the reactor.



Closed Brayton Cycle

From the short description given above several potential advantages of the HTGR gas turbine power plant are obvious. The high cycle temperatures of 800-900 C (1470-1650 F) and simple closed cycle can provide cycle thermal efficiencies in the 40-45 % range. This high efficiency and the lack of a complex steam turbine-based secondary plant result in a compact, high power density propulsion plant with reduced thermal signatures due to lower waste cycle heat for a given shaft horsepower. The AC generator supplies power to a propulsion motor which is directly coupled to the shaft (no reduction gears); the generator can be located some distance from the propulsion motor and shaft. This provides a measure of flexibility in the internal arrangements of components inside the submarine. Another well known benefit of electric drive is that the substantial propulsion power can be made available for as yet undeveloped high power offensive and defensive systems. Another implicit advantage of the propulsion system is that it would probably require fewer plant operators which also frees up interior space. The helium gas at the turbine exhaust is still at a high temperature and could be used for auxiliary functions such as fresh water production.

A potential design is described below. A hypothetical nuclear attack submarine is assumed which is a body of revolution of length 100 m (328 ft.) and maximum diameter of 10 m (32.8 ft.). From the unclassified submarine design course noted by Captain Harry Jackson, USN(Ret.), a straightforward calculation produces a hull wetted surface area of ~2700 m^2 and a displacement of ~6300 long tons. With reasonable assumptions for surface area and drag coefficients of the sail and appendages, it is found that an effective power of about 26.3 MW (35,300 EHP) is required for a 35 knot flank speed. This corresponds to a shaft horsepower of about 32.9 MW (44,100 SHP), assuming a propulsive coefficient of 0.8. The propulsion plant parameters for these powering requirements are shown in the table. The numbers given in parenthesis in the location column indicate the location in the cycle as shown in the above figure. Account is taken for turbine and compressor efficiencies, nominal generator and propulsion motor losses and assumed ship electrical loads of ~3 MW.

Location	Temperature C(F)	Pressure MPa (psi)
Turbine inlet (4)	850 (1562)	7.80 (1132)
Turbine exhaust (5)	591 (1096)	3.80 (551)
Precooler inlet (6)	193 (380)	3.68 (534)
Compressor inlet (1)	30 (86)	3.67 (532)
Compressor outlet (2)	159 (318)	8.06 (1169)
Reactor inlet (3)	557 (1035)	8.01 (1162)

Recuperator effectiveness	92 %
Total pressure drop	7.0 %
Turbine/compressor efficiency	91/89 %
Pressure ratio	2.2
Cycle efficiency	44 %
Reactor power	85.2 MW

It can be seen that the cycle efficiencies are significantly higher than is feasible with a Rankine cycle (steam turbine plant). This results in a lower reactor power for a given shaft

horsepower requirement and as explained above allows a smaller propulsion plant and less waste heat. It is emphasized that the compact powerplant is due not so much to the increase in cycle efficiency but to the inherent simple, single-process-loop nature of the closed Brayton cycle. Control of plant power on short times scales is an obvious requirement for a naval propulsion plant. Two primary means of transient control are envisioned. They are:

1. Bypass control, where a portion of the helium flow is bypassed around the turbine(s), and
2. Inventory control, where the working pressure of the helium is adjusted to match a particular power level.

Inventory control has the advantage of maintaining high cycle efficiencies at modest power levels but is not fast enough, especially on a negative power transient, for naval maneuvering. Bypass control is faster but has the disadvantage of low cycle efficiencies at significant bypass flows. Inventory control requires high pressure gas compression and storage; the volume of these components has to be accounted for in the total plant volume. In a realistic control system both of these control methods would be used to maintain plant efficiency over a broad power level while providing a capability to handle fast transients without significantly perturbing the turbine and compressor.

In fairness, this proposed plant, while showing significant potential, is not off-the-shelf nuclear technology. Gas-cooled reactors have an extensive operating history and a closed Brayton cycle plant using a non-nuclear heat source has been operated in Germany at power levels up to 50 MW. However, a closed Brayton cycle, nuclear-based power plant has never been operated at significant power levels. This is not so much a criticism of the concept as an indicator of the present state of innovative nuclear technologies. Several of the hardware and development issues associated with this concept are listed below:

1. An HTGR core design would need to be developed meeting the lifetime, power density and transient requirements for submarine applications.
2. Reliable, high power turbomachinery would have to be developed in the frequency range of this application which is of order 12,000-17,000 Hz. A concept like magnetic

bearings may be required to maintain the purity of the helium cycle gas.

3. Reliable, compact heat exchangers (recuperator and precooler) are required which can operate at high pressure and at effectiveness factors of 90-95 % with reasonable pressure drops.
4. A reliable and effective control system needs to be designed which occupies modest volume, has a good transient response while minimizing perturbations to the turbomachinery and gas-cooled reactor.
5. A plant layout should be conceptualized which provides efficient and innovative use of the submarine interior volume while providing a rational approach to maintenance. A maintenance approach needs to be worked out based on anticipated impurities in the circulating helium gas which can support high plant reliability levels. For some items the best approach might be component replacement due to their small size.
6. The electric propulsion system needs to be developed which has reasonable motor and generator efficiencies and is well integrated into other submarine systems. The acoustic signatures of the propulsion plant need to be studied after suitable sound isolation and dampening concepts are developed. It is noted that the elimination of reduction gears with the all-electric drive removes a substantial acoustic source term.

The above items are substantial but are less challenging than those faced by the pioneers of navy nuclear power in the 1950's in implementing the first naval nuclear propulsion plants. In conclusion, it is believed that HTGR's coupled with a closed Brayton cycle, all-electric propulsion plant is an attractive option for high plant power density submarine propulsion in the next century. This option can become a reality if investment is made now in the enabling technologies which support this concept.

[Acknowledgment: This research was sponsored by the U.S. Department of Energy under Contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.]

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NAVAL SUBMARINE LEAGUE

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PREPARING FOR SUBMARINE COMMAND

by Commander Paul J. Ryan, USN
Commanding Officer
USS PHILADELPHIA (SSN 690)

Command of a modern submarine has to be one of the best jobs in the entire Navy. Men don't join the Navy to be division officers or to qualify as Engineering Officer of the Watch or Officer of the Deck; they join because they want to be in charge. They want to be the man who makes the decisions, who stands on the bridge with the wind whipping through his hair, to be the man other men turn to in time of need, waiting for his guidance that tells them the right thing to do. On a warship this man is the Captain, and if every junior officer isn't looking forward to the day he can take command, watching the Captain's every move, and mentally filing away for future reference the good and not so good things their current Captain does, then they're not farsighted enough, and probably won't make good Captains themselves. They need to quickly get their heads out of their short term holes and start looking and planning for their futures.

Submarine command is a great experience, and the submarine officer career path, as it has evolved over the past 37 years of nuclear powered submarines, is ideally suited to train every junior officer for command-at-sea. An officer's first at-sea tour is a learning and qualifying experience. He qualifies as Engineering Officer of the Watch, Diving Officer of the Watch and Officer of the Deck. He learns how to tactically employ and fight his ship, and how to fix it when it breaks. He qualifies in submarines, earning his gold dolphins, qualifies as nuclear engineer, rotates through about three different division officer jobs, and in the process, learns not only how to be a good division officer, but also what the different department heads do. He may also develop a preference for what department head job he'd like to fill.

At the end of this first tour, which normally lasts about three years, it's time for shore duty. Nuclear Power School, Prototype, and Submarine School all need instructors. If an officer

wants to go to graduate school, fine, this is the time to do it; and if he doesn't want to go to the Naval Postgraduate School, he can volunteer for instructor duty at an NROTC unit and earn his Master's degree on the side. Overseas shore duty? This is the ideal time, because there are jobs for Lieutenants almost everywhere, and if married, his children probably aren't old enough that he should worry about changing schools. In an increasingly competitive and shrinking Navy, it's important for junior officers to work closely with their detailers to find the job that's right for them, and that meets the needs of the Navy.

Shore duty is followed by six months of preparation to return to submarine duty as a department head, at the Submarine Officers Advanced Course. It's an excellent review of many of the things an officer should have learned during his first tour, with increased emphasis on the tactical employment of the ship. Since submarine department heads are the primary assistants to the Commanding Officer and the senior Officers of the Deck, this course does an outstanding job preparing them for the responsible jobs they're about to undertake.

The department head tours available to a submarine line officer are Navigator/Operations Officer, Engineer Officer, and Weapons/Combat Systems Officer. The standard career path has traditionally only allowed time for one three year department head tour. Several years ago there was an opportunity for some officers to serve split department head tours, essentially two different department head tours of two years each. There was significant merit in this program because it gave each officer broader experience, but in a smaller Navy, three officers serving 4 years as department heads (12 man years in billet) take up the same billets that could be used by four officers serving 3 year department head tours (the same 12 man years in billet.) A new initiative has been started allowing some officers to serve split department head tours on the same ship, but not exceeding three years total tour length. This will save PCS transfer funds, time, and do away with the requirement to requalify when switching ships. The department head tour, regardless of which department, gives the officer a chance to demonstrate his leadership and organizational skills while supervising three or four divisions and division officers. The department heads interact with the Captain and Executive Officer several times a day, and are actively involved in running

the ship. Also, since they are that much closer to the Captain, it gives them a better chance to watch what the Captain does, find out why he makes the decisions he does, and file more *lessons learned* away for future reference.

After a department head tour each officer has the option of proceeding directly to Executive Officer, and then taking his second shore duty tour, or of taking shore duty and then going as Executive Officer. The advantages of going directly to Executive Officer and then shore duty are: tactical currency right from the start of the officer's Executive Officer tour, a refreshing two years of shore duty before taking command, and the more responsible shore duty available for senior Lieutenant Commanders or junior Commanders will allow an officer to broaden his horizons prior to going to command.

The Executive Officer tour is an officer's chance to start running the ship. He is the principal advisor to the Commanding Officer, the second in command, the ship's training officer, and he's responsible for the day to day routine of the ship. Whenever there's something happening on the ship, he should be at the scene of the action. While getting the ship underway he ought to be topside as a safety observer, or on the bridge with the Captain, getting the right perspective for when he's in command. If there's an evolution like weapons loading in progress, he ought to periodically inspect what's going on, then stop by and share his observations with the Captain. He needs to ensure that the training and other evolutions scheduled in the Plan of the Day actually happen. He gains insight and perspective by consulting with the Captain several times a day, but if he's always right next to the Captain, he's probably in the wrong place. Although the Executive Officer is also in charge of the ship's administration (paperwork), that's not what he should be spending the majority of his time on. This is his last chance to train for command, and to do that he needs to be out and about on the ship all the time.

As I was walking across the ceremonial brow when I took command of USS PHILADELPHIA (SSN 690) in May 1989, I was amazed that I felt no apprehension whatsoever about taking command: it was the natural culmination of years of training and preparation. I'd served on four other submarines, carefully watching and learning from seven Commanding Officers. I'd had five different divisions during my junior officer tour, I'd

served both as Engineer and Navigator/Ops officer, and had a very rewarding Executive Officer tour. I'd served on both SSNs and an SSBN, and my shore duty tours had given me significant insight into international affairs, and into the inner working of the Navy in Washington, DC. The system had worked just the way it was supposed to, and had produced a confident, competent Commanding Officer.

If command of a modern submarine isn't the best job in the whole Navy, I'd sure like to know what's better. The Submarine Force has developed an outstanding program to train officers for command, and it starts at the beginning of an officer's first tour in submarines. If each and every junior officer isn't looking forward to the day he can take command, those of us in command, or who have been in command, haven't done our jobs right. We expect a lot of our junior officers, and we owe it to them to make sure they have the right goal in sight.

■

THE "HUNT" FOR A UNIQUE OSCAR

by Bob Smith and Ron Patton

[Bob Smith and Ron Patton are former active duty submariners and are currently Vice Presidents and Principal Analysts at Sonalysts, Inc. of Waterford, CT. They were sound technical consultants to Paramount Pictures for the movie Hunt for Red October. This film recently won the Academy Award for Sound Effects Editing. In this article, Bob and Ron recount their experiences in working with Paramount to create the award-winning sound effects for the movie.]

And the winner is.... At times during the evening of March 25, 1991, the anxiety level was high. After all, the sound effects editing crew had said they were hopeful for at least an Academy Award nomination for their work on Hunt for Red October. Would it be the next award? And the winner is.....

But by 11:15 p.m., when the majority of the 22 Oscars had been handed out, some of the tension had waned. They don't give an award for anything as obscure as sound effects this late, do they? It's time for the big ones: actors, actresses, and

directors. Dances With Wolves beat Red October for an award for sound at 9:30 -- that was probably the one.

Then... what was that? Sound Effects Editing? That's the category! The nominees are Total Recall, The Hunt for Red October, and Flatliners. Anxiety peak again. And the winner is... Hunt for Red October!!

The next day was a flurry of media coverage. After all, it's not every day a small company in Waterford, Connecticut gets recognized as a player in an Academy Award win. The interviews seemed endless: television, radio, newspapers. But there were a few minutes at the end of the day to call and congratulate Cecelia Hall and George Watters II, the actual recipients of the statuettes.

For all involved, it was an exciting week. In Hollywood, it's their living, and many go through a lifetime in the motion picture industry without even a nomination. For us, there was one opportunity to work on one aspect of one film, once in a lifetime, and it went on to be the only part of that film to win an Oscar. Contemplating the odds was mind boggling. However, the odds can be turned in one's favor through perseverance and hard work, and both played a role in this win.

A FOOT IN THE DOOR

The road to that exciting moment began when the movie was still in the concept stage. Back in 1986 when a movie based on the novel Hunt for Red October was in the rumor stage, a letter was written to Tom Clancy to try to find an inroad to some involvement in the production. Clancy wrote back saying that the dramatic rights were sold to Mace Neufeld, the producer, and that as far as Clancy could tell, he was out of the decision loop for movie production.

Meanwhile, Jim Patton (a former submarine commanding officer and no relation to the author) was receiving the endorsement of the Submarine Force to be the technical consultant on the picture. At first, Jim recommended to Paramount that Sonalysts be contacted to get involved in the development of display screens for the various sonar equipments on DALLAS and RED OCTOBER. Somewhere along the line, however, this aspect of film support fell through.

All was quiet for over a year, and then through a connection made with Captain Mike Sherman (Director of the Navy Office of Information in Los Angeles), it was determined that Para-

mount might be interested in some outside assistance in the area of sound effects. This seemed like a perfect fit. Sonalysts knew submarines, had a complete sound recording facility, and knew the limitations of what could be put in a film without jeopardizing national security interests. The door was open.

The first order of business was to reread Clancy's novel, determine the array of sounds that would be required as part of the soundtrack, and get a letter off to Paramount demonstrating the knowledge and desire to be a part of the sound effects work. That February 1989 letter to Glen Neufeld further opened the door. Neufeld requested a cassette tape sampling of underwater sounds and information on a proposed approach to the job, which were sent in March.

Another couple months of silence made it apparent that Paramount had decided to proceed on its own; but then in July, a call was received from Cecelia Hall with a renewed interest in sound technical consulting services. It was arranged to meet with her and George Watters at Paramount in August to go over some raw movie footage and present some ideas for both background noise on the submarines and the more obvious sounds like torpedoes and sonar pings. Although movie budgets appear to be huge, in some departments, every penny is counted. The date of this visit was planned to be concurrent with a trip to California for other business.

The evening at Paramount involved viewing the first black and white footage of the not-yet-released film. The screening room was truly amazing with its seats like those in First Class on an airplane. In addition, there was an opportunity to meet the movie's executive producer and film editors. All in all, it was a unique and enjoyable experience.

For Cecelia and George, however, the evening was a revelation. For months, everyone had been telling them that submarines don't make any noise, that their reason for existence is silence. As the footage rolled, we rather matter-of-factly spoke of the abundance of sounds that characterized all phases of submarine operations. They were ecstatic. Submarines actually make noise! After all, sound is the sound editor's job, and if submarines literally constituted the silent service, their work on this film was destined to be pretty boring. This meeting at Paramount convinced Cecelia and George that they needed some help to make this picture as authentic as possible.

The next step was to make plans for them to come east to record some submarine sounds and to invent a few others.

PLANNING AND EXECUTION

Making plans according to the Submarine Force's operational schedule is sometimes a trial. Working within a movie production schedule can be equally trying. Making the two coincide is truly a test of patience. After several changes in the host submarine (even DALLAS itself was mentioned at one point) and in the times of Paramount's visit, a specific submarine and a date were finally agreed upon. Approval had been granted for two days of dockside recording in early October aboard the USS SHARK.

The only problem was that SHARK was at sea until the day prior to Paramount's scheduled arrival (we all know how port arrival schedules go), and the sound team had committed to the trip based on the assurance that all would come off as planned, assurance given with just a touch of uncertainty. So Cecelia, George, and John Fasal (one of their sound effects recording engineers) arrived as planned, even though SHARK was still at sea and no personal contact had as yet been made with the Commanding Officer, Russ Carr, because of the lateness of the decision.

After some initial discussions, the group headed to Groton for lunch at a nice restaurant overlooking the Thames River. As beverages were delivered, internal sighs of relief came as all eyes beheld the USS SHARK coming up the river into port. It was casually mentioned that this was the submarine on which we would be spending the next two days, and how nice of them to time their arrival during our lunch. One uncertainty down, one to go.

The phone call to Commander Carr that afternoon was private, consisting of introductions and initial plans rather than the final preparations I'm sure our guests thought it contained. Fortunately, Commander Carr, his entire wardroom and crew, and the parent squadron and group staffs were most accommodating, and in retrospect, the entire episode could not have gone more smoothly.

On SHARK during the next two days, every imaginable sound associated with an operational submarine was captured: the obvious sounds of alarms, masts going up and down, and hatches opening and closing, but also the subtle background

noise caused by ventilation fans and electronic hum. It was the director John McTiernan's goal to have each compartment on each submarine in the movie (DALLAS, RED OCTOBER, KONOVALOV, and the deep submergence research vehicle (DSRV)) have its own identifiable background sound, so a lot of time was spent in a lot of different compartments recording a lot of almost nothing.

One place on SHARK that could not be accessed for recording purposes was engineering. However, the movie required the sounds of an operational reactor plant, so it was arranged for a half a day at the Millstone Nuclear Generation Station to capture the sounds of steam noise, turbines, condensers, and the other unique combination of sounds that identifies an engine room.

Back in the Sonalysts sound studio after two very full and successful days of recording, it was time to create those sounds that could not be recorded directly, such as sonar and torpedo pings, propeller noise, and the infamous sound of the caterpillar engine on RED OCTOBER. So with oscillators, synthesizers, digital reverbs, and various household appliances, the first cuts at some of the more memorable movie sounds were made. Ever-present during those sessions, however, were the words of our Submarine Force leaders: credibility, not realism.

AN EDUCATION IN MOVIE SOUND

When the Paramount team left Connecticut, it was believed that the movie would contain many of those sounds precisely as they were recorded or created. A little known fact is that what you hear in a movie is often in no way related to the sound it's attempting to imitate. For example, during their work on Top Gun, Cecelia and George could not obtain through live recording the number and variety of jet engine sounds required throughout the movie. Therefore, the majority of those sounds are slowed down and otherwise manipulated renderings of leopard roars.

Red October was no different. The ultimate source of many sounds was as distant from the real thing as it could be. Crowd noise at a race track provided the underwater ambience in the movie. A combination of outboard motor, car, and howitzer sounds produced the torpedo sound that kept us all on the edge of our seats. The sound of evasion devices being ejected was created by dropping large bags of Alka Seltzer into a swimming

pool. Some sounds came from the vast Paramount library. Others were tailor-made and played over the phone for comment during late-night calls from California to our homes.

The sound of hull popping during submarine depth changes was unique in its origin. Originally, the sound of hammer taps of SHARK's exterior was recorded. Not satisfied with the result, Paramount engineers created a variety of alternatives, one almost too extravagant to believe. The sound of grand piano strings being severed by a wire cutter was recorded by one engineer in hopes of it being the *right* sound. It was nowhere close. The tape ended up on the floor along with many other rejects. Who knows what happened to the piano. The final sound in the movie was simply a recording of Cecelia tossing pebbles into a drain culvert.

The director of course is in ultimate control of what sound does and does not make it to the final product. John McTiernan had some very strong opinions about the overall effect he wanted to create with sound. So in some cases, Hollywood won over both credibility and realism. When the director wants beeps, the director gets beeps. That's why, despite mild protests, DALLAS' passive sonar displays had that very unique sound quality.

PREMIER NIGHT

After two visits to Paramount to help in the editing and sound evaluation process, our participation was more or less over by the beginning of 1990. With three months left until release, there was much work left to do, but it mostly involved editing and putting together all of the pieces that had been painstakingly created. This was Paramount's job. Meanwhile, it was back to the normal work schedule and trying to forget all of the footage seen dozens of times, in hopes that in March, the movie would be fresh.

That was wishful thinking. March 30, 1990... As important audiences gathered for the movie premiere in Hollywood and Washington, D.C., a mini-premiere celebration was also taking place in the Submarine Capital of the World as local submariners gathered in force to watch their movie. The aviators had their turn with Top Gun. Now it was the submariners' turn. The media coverage was an unexpected treat. There were interviews by local television and newspaper reporters, and just prior to the movie, an opportunity to speak to the audience in

the theater about the work on sound effects.

Then... it was showtime; and two hours and fifteen minutes later, it was over. Yes, the sounds were well done. Yes, the acting was solid. Yes, the story line was consistent. But the lingering question was: "Was it a good movie?" There was nothing new or fresh about it, even though this was the first time it was seen with all the parts put together. All of those scenes in their original black and white monotony kept flashing back; it was all too familiar. So it was necessary to ask others if it was a good movie, and we were relieved to find out that most thought it was an exceptional film, a real thriller. However, it was then realized why many movie people don't care to see the products of their work and why many recording artists don't listen to their own albums. They get so involved with the details of the creation that the artistic appeal is lost.

IN RETROSPECT

Participation in the making of Hunt for Red October provided a unique opportunity to bring the best of the submarine force to the big screen. Movies, especially good ones, have an impact that is far reaching and immeasurable. Many kids will likely grow up aspiring to be the Mancusos and Jonesys of tomorrow. They will see that being a submariner may not be a glamorous as some other Navy jobs, but it takes a special kind of commitment. and extra measure of leadership skill, and a determination to be the best of your kind in the world. They will realize that the cost is great, but the rewards are also great.

And the winner is..... the U.S. Naval Submarine Force. This was your opportunity to shine, to reach out to your leaders of tomorrow, and you succeeded. Congratulations one and all! ■

THE SUBMARINE REVIEW

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

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

A stipend of up to $200.00 will be paid for each major article published. Annually, three articles are selected for special recognition and an honorarium of up to $400.00 will be awarded to the authors. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League.**

The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League. In those instances where the NSL has taken and published an official position or view, specific reference to that fact will accompany the article.

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

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

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SUBMARINE REVIEW Literary Award Winners
1990 - 1991

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July 1990 Issue

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New Approaches to an Old Game

Third Prize Honorarium - $100.00
Midshipman Second Class Sean Osterhaus
The Use of Submarines in Small Scale Conflicts

LETTERS

SUBMARINE-BASED ASAT SYSTEM

I would like to congratulate D. Nahrstedt on his proposal (Jan 91 SUBMARINE REVIEW, pp. 50-55) that submarines would make ideal platforms for an ASAT system based at the antipodes of the known Soviet launch sites, a proposal first made in the open literature by A. Karemaa of General Dynamics in the April 1988 USNI Proceedings. While the thrust of Nahrstedt's proposal is valid and important, there are some important details which must be considered.

First, even the extended range version of the Standard missile is probably incapable of boosting a suitable kinetic kill vehicle (KKV) of approximately 20 kg mass to the necessary velocities. With its conventional warhead the SM-2 ER is cited in the open literature as having an effective ceiling of only 80,000 feet; for this missile to accelerate a roughly four-fold smaller mass (the KKV) to velocities of several thousand knots and altitudes over 100 miles would seem unlikely. While it may be possible to boost a very small KKV to near orbital velocity using this system, there are three reasons for not using the SM-2. There is substantial technical risk in this approach, in that a newer, smaller KKV would have to be developed (the ones used in the Army and Air Force ASAT systems would be too large). A truly useful system would require substantial altitude capability (perhaps 1500 km) to assure successful intercept of satellites launched in elliptical orbits with their apogee (high point) over the antipode to avoid interception. The SM-2 ER (RIM-67B) is not configured for submerged launch, is currently semi-actively radar guided, and at 26 ft. is rather long for most torpedo tubes.

A better choice might be to configure the KKV to be mounted on a POSEIDON or TRIDENT C-4 missile as booster, and launch the vehicle from a dedicated SSBN, perhaps a late model SSBN-640 class. This approach would have several advantages. First, it would use an existing platform instead of adding another mission to an already overbooked attack submarine force. An ICBM-type booster clearly would be able to boost an existing KKV to whatever velocity and altitude was necessary, perhaps even to synchronous orbit. The KKV need

not be ultraminiaturized, reducing technical risk and enhancing kill probability. The TRIDENT and POSEIDON missiles are of course configured for submerged operation, and would not require lengthy development before introduction into the Fleet. The SSBNs are designed for launching missiles with high accuracy using inertial guidance for the submarine and the missile, a prerequisite for this scenario where no external guidance of the vehicle is possible during its flight. Finally, the longer range of the SLBM-boosted vehicle enables the submarine to attack the satellite from points in the ocean more distant than the exact antipode of the launch point (corrected for the earth's rotation). A smaller booster would oblige the submarine to be almost directly under the path of the satellite, limiting the area of ocean it can operate in, and putting it at greater risk.

A second important point is that the antipodes of the American launch centers at Cape Canaveral, Vanderberg AFB, and Wallops Island are all in the Indian Ocean, and the Soviets may find basing ASAT's on submarines to be effective as well. If the Soviets are believed to possess such a capability, it will be necessary to station some number of SSNs in the Indian Ocean to counter this threat. At present this is not an issue, inasmuch as the U.S. currently does not plan a *surge* in satellite launchings during a crisis. However, the vulnerability of our current satellite systems may change this position. It is of interest, however, that the antipodes to the launch sites of many other nations are also in ocean areas and therefore may be held at risk by U.S. submarines. Thus the U.S. may blockade space-borne commerce in precisely the same fashion it can for seaborne commerce. Thus the antipode to the Chinese launch site at Xi Chang is off the north Chilean coast, that to sites in the Middle East (such as Iraq) is in the South Pacific, and the antipode to the Indian launch site at Srihari-Kota is also in the South Pacific.

A final issue in this scenario is tracking of the target and guidance of the missile to intercept it. It will be necessary to not only see the launch of the satellite, but to track it long enough to determine its orbital elements with some precision, then pass this information along to the submarine in time for it to program its missile(s) for launch and intercept. In the absence of other cues, this process must occur in the time period of half an orbit; i.e., 45 minutes. Note that while the

terminal guidance of the KKV can be passive IR or visible, the KKV must first be guided to the vicinity of the intercept by other means (probably inertial) before the KKV sensor is in range and can take over. A feasible system might entail an ELF alarm to announce a launch and summon the submarine to a depth where it can receive the orbital elements as they become available, perhaps by blue-green laser from the American satellite tracking the launch. The submarine would require substantial onboard computational power to calculate and program its missiles for a high velocity intercept trajectory (or two) in only a few minutes. Clearly a responsive positive control system would be required for weapons release given the political sensitivity of destroying another nation's satellite(s). While these tasks may be technically demanding, they are clearly within the state of the art.

Richard Thompson

■

NAMES OF SUBMARINES

Dear Sir,

I feel that the SEAWOLF (SSN-21) Class should be named SKIPJACK, SEADRAGON, SKATE, SHARK, SCAMP, SNOOK, SCULPIN, SWORDFISH and SARGO.

They have the Burke Class to name after Congressmen.

Yours truly

Ted E. Minter

■

APPROACH OFFICER RANGING

I enjoyed LCDR Peppe's article on mental ranging techniques in the January 1991 issue of the SUBMARINE REVIEW and thought it was important enough to warrant special attention during wardroom training. An OOD needs quick target range estimates to verify the validity of other solutions and to determine effective approach and attack courses. The article provided a means to obtain those quick estimates.

I believe that there are a few errors in the triangulation range section; two are typographical, and one was the choice of a range reference point. However, the final result was correct. The equation on page 81 should equate the range to

$$\frac{x}{2 \tan (\Delta/2)} \quad \text{not} \quad \frac{2x}{\tan (\Delta/2)}$$

Also, the third equation on page 82 should equate the range to

$$\frac{\text{Scope}}{2[(\Delta/2)/60]} \quad \text{not} \quad \frac{\text{Scope}}{2(\Delta/60)}$$

Finally, by convention, sonar ranges based on spherical array outputs are referenced to the spherical array. Peppe's range is based on the intersection of the towed array axis with a line perpendicular to the towed array axis which passes through the intersection of the spherical bearing and the towed array bearing. The difference between the two ranges can be significant for targets not within 20' of the spherical array beam, but his simplification corrected this problem. I have included an enclosure which illustrates the difference between his range reference and the conventional range reference and which validates his simplification.

Derivation of Simplified Triangulation Range Equation

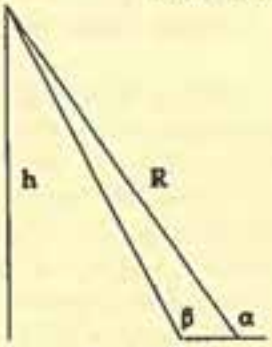

Figure 1

α = SA By
β = TA By
h = range as defined in article
R = range to target from spherical array

$h = R\sin(\alpha)$

$\text{error}\% = 100(R-h)/R$
$= 100(1-\sin(\alpha))$

If α = 125°, the range as defined in the article would have almost 20% error and a geometry like figure 1. If α = 45°, the error would be almost 30%.

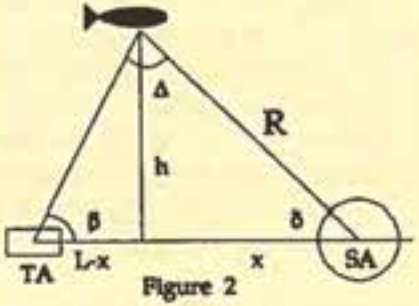

Figure 2

For the geometry of Figure 2,

$\Delta = 180-\delta-\beta = 180-(180-\alpha)-\beta$
$= \alpha-\beta$
$h = x\tan(\delta) = (L-x)\tan(\beta)$
$x[\tan(\delta)-\tan(\beta)] = L\tan(\beta)$
$x = \frac{L\tan(\beta)}{\tan(\alpha)+\tan(\beta)}$
$R = x/\cos(\delta)$
$= L\frac{\frac{\sin(\beta)}{\cos(\beta)\cos(\delta)}}{\frac{\sin(\delta)}{\cos(\delta)}+\frac{\sin(\beta)}{\cos(\beta)}}$
$= \frac{L\sin(\beta)}{\sin(\delta)\cos(\beta)+\sin(\beta)\cos(\delta)}$

Since $\sin(a+b)=\sin(a)\cos(b)+\sin(b)\cos(a)$,
$R=L\sin(\beta)/\sin(\delta+\beta)$
$=L\sin(\beta)/\sin(180-\alpha+\beta)$
$=L\sin(\beta)/\sin(-\alpha+\beta)$
$=L\sin(\beta)/\sin(\alpha-\beta)$
$=L\sin(\beta)/\sin(\Delta)$

Assuming the target is greater than 1000yds away, Δ is less than 40 degrees. Therefore,
$L/\sin(\Delta) \approx 60L/\Delta$.
If TA scope is in feet, and the target is within 15 degrees of the TA beam ($\sin(\beta)\approx 1$), then
$R \approx 20L/\Delta$.
This is the same equation stated in "Approach Officer Ranging".

Edward M. O'Gara, LT, USN
USS WEST VIRGINIA (SSBN 736) Blue

■

THE FIRST SOVIET NUCLEAR SUBMARINES

Dear Sir,

I've read "The First Soviet Nuclear Submarines" by Norman Polmar (The SUBMARINE REVIEW, January 1991) with great interest.

Research work on and development of nuclear submarines had been kept secret even from us "conventional" submariners, but when I came across the name of Eng.-Capt. 1st Rank PEREGUDOV, I immediately recalled that particular name.

Back in 1954, I served in a WHISKEY-class sub with Peregudov's son. He was Executive Officer and I was a Department Head. I knew that his father, Rear Admiral Peregudov, held an important position in the Navy in Leningrad, but that was all I knew about him. Unlike his father, the son had no special talents. Thanks to his father he was promoted to Executive Officer and later on to Captain and that last assignment proved fatal. His maiden voyage became also the last one: his submarine ran aground in shallow waters and he was promptly relieved of his duties. Again, because of well placed connections in the Navy, he got a sinecure in the office of the Main Naval Staff in his hometown of Leningrad which was, incidentally, the most favourite city for Soviet naval officers.

From that time on I never met or heard of him again.

Cordially yours,

J. Roitman
LCDR, Soviet Navy (Ret.)
Haifa, Israel

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IN THE NEWS

While the biggest item of submarine news over the past several months had to do with the award of the contract for the second ship of the SSN-21 SEAWOLF class, there were plenty of other subjects of interest that were covered by the press, wire services and broadcast news. To reverse the trend of front page editors and network anchormen, SUBMARINE REVIEW feels that it might be a good idea to start with a light note; therefore, the Reuters piece of April 28th is duly acknowledged. It reported that the U.S. Navy is planning to send a research submarine to explore the wreckage of the USS MACON, an airship that disappeared 56 years ago off the coast of California. The news service went on to say that the object of the search is to find a way to salvage one of the four vintage SPARROW-HAWK biplanes that went down with the dirigible on February 12, 1935, so that it can be placed in the Smithsonian.

The Second SEAWOLF: The popular press noted the issue in earnest after the 19 March hearings of the Senate Defense Appropriations subcommittee and continued through the various Executive, Judicial and Congressional actions which followed. A brief summary from the press will track the story from that which was outlined in depth by the heads of both Electric Boat and Newport News in the April issue of THE SUBMARINE REVIEW.

- Hartford Courant, 20 March 1991: "Top shipbuilding and Navy officials predicted Tuesday that if the Navy cuts submarine production to one ship a year, as planned, either the Electric Boat Division or its only competitor (Newport News Shipbuilding Company) will be forced out of the submarine business by the mid-1990s."
- Defense News, 25 March: "At issue is whether the Navy can preserve its fragile submarine industrial base at a time when the service is facing steep budget cuts and limited submarine construction rates." The paper went on to review the circumstances leading to the current situation. "Electric Boat won the contract to build the first SEAWOLF in January 1989, and is continuing work on the program. At the time, Navy acquisition plans envisioned having two shipyards build the submarine and the service planned to award the second submarine contract to Newport News without competition. In the interim, however,

the Pentagon-mandated Major Warship Review reduced the Navy's buy of SEAWOLF submarines to only six through 1996, instead of a planned 29. With the construction program being truncated, Congress directed the Navy in the 1991 budget to resume competition between the shipyards for the second submarine.

- The Washington Post, 2 May: In somewhat more of a commentary tone, and under the headline "Sinking Sub Firms Seek A Life-Giving Navy Pact," reported on the situation as "...this latest outbreak of submarine warfare..." in which "the nation's two remaining nuclear submarine makers are vying for a $2 billion contract that both say is critical to their survival." It noted that "...the Navy ...30 years ago had six yards qualified to produce an expanding fleet of nuclear-powered submarines." The Post explained that in late April, Donald Yockey, the Pentagon's top procurement official, "rebuffed the Navy's plan and told Navy Secretary H. Lawrence Garrett III to award the contract based on overall cost and technical approach." This was said to cause immediate action from Senator John Warner (R-VA) who had "...inserted language in the various Pentagon spending bills requiring the Navy to pursue a competitive acquisition strategy for the SEAWOLF program, even if it meant taking a higher bid offer." The Post ended the piece by commenting that: "The Bush administration has turned aside attempts to link contract awards to economic distress, or even the survival of individual weapons contractors. Although top officials routinely express concern about the deterioration of the defense industrial base, they have yet to formulate any policy about what to do to preserve it. Instead, the administration seems content to award contracts one at a time, based largely on cost, and let market forces shape the industry."
- New York Times, 4 May: In reporting the award of the second SEAWOLF contract for the Navy's "next $2 billion attack submarine," the paper stated that "Electric Boat... was awarded $614.7 million to build the submarine itself. The balance will go to the vessel's nuclear reactor and other components." The Times also referred to the EB/Newport News controversy and said that "Senator Warner asked the General Accounting Office, the investigative arm of Congress, to do a detailed review of the entire acquisition process used in the SEAWOLF competition."

• The Washington Post, 8 May: When Newport News won a 10 day reprieve on the award of the contract to EB, the Post reported that "Judge Robert G. Doumar ruled... that Tenneco Inc.'s Newport News Shipbuilding Company in Virginia would suffer immediate and irreparable harm if the Navy were allowed to proceed with implementing its decision to award General Dynamics Corporation's Groton shipyard the contract to construct the Navy's second SEAWOLF attack sub." The article explained that the Federal judge had "acted on a complaint ... that the Navy had ignored the express language of Congress, and its own procurement criteria, by choosing the Groton yard, which won the first SEAWOLF contract two years ago." It continued to note that Newport News officials state that the overall effect of being shut out of the first two submarines of the class will be the loss of 12,500 jobs by 1995.

That same issue of the Post reported that "General Dynamics' top executives doubled their base salaries under a motivational program designed to boost the company's stock price."

• Reuters, 9 May: "General Dynamics Corporation said a temporary restraining order that halted work on the Navy's second SEAWOLF attack submarine may force the company's Electric Boat Division to lay off some employees."

• Defense News, 13 May, and Inside the Navy, 13 May, both ran featured articles describing the award situation, the predicted consequences to each yard of not getting the contract, the dispute over the previous congressional language and the part played in the award by the Office of the Secretary of Defense.

• Hartford Courant, 16 May: "New England congressmen will counterattack their Virginia colleagues next week when they try to get Congress to direct Secretary of Defense Richard B. Cheney to award the construction contract for the next SEAWOLF submarine on the basis of competitive bids."

• Inside the Pentagon, 16 May: Under a page one headline of "Navy Abruptly Cancels Newport News Contract Amid Reports of Retaliation," it was reported that, on 7 May, the "Navy pulled Newport News off a contract for new technology design for a submarine nuclear propulsion system..." The article went on to report that Newport News officials said that there was no connection between the contract protest and this design contract cancellation. The body of the news was contained in

the following four lines out of over sixty in the article: "Newport News and Electric Boat were heading competing teams that were conducting design studies for the next-generation submarine, known as the CENTURION program; the Navy intended to select one of the teams in 1992 for the final design contract. Instead the Navy last week selected Electric Boat as the winner and removed Newport News from the contract."

- Wall Street Journal, 21 May: "The House, inserting itself into a heated Pentagon contract dispute, rejected language that would have required Tenneco Inc.'s shipbuilding unit to build the Navy's third SEAWOLF attack submarine. By a 235-157 vote, lawmakers approved an amendment mandating that Newport News Shipbuilding Company compete with General Dynamics Corporation's Electric Boats Division for the $2 billion job."
- The Washington Post, 25 May: "A federal judge issued an injunction today barring construction on the nation's second SEAWOLF submarine until a lawsuit over the contract for the vessel is heard later this summer. U.S. District Judge Robert G. Doumar's action extended a restraining order he issued May 7. The order bars Electric Boat from starting work on the SEAWOLF. The report continued to say that "The judge ordered Newport News Shipbuilding to maintain a $2 million bond to protect Electric Boat from any losses during the life of the injunction."
- Wall Street Journal, 27 June: "Navy Secretary Lawrence Garrett acknowledged that by the end of the decade, the Navy most likely won't be able to afford any more of the fast, very quiet attack submarines, which cost roughly $2 billion apiece. In his first interview spelling out revised submarine building plans, Mr. Garrett also said he has ordered Navy brass to speed up research and development work on a smaller, less expensive vessel -- code named CENTURION -- now intended to be America's premier underseas weapon."

After briefly describing the legal battle between the two shipbuilders over the second SEAWOLF contract, the Journal went on to report: "Documents filed by the government in the case reveal that David Yockey, the Pentagon's chief acquisition official, has flatly told the Navy it is inevitable that only one of the yards will receive SEAWOLF work after 1994. Mr. Yockey also has overruled Navy desires to keep both yards in conten-

tion throughout the life of the program, arguing that such a policy, designed to maintain the U.S. industrial base, is bound to increase unit costs."

The Gulf War: There have been quite a few observations printed about the Gulf War and what it means to the future security needs of the United States. A number of those are, in general, applicable to each component of the U.S. armed forces. Perhaps the most pertinent, however, is the often-heard caution that we should not learn the wrong lessons. This was said quite succinctly in a mid-May column by the noted defense analyst, Jeffrey Record. Portions of that commentary are reproduced below. Another important facet of the Gulf War was not treated in any significant depth by the press commentaries and that had to do with the first testing of the latest revision to our basic defense organization laws. Senator Sam Nunn, Chairman of the Senate Armed Services Committee spoke to that in the second article cited below.

• Baltimore Sun, 16 May: "The U.S. defense analytical community is erupting with instant lessons learned from the recent war against Iraq." ... "Caution, however, is in order. From a purely military standpoint, it is far from clear just how much Operation Desert Storm proved, in terms of lessons meaningful for future U.S. military operations. The stunning U.S. and allied victory over Iraq forces in Kuwait was in large measure the product of a unique set of highly favorable diplomatic, political, strategic, operational, and other conditions that are most unlikely ever again to be replicated."

"The United States ... had the luxury of almost six months to deploy forces to the Gulf and provide them on-the-spot training, and **Iraq was in no position to disrupt U.S. and allied supply lines to the Gulf** (SubRev emphasis) ... Saudi Arabia itself was a logistical cornucopia without equal anywhere in the third world."

"Against no other opponent in history has the U.S. military enjoyed so swift and unqualified a success. The Plains Indians put up a better fight against the U.S. Cavalry. All of this suggests that great care should be taken in assessing the more general lessons of Desert Storm. The unique strategic, political and logistical conditions that made Desert Storm such a success may be absent in future crises, and Iraq's military incompetence cannot be duplicated on demand elsewhere. Indeed, our future

adversaries are drawing their own lessons from Desert Storm, and are not likely to be caught as flat-footed as the Iraqi army was in Kuwait."

• Atlanta Constitution, 31 March: Senator Sam Nunn (D-GA) wrote an article entitled "Military Reform Paved Way for Gulf Triumph" in which he cited the effects of recent legislation in streamlining the way that the U.S. military does business. In explaining the reasons for the legislation, he said: "Before 1986, the Defense Department suffered from serious organizational problems. Professional military advice to the Secretary of Defense and the President was sometimes slow and watered down, often the product of a four-service compromise. The military chain of command was confused, with the field component commanders usually looking to their service chiefs in the Pentagon for guidance rather than to the Commander in Chief in the field."

He went on to describe the action which Congress took to remedy that situation: "The 1986 Goldwater-Nichols Act sought to improve military advice to civilian decision-makers by enhancing the position of the Chairman of the Joint Chiefs of Staff. To clarify the chain of command, it mandated that the four services are to train, equip and organize our military forces; however, the operational command of those forces was clearly reserved to the war-fighting commanders."

In discussing the way in which the new law was applied, Senator Nunn said: "...Admiral William Crowe led the way in implementing the new system. The reform with the most significance for Operation Desert Storm was the strengthening of the command and personnel authority of the field commanders." ..."As a result of the Goldwater-Nichols Act, General Schwarzkopf clearly had the authority necessary to carry out his demanding responsibilities."

"Another benefit of the Goldwater-Nichols Act has been its effect on the quality of joint or multi-service staffs," ..."The resulting infusion of high-quality officers was evident in the superb performance of the staffs of General Schwarzkopf and the other joint organizations that participated in the Persian Gulf."

• Navy Times, 8 April: Some specific news of the U.S. submarine involvement in the Gulf War was reported in the press as a result of Vice Admiral Roger F. Bacon's words at the

Navy League's Sea-Air-Space Exposition in Washington. The trade paper reported that "Thirteen U.S. Navy attack submarines played a crucial surveillance role during Operations Desert Shield and Desert Storm..." They went on to detail that participation as: "Before and during hostilities, eight attack submarines were involved in surveillance and reconnaissance operations and provided a warning screen for carrier battle groups as they transited the Mediterranean enroute to the Persian Gulf. Bacon said."

"After hostilities began, five additional submarines operated under the tactical command of Army General H. Norman Schwarzkopf, Commander-in-Chief of U.S. forces in the Gulf. Two conducted submerged submarine-launched cruise missile attacks on Iraq, Bacon said."

Cruise Missiles: The introduction of submarine-launched cruise missiles into actual combat has focused attention on those weapons and on the potential they have for the future of underseas warfare forces.

- Inside the Pentagon, 20 June: reported on the Navy's use of cruise missiles in the Gulf War, citing a 15 May report compiled by the CNO: "The USS LOUISVILLE (SSN-724) fired the first submarine-launched TOMAHAWK cruise missile in combat history on January 19 while submerged in the Red Sea ... The LOUISVILLE fired a total of eight TOMAHAWKs during the integrated air campaign against Iraq, the Navy says. The USS PITTSBURGH (SSN-720), the only other U.S. submarine to fire TOMAHAWKs during the Persian Gulf War, shot off four TLAMs while submerged in the Mediterranean Sea, say sources familiar with the Navy's activities during Operations Desert Shield and Desert Storm. A total of 288 TOMAHAWK land-attack missiles (TLAMs) were successfully launched by the Navy during Operation Desert Storm... Of the 288 missiles fired, six hit the water and never made it to shore, sources say. Additionally, nine TOMAHAWKs never made it out of the missile tubes. Had those firings been successful, the total TLAMs launched during Desert storm would have been 297."
- Defense News, 3 June: published two articles related to the enhancement of Navy cruise missile capability. The first concerns an upgrade of the TOMAHAWK missile and the second refers to an advanced missile development effort.

"Planners in the Pentagon's Joint Cruise Missile Project Office are accelerating efforts to define an improved Block IV version of the TOMAHAWK cruise missile, officials say. Putting the Block IV on a faster track is a result of TOMAHAWK's success in the Persian Gulf War and the demise of the Long Range Conventional Standoff Weapon (LRCSW)." ..."Block IV, however, will not be a second-generation cruise missile, officials say. Instead, it will represent a continuing evolution of the existing TOMAHAWK's capability with an emphasis on increasing the types of targets the weapon can hit, such as relocatable missile launchers. Block IV also will focus on reducing the time required to plan TOMAHAWK missions."

In that same issue, the paper reported that: "Navy researchers are launching a new effort to dramatically improve the capabilities of the next generation of cruise missiles to enhance the future power projection capabilities of U.S. Navy surface ships in low-intensity conflicts. Termed Precision Strike Initiatitve (PSI), the long-term research effort's objective is to assess a variety of guidance and mission planning technologies that can be integrated into future versions of TOMAHAWK cruise missiles or other advanced unmanned strike systems...."

TRIDENT Missiles: On 9 May, Inside the Pentagon speculated on the effect that will be felt due to the shortage of Mk-5/W-88 warheads for the TRIDENT II missile. On 17 May, the Washington Times reported that: "The Navy has decided not to fully arm the long-range ballistic missiles carried aboard some of its new TRIDENT submarines because of a shortage of its most powerful nuclear warheads, military sources said yesterday. Unlike the eight subs in the Pacific Fleet, which are fully armed but with older missiles, the first four subs assigned to the Atlantic Fleet will have fewer than the maximum 192 W-88 warheads each, said the Pentagon sources, who discussed the matter on the condition they not be identified. The Navy's decision, which private analysts say has little or no immediate effect on national security, was forced by a prolonged shutdown of the Rocky Flats weapons plant near Denver that is the only maker of plutonium pits, which form the core of all nuclear warheads."

- The Guardian (UK), 23 April: "The Ministry of Defense has dismissed calls for a halt to the handling and transportation of

British nuclear weapons pending the outcome of an independent safety review. The demand follows an investigation -- The Drell Report -- commissioned by the U.S. Department of Energy, which indicates that the TRIDENT submarine-launched missile and some other American nuclear weapons are more likely to explode accidently than was supposed." *[Ed.'s Note: see April 1991 SUBMARINE REVIEW, In the News, pages 95 & 96].*

Submarine Safety Concerns: As a front page story on both 20 and 21 May, The San Diego Union reported allegations of serious safety concerns among several members of the USS GUARDFISH crew. The Los Angeles Times, on 23 May, reported that the ship had gone to sea on the 21st without the predicted incident of crew members missing movement. They also reported that Greenpeace had held a press conference on the 22nd to further publicize the allegations. The paper also printed the Submarine Group 5 statement calling the allegations unfounded.

In an unrelated issue, Associated Press reported on 30 April that "The Navy has rejected safety recommendations from the National Transportation Safety Board for submarines in coastal waters, the board said Monday. The board made the recommendations after the June 14, 1989 sinking of the tug BARCONA off California after a tow cable was snagged by a submerged nuclear submarine, the USS HOUSTON." Navy Times of 13 May carried a full page report of the incident and the NTSB report.

Unified Command Plan Changes: *[Ed.'s Note: see America's New National Security Strategy, SUBMARINE REVIEW, April 1991].* Defense News of 13 May reported, under the headline "Pentagon Irons Out Plan to Merge Nuclear Forces," that "U.S. Department of Defense officials are preparing a plan that would merge Air Force and Navy nuclear forces into one command responsible for planning, deterring and implementing nuclear war, U.S. military sources say. The new U.S. Strategic Command could combine all three legs of the strategic triad with an Air Force general or a Navy admiral rotating command responsibility for the Navy-operated nuclear submarines and Air Force-operated bombers and land-based missiles, sources say."

Royal Navy Submarines: Defense News of 20 May, in commenting on criticism of the UPHOLDER submarine

program in the UK, reported that "Defense Ministry officials were grilled by the House of Commons Defense Committee last Wednesday over the development of production problems of the new UPHOLDER submarines. Brian Hawtin, Assistant Under Secretary (Materiel/Naval), said "I would not like to pretend it was a total success story." He said HMS UPHOLDER, the first of the four boats to be ordered, was three years late and $70 million -- more than ten percent -- over the original estimate. The in-service dates for the other three boats had slipped between three and 18 months, he said. The major problems have been encountered with the weapon handling and discharge system and the main propulsion system. Trials have revealed that UPHOLDER's torpedo doors cannot be properly shut, allowing water into the tubes. Officials acknowledged the fault is with the original design of the system by the Admiralty Research Establishment and not by the builders. House member Winston Churchill asked last Wedsneday, 'Does it still make sense for the MoD to continue to insist on designing those vessels and large parts of them in-house?'."

On the nuclear submarine side of the RN house the news was about program cancellation. London Times of 26 June reported that "Royal Navy plans to design a new nuclear-powered submarine for the next century have been abandoned for lack of money. An announcement about the death of the proposed SSN-20 submarine is expected early next month." ...."Now the Navy has come up with an alternative -- an ungrading of the TRAFALGER class boat, the Navy's latest generation submarine and one of the quietest in the world. The defense misinstry is expected to order six of the uprated TRAFALGAR class boats from the mid-1990s."

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U-BOAT ACE
The Story of Wolfgang Lüth

ISBN 0-87021-666-X
U.S. Naval Institute, 1990

reviewed by RADM M. H. Rindskopf, USN(Ret.)

"Wer Ga" -- Who goes there? -- "Wer Ga". No response to the sentry's cry. Important, indeed! But that's the end of "U-Boat Ace", not the beginning.

It is coincidental, or perhaps it's the *in thing*, but this is the fourth U-boat treatise I've read in three months. Each is interesting, even gripping, in its own way but each author has an additional message for his readers, beyond a recitation of attacks and counterattacks.

Operation Drumbeat was written by a University of Florida professor of history, Michael Gannon, after some five years of research. It is the story of U-Boat operations off the East Coast of North America during the six months after the United States entered the war. In it Gannon carefully describes the planning which went into DRUMBEAT strategy, the assembly of the force, the deployment of the boats, the final directives from BdU (U-Bootwaffe Command), and the inordinately lucrative results achieved. He does this by riding U-123 with Reinhard Hardegan, the skipper. These operations were rewarding because ... and this is the author's added message ... the U.S. was woefully remiss in developing an effective ASW strategy to protect the tankers and other coastwise shipping until months and months had elapsed. He names names, and does not spare Admirals King, Stark, Low, Andrews, and more.

Gannon discusses actions of many other U-Boat skippers who comprised the DRUMBEAT forces. He included two references to Hardegan's friend, Wolfgang Lüth -- one related to Lüth's strict rules for upholding crew morale at sea; and the other on the final page of the story itself.

In sum, Gannon gets high marks for realism in putting the reader on the bridge in heavy weather, wet through after five minutes of the mid-watch; and for his re-creation of the tension of depth charging. He spent many hours with Reinhard

Hardegan, including a PR tour of the U.S. to sell the book, and with several members of the crew of U-123. He tells the story from the submariner's viewpoint.

Slide Rules and Submarines by COL Montgomery C. Meigs, USA, approaches World War II submarine warfare from a different direction. It is ably summarized in the January 1991 SUBMARINE REVIEW by Lt. Daphne Kapolka, USN, now at the PG School. It is less a re-telling of the U-Boat overall campaign or its massive efforts against convoys, or the exploits of one or more individual skippers. Rather its message is the relationship of scientists to the tactics and hardware which were offered to the Submarine Force. In passing, Meigs criticizes the rigidity of the Navy ASW high command, though not quite so forcefully as Professor Gannon.

The U-Boat War in the Atlantic 1939-1945 adds yet another dimension to the complete story. This three volume work was analyzed well by Captain Charlie Rush in the April 1990 SUBMARINE REVIEW. It is a German analysis of the U-Boat war from German sources alone. However, with the assistance of such as Jurgen Rohwer (he of Axis Submarine Successes 1939-1945, SUBMARINE REVIEW January 1984), this document contains excruciating detail from Patrol #1 on 21 August 1939 to the surrender of the 43 U-Boats at sea on 8 May 1945. Accompanying this narrative is an unbelievably complex series of 32 diagrams from which the operations of *every* U-Boat can be traced from base to sea and back (or sunk). In addition, the pertinent operational areas are depicted with U-boat and convoy dispositions minutely shown. It is all there for the reader to spend as much time and effort as he chooses to compare the German analysis with others such as presented in U-Boat Ace.

U-Boat Ace is the story of a hero of the Kriegsmarine U-Bootwaffe, Wolfgang Lüth. It follows him from his enlistment to the end of his career. The author, Jordan Vause, is a 1978 graduate of the Naval Academy who spent time in destroyers, resigning as a Lieutenant(jg).

Vause selected Lüth because he achieved tonnage sunk second only to Otto Kretschmer; he was one of only two U-boat skippers to be awarded the Third Reich's highest honor, the Knight's Cross with Oak Leaves, Swords, and Diamonds; he was unique in his approach to his crew and leadership; and finally,

because he was one of the few Naval officers who openly professed Nazism.

Vause used typical sources in his research -- ships logs, German U-boat records, some British corroborating data, and interviews with surviving members of the four boats commanded by Lüth. His best source was Theodore Petersen who joined Lüth in U-9 as *Obersteuermann* (clearly the Chief of the Boat although Vause does not equate these titles), and stayed with him in U-138, U-43, and U-181, finally commanding two of his own boats.

Inasmuch as Lüth made 16 war patrols, and was credited with 47 sinkings, U-Boat Ace contains almost too many descriptions of tracking and firing at his many targets. The reader is left with the strong impression that Lüth was dogged in his effort to excel, that he trained his crews meticulously, that he was conservative under some situations with respect to the expenditure of torpedoes, and seemingly reckless in others. But, once he had engaged, he was reluctant to let any quarry get away.

Vause goes to considerable length to describe several sinkings wherein Lüth took great pains to ensure that the survivors were given a fair chance to reach safety, even delivering one crew to a neutral American ship. Then, in contrast, there are a few occasions where Lüth apparently *lost his cool* and poured literally hundreds of shells into burning, sinking hulks giving the crews no chance of survival. There is speculation for this behavior, but no clear conclusions.

His leadership qualities spread far beyond the submarines he commanded. He achieved fame for leadership lectures which were thereafter widely quoted within the Kriegsmarine. He was loved by his crews because he cared for them. He was solicitous of the welfare of the families, and strove to convince the men to avoid the ladies of the night and instead marry and beget children. He recognized the relationship of morale to success at sea -- and devised means of keeping his men alert with team games, chess, poetry, taped music, contests, special food, and even *leave on board* especially during transits. (I pursued the same morale building ideas during 11 patrols in DRUM, and I believe that many another U.S. submariner, and German, as well, did the same thing.) However, when we realize that Lüth spent 203 days at sea transitting from a

French port to Madagascar and environs and back, refueling once, on his last patrol, we can understand his appreciation of the worth of *fun and games.*

Lüth was a professed Nazi. The impact upon his performance is questioned in the introduction and elsewhere. Yet, aside from the occasional aberrations of his performance, his pressure on his crews to marry and have children, and one incident of anti-semitism, I find little to suggest that he would have acted otherwise had he not been a party member.

The story of successful patrols, and the rewards which were bestowed upon Lüth, is the dominant thread of the saga. However, as with wartime submarining in every Navy, there were patrols which were curtailed by mechanical problems, patrols to unpromising areas, assignment to weather reporting or mining, and tours with the Training Command in the Baltic. But the bitterest pill Lüth had to swallow was the sinking of U-43 in port while the officers and most of the crew were on R&R. He was dressed down by Donitz to his embarrassment, and was *off-the-line* for more than three months. U-43, somehow without new batteries, was never the same again.

So, a submariner's premier job came to an end on 11 November 1943 (exactly one year to the day prior to my departure from DRUM), when Lüth bid farewell to U-181 and his crew. Donitz had lost Prien and Kretschmer, but he could not lose Lüth.

Six months with the Flotilla in Bordeau, and another similar period in command of the Training Flotilla in Memel led to Lüth's assignment to the staff of the Marinekriegschule. After his promotion at 30, as the youngest 4-striper in the Navy, he became Commandant. Only ten years out of the school, he took the challenge of producing naval officers deeply to heart since he realized it was all but impossible to save his beloved Kriegsmarine.

On 14 May, 1945, the sentry at the north-eastern corner of the school perimeter cried out for the third time *"Wer Ga."* No response. One shot rang out in the night.

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SUBMARINE DIARY

by Admiral Corwin Mendenhall, USN(Ret.)
Algonquin Books of Chapel Hill, 1991
ISBN 0-945575-34-3

reviewed by Larry Blair

Beginning in the late 40's books began to appear relating the shoot-'em-up, macho aspects of undersea battle during World War Two. The drama of depth charging and fascinating tales of underwater/surface action brought home to the reader the realities of what had gone on out there in the far flung Pacific Theater. Authors like Roscoe, Cope and Karig, Lockwood and Beach told of all the brave, young seawolves who were instrumental in bringing the Japanese Empire to its knees. More recently we have seen treatises by skippers who related their own individual experiences: O'Kane, Gugliotta, Davenport, Galantin, Enright and Schratz.

Now the latest book on "big" war submarining has been introduced by Admiral Mendenhall. From December 8, 1941, serving as an ensign aboard USS SCULPIN (SS-191) in Manila, three and a half years would pass before he arrived in Alameda, California, having done his job in the war. During that time "Mendy" was to work his way up the ladder of rank and duty aboard SCULPIN for seven patrols and four more as exec on USS PINTADO (SS-387).

What makes this book shades different from the other volumes is the author's human and philosophical approach to what went on around him. If the reader is looking for a pure blood and guts story, this is not the book for you. This is an insight into the minds and foibles of those with whom he served, from the lowest enlisted man up to the brass in COMSUBPAC. For those who served on submarines then, and who do so now it will come as no surprise the various personality differences and quirks shipmates have. To the lay person however, reading this diary might astonish them to know that submariners have the same frailties as any ordinary Joe. They are not super-human as seen in movies or read about in books. Throughout his narrative, "Mendy's" insight into people and situations is expressed in a down-to-earth fashion. Whether it be below deck, on the bridge or in a rest camp between patrols, a word picture is painted of men under constant stress. Men of

discipline or lack of it. Men of binding faith and resoluteness. Men with hope, fear, joy and sorrow and their own ways of dealing with those feelings. It is said that airline pilots spend hours of unrelenting boredom, interspersed by minutes of sheer terror. An apt description portrayed in this work.

Here are stories of officers and crew suffering from nervous break-downs, seasickness and other physical ailments, infractions of duty with attendant penalties, poor food, water and air quality and the always prevalent personal hygiene problems. Many of these were made more palatable on later fleet boats such as the author's second sub, the PINTADO. Infamous torpedo problems which existed during the first two years of the war are dealt with. The on-the-scene quick fixes instituted by SCULPIN's intuitive skipper is an interesting dialogue which shows the utter frustration and anger felt by many captains.

The author's personal relationships with family, friends, wife and submates permeate 290 pages filled with earthy slices of life. Life that seemed suspended in a surreal existence. The roster of characters and names pass before you as ships in the night. Some last out the war, others disappear into eternity.

"Mendy's" quest for command was not to materialize until after the war. This pervasive and poignant aspect rears its ugly head many times. Whether this was by his captain's design, Navy bureaucracy or command politics can only be conjecture. Undoubtedly you will form your own opinion half way through PINTADO's four patrols. To quote Corwin Mendenhall, "My eternal optimism, ingrained respect for the Navy and my ship, and deference to authority pulled me through."

SUBMARINE DIARY was published at a most propitious time. December 7, 1991, marks the 50th anniversary of our entry into World War Two. A terse message flashed to all Pacific subs which till this day rings like an anvil to all who served, "Japan has attacked Pearl Harbor, govern yourself accordingly." This represents a fitting tribute to all who went in harms way under the sea in boats.

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REUNIONS

USS TRITON (SSR(N) 586)

All crewmenbers are notified of a reunion to be held August 2, 3 and 4, 1991, at the Groton Motor Inn, Groton, CT.

Please contact: TRITON Reunion
P.O. Box 991
Groton, CT 06340

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USS CLAMAGORE (SS-343)

24, 25, 26, and 27 October, 1991
Charleston, South Carolina

Please contact: Jim Storms
3029 Thrush Drive
Melbourne, FL 32935
(407) 254-9223

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50th Anniversary of the Attack on Pearl Harbor
SUBMARINE FORCES OF WW II
To be honored at a large commemorative ceremony
7 December, 1991 -- at 1730
Bowfin Park, Honolulu, Hawaii

We expect to pay tribute to both the enlisted and officer personnel who contributed to our victory in WW II, and who have later served our nation to give us such super attack and deterrent submarines that are the envy of the world.

All NSL members are invited to attend if they are planning to be in Honolulu at that time.

Please Contact: Robert L. Tanner, President
Pacific Fleet Submarine Memorial Asso.
11 Arizona Memorial Drive
Honolulu, HI 96818
(808) 423-1341

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Proposed Reunion of
USS THOMAS A. EDISON (SSBN-610)
Spring of 1992

This ship has never held a reunion and is now decommissioned. The widest dissemination of the proposed reunion is crucial in reaching as many past crew members as possible.

also

USS JOHN C. CALHOUN (SSBN-630)
VETERANS ASSOCIATION

Is planning a reunion to be held from 30 July to 2 August, **1992** in Charleston, SC.

Jack Ensminger is organizing both of these meetings.

Please contact: J. B. Ensminger
P.O. Box 174
Waynesboro, PA 17268-0174

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USS JACK (SS-259/SSN-605) ALUMNI ASSOCIATION
is
Searching for former crew members

Please contact: Mr. Patrick Kerrigan
8300 South Springfield Avenue
Chicago, IL 60652-3247

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NAVAL SUBMARINE LEAGUE
HONOR ROLL

BENEFACTORS FOR FIVE OR MORE YEARS

1. ALLIED-SIGNAL AEROSPACE COMPANY
2. AMERICAN SYSTEMS CORPORATION
3. ANALYSIS & TECHNOLOGY, INC.
4. ARGOSYSTEMS, INC.
5. ATLANTIC RESEARCH CORPORATION, DEFENSE SYSTEMS DIV.
6. BABCOCK AND WILCOX COMPANY
7. BATTELLE MEMORIAL INSTITUTE
8. BENDIX OCEANICS INC.
9. BIRD-JOHNSON COMPANY
10. BOEING AEROSPACE COMPANY
11. BOOZ-ALLEN & HAMILTON, INC.
12. DATATAPE, INC.
13. EDO CORPORATION
14. EG&G, WASHINGTON ANALYTICAL SERVICES CENTER, INC.
15. ELECTRIC BOAT DIVISION OF GENERAL DYNAMICS
16. ELIZABETH S. HOOPER FOUNDATION
17. ERIE FORGE AND STEEL (Formerly National Forge)
18. FMC CORPORATION
19. GE AEROSPACE
20. GNB INDUSTRIAL BATTERY COMPANY
21. GTE GOVERNMENT SYSTEMS CORPORATION
22. GENERAL DYNAMICS/ELECTRIC BOAT DIVISION
23. GENERAL ELECTRIC MARINE & DEFENSE FSO
24. GENERAL ELECTRIC OCEAN & RADAR SYSTEMS DIVISION
25. GENERAL PHYSICS CORPORATION
26. GLOBAL ASSOCIATES, LTD.
27. HAZELTINE CORPORATION
28. HUGHES AIRCRAFT COMPANY
29. IBM CORPORATION, FEDERAL SECTOR DIVISION
30. KAMAN DIVERSIFIED TECHNOLOGIES CORPORATION
31. KOLLMORGEN CORPORATION, E-O DIVISION
32. LIBRASCOPE CORPORATION
33. LOCKHEED CORPORATION
34. LOCKHEED SANDERS INC. (formerly Sanders Associates, Inc.)
35. LORAL CONTROL SYSTEMS
36. LORAL DEFENSE SYSTEMS - AKRON
37. NEWPORT NEWS SHIPBUILDING
38. NORTHROP CORPORATION
39. PRC, INC. (Formerly Advanced Technology)
40. PACIFIC FLEET SUBMARINE MEMORIAL ASSOCIATION
41. PRESEARCH INCORPORATED
42. PURVIS SYSTEMS, INC.
43. RAYTHEON COMPANY, SUBMARINE SIGNAL DIVISION
44. ROCKWELL INTERNATIONAL CORPORATION
45. SAIC
46. SCIENTIFIC ATLANTA, GOVERNMENT PRODUCTS DIVISION
47. SIPPICAN, INC.

48. SPERRY MARINE, INC.
49. TITAN SYSTEMS, INC.
50. TREADWELL CORPORATION
51. VITRO CORPORATION
52. WESTINGHOUSE ELECTRIC CORPORATION

ADDITIONAL BENEFACTORS

1. ADI TECHNOLOGY CORPORATION
2. AT&T
3. ALLIANT TECHSYSTEMS
4. APPLIED MATHEMATICS
5. ARETE' ASSOCIATES
6. BELL AEROSPACE TEXTRON
7. BINGHAM GROUP, INC.
8. CAE/LINK TACTICAL SIMULATION
9. COMPUTER SCIENCES CORPORATION
10. CORTANA CORPORATION
11. DSDJ, INC.
12. DEFENSE - MARINE MARKETING, INC.
13. DIAGNOSTIC/RETRIEVAL SYSTEMS, INC.
14. EG&G SEALOL ENGINEERED PRODUCTS DIVISION
15. ESL INCORPORATED
16. FOSTER-MILLER, INC.
17. GENERAL DYNAMICS/UNDERSEA WARFARE
18. HYDROACOUSTICS, INC.
19. INTEGRATED SYSTEMS ANALYSTS, INC.
20. INTERSTATE ELECTRONICS CORPORATION
21. KPMG PEAT MARWICK
22. MARTIN MARIETTA AERO & NAVAL SYSTEMS
23. MCQ ASSOCIATES, INC.
24. NOISE CANCELLATION TECHNOLOGIES, INC.
25. PAC ORD INC.
26. PHYSICAL DYNAMICS INC.
27. PLANNING SYSTEMS INCORPORATED
28. RADIX SYSTEMS, INC.
29. RIX INDUSTRIES
30. SARGENT CONTROLS
31. SEAKAY MANAGEMENT CORPORATION
32. SIGNAL CORPORATION
33. SOFTECH, INC,
34. SONALYSTS, INC.
35. SPACE & MARITIME APPLICATIONS CORPORATION
36. STONE AND WEBSTER ENGINEERING CORPORATION
37. SYSCON CORPORATION
38. SYSTEMS PLANNING & ANALYSIS, INC.
39. TASC, THE ANALYTIC SCIENCES CORPORATION
40. TECHNAUTICS CORPORATION (formerly Argo-Tech)
41. TRIDENT SYSTEMS, INC.
42. UNIFIED INDUSTRIES, INCORPORATED

PATRONS

GEORGE S. ZANGAS

NEW SKIPPERS

RADM JOHN M. KERSH, USN(RET.)

NEW ADVISORS

DR. KARL L. DREWS

NEW ASSOCIATES

CAPT F. W. LACROIX, USN
RICARDO CELI
LT SAMUEL J. DAVY, USNR(RET.)
ENS ANDREW B. GENTRY, USN
CASIMIR KROLASIK, JR.
PHILIP B. GUSTAFSON
LCDR PAUL F. HEALY, USN
LCDR MITCHELL N. SHIPLEY, USN
CAPT KEITH P. GARLAND, USN(RET.)
LCDR NORMAN P. ELTRINGHAM, USN(RET.)
WEBSTER F. SMITH
MM2(SS) DOUGLAS E. BUTLER, USN
LCDR DOUGLAS A. HOCKING, USN
MMC(SS) WARREN TAYLOR, USN
RADM PAUL D. TOMB, USN(RET.)
VADM CHARLES H. GRIFFITHS, USN(RET.)

Naval Submarine League
Balance Sheet
at March 31, 1991

Assets		
Current Assets:		
Cash	$169,501	
Short Term Investments	60,000	
Accounts Receivable	900	
Prepaid Expenses	4,290	
Total Current Assets		$234,691
Fixed Assets:		
Equipment, Furniture and Software	45,277	
Less Depreciation	(30,305)	
		14,972
Office Condominium	251,021	
Less Depreciation	(8,180)	
		242,841
Total Fixed Assets		257,813
Total Assets		$492,504
Liabilities and Fund Balance		
Current Liabilities		
Deferred Income	$138,530	
Deferred Membership Dues	32,768	
Rental Deposit	675	
Mortgage Principal	8,000	
Total Current Liabilities		$179,973
Long Term Liabilities		
Deferred Membership Dues	$63,353	
Mortgage Principal	18,517	
Total Long Term Liabilities		$81,870
Total Liabilities		$261,843
Fund Balance		
Reserved	$15,000	
Unreserved 215,000		
Total Fund Balance		230,661
Total Liabilities & Fund Balance		$492,504

Speaker Package Contents

July 1991

Presentations:

1. U. S. FLEET - SUBMARINE NAVY (with slides)
2. SUBMARINE ARCTIC OPERATIONS (with slides)

Video:

1. SUBMARINE: Steel Boats, Iron Men (55 min version)
2. SUBMARINE: Steel Boats, Iron Men (18 min version)

Background Material:

- OP-02 Statement before HASC Subcommittee on Sea Power Mar 91 (VADM BACON)
- OP-02 White Paper, 24 May 1990 (VADM COOPER)
- OP-02 Address to 8th Annual NSL Symposium 14 June 1990 (VADM COOPER)
- SEAWOLF Program, NAVSEA PMS 350
- FBM Facts/Chronology - Polaris, Poseidon, Trident
- FBM...the first thirty years
- The Nuclear Navy 1955-1965
- The Deep Questions, Ensign Jay M. Cohen, USN
- A Portfolio on Submarines, J. Cohen
- Newspaper Releases for possible use with younger audiences

Viewgraphs:

1. Attack Submarine Missions
2. Nuclear Power Plant

Loan copies of the Speaker Package, including back-up material and the videos are available from NSL Headquarters.
Call (703) 256-0891 to borrow the package.

NAVAL SUBMARINE LEAGUE

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